Global Farming Systems Study:

Challenges and Priorities to 2030

REGIONAL ANALYSIS
LATIN AMERICA AND THE CARIBBEAN

A. Gulliver, J.C. de Grandi, C. Spehar and G. Majella

The Global Farming Systems Study was conducted by FAO under the overall coordination of S. Funes (Director, Rural Development Division) and the technical leadership of J. Dixon (Senior Officer, Farming Systems, Farm Management and Production Economics Service, Agricultural Support Systems Division) and A. Gulliver (Economist, Investment Centre Division). The Study benefited from the guidance of D. Forbes Watt (Director, Investment Centre Division), J. Monyo (Director, Agricultural Support Systems Division), D. Baker (Chief, Farm Management and Production Economics Service, AGS) and A. MacMillan (Principal Adviser, Project Advisory Unit, TCI) in FAO and of C. Csaki (Senior Advisor/Team Leader-Rural Strategy) and S. Barghouti (Research Advisor) of the Rural Development Department, World Bank.

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Preface

For more than a decade, the proportion of internationally supported public investment directed at agriculture and the rural sector in developing countries has been declining. In the year 2000, World Bank commitments to the rural sector reached their lowest ever levels, measured as a proportion of their total lending portfolio. Moreover, this has occurred at a time when the process of globalisation is bringing about profound changes in patterns of trade and investment, placing agricultural producers and rural communities, more generally, under tremendous pressure to adapt to changing circumstances. Nor is there any evidence of significant progress in reducing the incidence of hunger. In order to reinvigorate its efforts aimed at poverty reduction and sustainable growth among rural populations, the World Bank initiated in 2000 a review of its rural development strategy[1].

As part of this review, the World Bank sought the assistance of the Food and Agriculture Organization of the United Nations (FAO) in evaluating how farming systems might change and adapt over the next thirty years. Amongst other objectives, the World Bank asked FAO to provide guidance on priorities for investment in food security, poverty reduction, and economic growth, and in particular to identify promising approaches and technologies that will contribute to these goals. The identification of future changes affecting farming systems relied heavily on work undertaken in FAO over many years in monitoring trends affecting agricultural production and assessing their likely implications for future output, productivity and nutrition levels.[2]

The global study commenced with the delineation and characterisation of about 70 major farming systems encompassing all developing regions of the world. As existing data systems are based, almost without exception, on national and sub-national administrative areas, while farming systems cross national and even regional boundaries, it was necessary to re-estimate and re-analyse a wide variety of data relating to system characteristics, including physical, social, economic, demographic and environmental parameters. This analysis provided the necessary quantitative underpinning for the central, qualitative, task of developing expert judgements on the future evolution of farming systems and their developmental priorities. In all, the study encompassed the contributions of over 40 specialists in a range of disciplines, both within and outside of FAO, and took into account comments from many others.

Although any specific farming system embraces considerable heterogeneity, the diagnosis of the dynamics, constraints and opportunities of typical farm households contributes to the identification of interventions to improve system performance and sustainability. Therefore, the farming systems presented in this study are considered to provide an effective broad framework for the prioritisation of development actions and investments for accelerating agricultural development, particularly in ways which can reduce rural poverty and hunger.

The results of the study are summarized in a set of seven documents, comprising six regional reports and a global overview. This document, prepared for the Consultation on the draft Latin America and Caribbean Rural Development Strategy, summarises the analysis and strategic priorities for the reduction of rural poverty and improvement of food security through farming systems development in the region. This document is supplemented by case study reports of successful development initiatives in the region.

S. Funes,
Director,
Rural Development Division,
Sustainable Development Department,
Food and Agriculture Organization.

[1] "Rural Development: From Vision to Action". World Bank, Washington D.C., 1997.
[2] Most recently in "Agriculture: Towards 2015/30. Technical Interim Report" Global Perspective Studies Unit, FAO, Rome, April, 2000.

Table of Contents

Aidan Gulliver is an Agricultural Economist with the Project Advisory Unit, Investment Centre Division, FAO, Rome, Italy.

Juan Carlos de Grandi is an independent consultant, based in Buenos Aires.

Carlos Spehar is Project Leader with Embrapa Cerrados, Planaltina, DF, Brasil.

Geraldo Majella is an agricultural researcher with Empresa Pernambucana de Pesquisa Agropecu·ria – IPA, Recife, Brasil.

The Study benefited from discussions at a series of FAO seminars, working sessions and video conferences. In particular, the contributions and editing of I. Tsakok (World Bank), J. Dixon and P. Santacoloma (Agriculture Department), S. Funes and A. Herrera (Sustainable Development Departmet), and R. Brinkman and M. Hall (Consultants) have enriched the document. The comments of FAO staff of the Agriculture Department (T. Bachman, C. Batello, E. Kueneman, M. Porto, J. Poulisse and S. Reynolds), Economic and Social Department (J. Schmidhuber and K. Stamoulis) and Technical Cooperation Department (P.Lucani) and the regional rural strategy update team in the World Bank are gratefully acknowledged -- any remaining errors are the responsibility of the Study team.

1 Introduction

CHARACTERISTICS OF THE REGION

Stretching from latitude 29° North on the Mexican border to 56° South at the tip of Tierra del Fuego, the Latin America and the Caribbean region (LAC – as defined by the World Bank) covers some 20.5 million km^2 and encompasses 42 countries with a total estimated population in 2000 of 505 million[3]. The size of the region, and its enormous variation in ecological conditions, combined with its relatively low population density (25 persons/km^2) and high rates of urbanisation (75 percent) have permitted the development and preservation of an extremely high level of biodiversity. According to UNEP[4], five of the ten richest countries in the world in terms of biodiversity are in LAC, and the region contains 40 percent of the plant and animal species of the world's tropical forests and 36 percent of the main cultivated food and industrial species. The world's largest unfragmented tropical forest is found in the Amazon basin, and the region possesses 28 percent of the world's forest area – 10 million km^2 in 1994.

LAC possessed some 160 million ha of agricultural land[5] in 1999, equal to 14 percent of the total within the developing world. This represents an increase of 47 percent since 1961, but is still only 18 percent of the estimated potential of the region[6]. An estimated 18.3 million ha of this agricultural area is under irrigation, with a further 600 million ha under grazing and pastureland. Part of this abundance stems from the region's relatively favourable agro-ecological conditions; 40 percent of the developing world's humid areas are to be found in LAC, in contrast to only 4.2 percent of the arid and semi-arid lands. Humid and sub-humid lands account for over 90 percent of the LAC land area. This abundance is further demonstrated when water resources are considered. The region accounts for 48 percent of the total renewable water resources in the developing world. Based upon irrigated area and water use efficiency, it is estimated that no more than one percent of the available water in LAC is currently utilised[7].

Despite a relatively low cropping intensity of only 64 percent[8], LAC is globally important in a number of crops and, for these crops, often achieves yields significantly above the developing world average (see: Table 1 below). During the period 1995-97, however, LAC had an annual net trade deficit in cereals of 16 million tonnes – equivalent to a self-sufficiency ratio of 90 percent. LAC also has a net deficit in dairy products of 6.3 million tonnes per year, but it is the only region in the developing world with a trade surplus in livestock products as a whole.

With an average per capita GNP of US$3 940 in 1998, LAC is the wealthiest of the developing regions of the world, and also the least dependent on agriculture – only 8 percent of GDP was derived from the sector in 1998. As growth in agricultural value added is lower than for industry or services, that share is likely to continue declining. Furthermore, FAO nutritional data indicate that the average LAC diet contains 2 791 calories, 6 percent higher than the average for

[3] World Urbanization Prospects – 1999 Revision. UN Population Division.
[4] Global Environment Outlook – On-line document at : www.grida.no/prog/global/geo1/ch/ch2_9.htm.
[5] Arable plus permanent crop areas.
[6] AT 2030 Interim technical report, FAO, Rome, April 2000
[7] ibid
[8] Cropping intensity (CI) is the ratio of total harvested area of crops to the area of arable land. If land is left fallow CI may be below 100 percent, while multiple harvests (e.g winter and summer crops) may result in CIs over 100 percent

all developing countries and 120 percent of the required minimum daily allowance[9]. The ECLAC per capita food index rose by 15 percent over the period 1980-97[10].

Nevertheless, serious problems of equity exist. Not only do the wealthy control one of the highest proportions of resources of any region in the world[11], but there is also a strong urban bias. According to 1997 estimates by CEPAL[12], 54 percent of rural households in the region were classified as poor, against only 30 percent from urban areas. Extreme poverty affected 31 percent of rural households but only ten percent of urban ones. In total, 47 million rural inhabitants were classified as being in extreme poverty, and a further 78 million are in poverty.

Internationally comparable poverty data vary extensively for those countries studied within the region – from fewer than two percent of the population with an income of under US$1/day in Uruguay (1989 data) to 40 percent in Guatemala and Honduras[13]. Equity problems are particularly evident in respect of land distribution, with LAC historically possessing some of the highest GINI (inequity) coefficients in the world: reaching over 0.9 in Peru, Paraguay and Venezuela and close to those levels in Colombia and Brazil[14].

MAJOR REGIONAL FARMING SYSTEMS[15]

Due to its enormous latitudinal range, varied topography and rich biodiversity, Latin America and the Caribbean has the most diverse and complex range of farming systems of any region in the world. Fifteen major systems have been defined for the purposes of this study, divided into four principal agroecological categories. Several of these systems have clearly identifiable, although not geographically separate, subsystems. Even this number, however, could easily be expanded: in the Andean cordillera alone at least six separate systems could be defined. The 15 major farming systems are presented graphically in the opening Map, and summarised in Table 2 below.

Irrigated Farming System – This farming system is the most fragmented geographically within the region and covers a total of 1.65 million km^2, principally across Northern and Central Mexico and coastal and inland valley areas of Peru and Chile. The approximately 5 million ha of cultivated land is almost entirely irrigated, allowing intensification of production – generally commercially oriented – and supporting an agricultural population of almost 9 million.

Table 1: Comparative Performance and Importance of LAC Crop Production

Crop	Area		Yield		Production	
	LAC (000 ha)	% of ADC	LAC (t/ha)	% of ADC	LAC (t 000)	% of ADC
Maize	29.083	30	2,5	96	73.972	29
Rice	5.618	23	3,2	126	18.109	30
Wheat	8.661	8	2,4	92	20.464	7
Sugar Cane	8.403	46	62,8	104	527.860	47
Banana	1.205	33	19,7	132	23.771	43
Citrus	1.999	27	17,4	198	34.734	52
Soybean	18.941	51	2,2	129	40.810	64
Sunflower	3.312	43	1,8	138	5.876	59
Cacao	1.583	26	0,4	80	592	21
Coffee	5.603	53	0,6	120	3.380	58

ADC: All developing countries. Source: FAOSTAT, 1998.

[9] AT2030 data. FAO estimates that, for those engaged in moderate levels of activity, a food intake of 2,000-2,300 kcal/day is the minimum requirement. It should be remembered that these intake levels are averages, actual intake will vary widely by income group, location, etc.

[10] Statistical Yearbook 1999, Economic Commission for Latin America and the Caribbean, Santiago, Chile

[11] World Bank data show Brazil to have the highest income disequality in the world (47.9 percent controlled by the top 10 percent of the population), and that 11 of the 20 most inequitable countries in the world are in LAC.

[12] Cited in "Opciones para reducir la pobreza rural en América Latina y el Caribe' Rubén Echevarria, Revista de la CEPAL 70, April 2000.

[13] World Development Report 2000/2001. Table 2.7

[14] Unpublished data prepared by Klaus Deininger, World Bank. Data vary from 1960s to 1990s.

[15] Almost no data exists wirth respect to individual farming systems and most sources are decomposed only to national or first adminsitrative level. Frequently, contradictions exist at the local level between data from different sources. Data provided in this study on individual farming systems has attempted to reconcile these contradictions and, in addition, has used extensive expert judgement from within FAO and elsewhere in preparing estimations. However, numbers related to farming systems must be viewed as provisional at this time.

Table 2: Major Farming Systems in Latin America and the Caribbean

Farming Systems	Land area (percent of region)	Agric Popn[a] (percent of region)	Principal Livelihood[b]	Incidence of Poverty	Potential for poverty reduction	Potential for agric. growth
Irrigated	9	8	horticulture, fruit, cattle	Low/ Moderate	Low	Moderate
Forest-Based	30	9	subsistence/cattle ranching	Low/ Moderate	Moderate	Moderate/ High
Coastal Plantation and Mixed	9	18	export crops/ tree crops, fishing, tubers, tourism	Low/Severe (highly variable)	Moderate	Moderate
Intensive Mixed	4	9	coffee, horticulture, fruit	Low (except labourers)	Low	Moderate
Cereal-Livestock (Campos)	5	6.5	rice & livestock	Low/ Moderate	Moderate	Moderate/ High
Maize-beans (Mesoamerica)	3	11.5	maize, beans, coffee, horticulture	Severe/ Very Severe	Moderate/ High	Low/ Moderate
Extensive Mixed (Cerrados & Llanos)	11	8.5	livestock, oilseeds, grains, some coffee	Low/ Moderate (smallholders)	Low (in system)[c]	High
Intensive Highlands Mixed (N. Andes)	2	3.5	vegetables, maize + coffee, cattle / pigs, cereals, potatoes	Low/Severe (high altitudes)	Moderate/ High	Moderate
High Altitude Mixed (C. Andes)	5	5.5	tubers, sheep, grains, llamas, vegetables	Severe/ Very Severe	Moderate	Low
Mediterranean Mixed	2	2	wheat, olives, horticulture, fruit	Low	Low	Low
Temperate Mixed (Pampas)	5	6	livestock, wheat, soybean	Low	Low	Moderate
Extensive Dryland Mixed (Gran Chaco)	3	1.5	livestock, cotton, subsistence crops	Moderate	Low/ Moderate	Moderate
Dryland Mixed	6	9	livestock, maize, cassava, labour	Severe/Very Severe (drought)	Moderate	Low
Pastoral	3	<1	sheep, cattle	Low/Moderate	Low	Low
Sparse (forest)	3	<1	sheep, cattle, forest extraction, tourism	Low	Low	Low

Priority systems for poverty reduction and/or growth are shaded.

[a] Agricultural populations are defined as those working in farming, forestry or fishing and their dependants
[b] A slash (/) in the livelihoods column indicates distinct sub-systems.
[c] The Frontier Tropical Savanna farming system may have considerable potential for poverty reduction for immigrants from other high-poverty systems.

Forest Based Farming System – Centred on the Amazonian basin and covering approximately 6 million km^2, or 30 percent of the total land area of LAC, this system comprises scattered indigenous and low-input settler agricultural activity, interspersed with extensive beef and occasional plantation farming – especially towards the margin of the area. Cultivated area is 1.4 percent, with negligible irrigation. Population density is very low; under three persons/km^2.

Coastal Plantation and Mixed Farming System – This system covers 1.86 million km^2, and has an estimated agricultural population of 20 million. There are an estimated 20 million ha of cultivated land of which 13 percent is irrigated. The system occupies some of the richest agricultural lands in the region, but also includes mangrove swamps and isolated areas of tropical forest. There are two major sub-systems: (a) small-scale family farms with mixed agriculture, in-shore fishing and frequent off-farm employment (e.g. tourism); and (b) large-scale plantations, typically export-oriented and often internationally owned, with intensive production and significant poverty among labourers.

Intensive Mixed Farming System – Centred on East-Central Brazil, this intensive mixed agricultural system represents the heartland of Brazilian agriculture, and occupies an estimated 0.81 million km^2 with an agricultural population of almost 10 million. There are approximately 13 million ha of cultivated land, of which about 8 percent is irrigated. Coffee, horticulture and fruit are important products. Poverty levels are relatively low in this system.

Cereal-livestock (Campos) Farming System – The Campos represent a gradation in moisture, and often soil quality, from the intensive system described above. Covering just over 1 million km^2 in S. Brazil and N. Uruguay, the system has an estimated rural population of about seven million, and is strongly oriented to livestock and rice production. There are an estimated 17.5 million ha of cultivated land, of which 10 percent is irrigated. Poverty is low to moderate.

Maize-Beans (Mesoamerican) Farming System – Stretching from Central Mexico to the Panama Canal and with an estimated agricultural population of about 13 million – with a substantial indigenous population – this system covers 0.65 million km^2 and is based upon the production of maize and beans for subsistence. Although there are more than 2.4 million ha of irrigation within the system, the historical loss of better valley lands has led to widespread and severe poverty and serious land degradation in many areas.

Extensive Mixed (Cerrados and Llanos) Farming System – Covering the enormous wooded and open savannah areas of Central Western Brazil and E. Colombia, Venezuela and Guyana, this system encompasses 2.3 million km^2 and has an agricultural population of over 9 million. There are an estimated 31 million ha of cultivated land, with little more than 1 percent irrigated. Only recently starting to become intensively developed, this frontier system offers enormous potential for future agricultural growth in livestock, cereals and soya, among other crops. Poverty is relatively low, although higher among landless immigrants.

Intensive Highlands Mixed (Northern Andean) Farming System – Covering 0.43 million km^2 and with an agricultural population of 4 million, this system contains two distinct sub-systems, generally differentiated by altitude: (a) the well-developed intermontane valleys and lower slopes – the heartland of Andean coffee and horticultural production; and (b) the highlands and upper valleys where temperate crops, maize and pigs predominate and where the traditional indigenous culture is strongly established. Total cultivated area is estimated at 4.4 million ha and some 20 percent is irrigated. Poverty is generally moderate in the lower areas, but severe at higher altitudes.

High Altitude Mixed (Central Andean) Farming System – Again divided into two distinct sub-systems, the Central Andean system covers 1.1 million km^2 and has a total agricultural population of over 6 million. Through most of Peru the system occupies the steep valleys of the high Sierra, while from Southern Peru through Western Bolivia into Northern Chile and Argentina, the altiplano is the predominant landform. Throughout the zone the key characteristics are production at an altitude of more than 3 200 m., a dependance on indigenous grains, potatoes, sheep and llamas, and a very strong indigenous culture. Where altitude and moisture permit, the same temperate crops are cultivated as in the Northern Andes. As much as 40 percent of the total cultivated area of 3.2 million ha is irrigated. Poverty is very severe in this system.

Mediterranean Mixed Farming System – Although it covers a relatively small area – 0.33 million km^2 – this system accounts for an agricultural population of 2.4 million and a significant proportion of the commercial agriculture in Chile and Western Argentina. Cultivated area is 3 million ha, of which more than 20 percent is irrigated. The rural population in this system is estimated at 3-4 million. Wheat, olives, horticulture, fruits and livestock are all important. Poverty is generally low.

Temperate Mixed (Pampas) Farming System – Covering some 1.1 million km^2 in Central and Eastern Argentina and Uruguay, this system was originally largely devoted to livestock but now contains over 20 million ha of cultivate land, 5 percent of which is irrigated, as a result of expansion in such crops as wheat, soybean and sunflower as well as horticultural production for Buenos Aires and Montevideo. The agricultural population is now estimated at over 6 million, and further intensification of production is expected within the system. Poverty is generally low.

Extensive Dryland Mixed ("Gran Chaco") Farming System – Stretching from North-Central Argentina, through Paraguay and into Eastern Bolivia, this system of 0.7 million km^2 has only recently been economically developed and still has a rural population of less than two million. Total cultivated area is estimated at under 8 million ha, and only one percent is irrigated. Unlike the Cerrados and Llanos areas, the growth potential of the Gran Chaco is severely limited by soils and moisture. Significant poverty is found among the small colonists.

Dryland Mixed Farming System – Due to its location near the coast of North East Brazil and in the Yucatan peninsula of Mexico, this large system of 1.3 million km^2 has a well-established economic and productive structure and an agricultural population of over 10 million, but faces many of the same agro-ecological limitations as the Gran Chaco. Little more than 2 percent of the 18 million ha of cultivated land is irrigated. It is a system with severe and chronic poverty among small-scale producers, who exist alongside large-scale extensive ranches. Land degradation is a serious problem.

Pastoral Farming System – As the Pampas extend southwards, they become drier and cooler, merging eventually into the very sparsely populated plains of Patagonia covering some 0.6 million km^2, where sheep and cattle ranching is the only widespread agricultural activity. Cultivated area is negligible, and there is no reported irrigation in the system. Poverty is low to moderate among the agricultural population of approximately 0.5 million.

Sparse (Forest) Farming System – At the southern end of the Andes, lower temperatures combined with continued high altitudes, render cultivation generally sub-marginal. The rural population of approximately half a million (1 person/km^2) has less than 200 000 ha under cultivation, and is largely dependent upon livestock grazing, forestry and tourism for income. Poverty is low to moderate, reflecting the low population densities.

REGIONAL PRIORITY SYSTEMS

Four of the systems distinguished above have been selected for more detailed analysis, using selection criteria based upon poverty and growth potential. The selected systems, which are discussed in subsequent sections of this document, are:

- Using primarily poverty criteria related to severe poverty and significant populations:
  - i) Dryland Mixed Farming System
  - ii) Maize - Beans (Mesoamerican) Farming System
  - iii) High Altitude Mixed (Central Andes) Farming System.

- Using primarily growth criteria related to major potential for expansion of production:
  - iv) Extensive Mixed (Cerrados & Llanos) Farming System.

2 Region-Wide Trends

The following section summarises regional trends and issues with particular reference to the position of LAC vis a vis all other developing countries. Unless otherwise stated, historical data is taken from the FAOSTAT statistical system, while future projections are largely extracted from the technical interim report "Agriculture: Towards 2015/30" issued by FAO in April 2000. The projections largely assume a continuation of present trends, which have been modified where it is clear that physical or other limitations are present. Unanticipated major changes in existing trends with respect to globalisation, climate or technology availability could render the AT2030 projections incorrect, but this risk must always be present when discussing periods 30 years into the future.

The following listing of some key quantitative trends is followed by a review of specific issues affecting LAC farming systems in the areas of: (a) natural resources and climate; (b) science and technology; (c) globalisation and markets; (d) policies, institutions and public goods; and (e) information and human capital.

In the last 20 years, agricultural production in LAC has grown at 2.8 percent annually, in line with demand for agricultural products. However, due to the slowdown in total population growth, rapid urbanisation and a relatively low income elasticity of demand, the growth in demand for food and raw materials has been declining in recent years and for the next 30 years it is estimated at about 2.4 percent per annum[16]. The way in which LAC will respond to this changing demand will depend not only on the underlying natural resource potentials for agricultural production and economic development, but also on the socio-economic evolution of the region.

Population

During 2000-2030, LAC population is estimated to increase 40 percent to 725 million[17]. This is lower than the overall 47 percent rate projected for developing countries as a whole, but higher, for example, than East Asia. In fact, the rate of regional population growth has declined dramatically in the last 40 years, from 2.8 percent per annum in the 1960s to about 1.55 percent in the 1990s.

The proportion of population living in rural areas[18] will decline to 17 percent over the next 30 years. Given the overall rate of population growth, this will leave the rural population at regional level only marginally lower than at present (from 128 to 121 million), but significant sub-regional differences are anticipated. The poorer countries are expected to maintain high rates of overall population growth, resulting in an absolute increase in rural populations. Thus Central America, Bolivia, Paraguay and Haiti will see increased rural populations, while Peru, Colombia, Mexico and Panama will see only very marginal declines. On the other hand, countries such as Argentina and Brazil will experience declines in rural population of 20 percent or more. In general, those countries with overall population increases of 50 percent or more will see rural populations increase.

Nutrition

During 2000-2030, the average LAC per capita daily nutrient intake is expected to increase by 10 percent

[16] FAO. Agriculture Toward 2010. Rome 1993
[17] "World Population Prospects: the 1999 Revision" File 1. United Nations Population Division, Department of Social and Economic Affairs.
[18] Rural is defined to exclude cities with a population of more than 50,000 inhabitants, and peri-urban areas with densities of more than 1,000 persons/km^2. Thus small towns would be included in the definition of rural.

to 3 080 calories. This is a marginally slower rate of increase than for developing countries as a whole, but will still leave LAC above the developing world average in 2030. The increase in calorie intake in LAC is expected to derive principally from meat and vegetable oils (33 percent each), dairy (18 percent) and cereals (7 percent). Roots and tuber consumption is expected to decline. For all developing countries, the expected calorie increases from meat, vegetable oils and dairy exceed 50 percent for each category, the increase from sugar by 25 percent, roots and tubers by 13 percent, and cereals by 3.4 percent.

The overall number of people suffering from under-nourishment (as defined by the UN) – currently estimated at 53 million – will decline to 32 million by 2030. This represents a drop from 11 percent of the population to five percent.

Land Cover

Forest: At the end of the 1980s, the deforestation rate in LAC was estimated at 7.4 million ha per year, equivalent to a loss of 0.8 percent annually[19]. This rate appeared to decline in South America, to 0.5 percent per annum over the period 1990-95, but accelerated in Central America, to 1.3 percent per annum The 9 million km^2 of total forest area reported regionally in 1999 was accounted for by tropical forest (75 percent), non-tropical forest (6.5 percent), sparse trees and parkland (18 percent) and mangroves (0.5 percent)[20].

Pasture: Over the ten year period 1982/84-1992/94, the area of LAC under pasture and grazing land increased by a total of 3 percent in South America and 6.2 percent in Central America to reach 600 million ha. According to World Resource Institute data, pasture lands in Guatemala increased by an astonishing 65 percent (albeit from a small base) to 2.6 million ha. A smaller, but still impressive, 27.6 percent increase in Paraguay resulted in 21.7 million ha of pasture.

Arable land: Cultivated arable land in LAC has expanded by 47 percent since 1961, but cropping intensity increased only one percent during this period. During 2000-2030, cultivated arable land is estimated by the FAO 2030 study to expand 20 percent (global expansion is estimated at 12 percent), while cropping intensity will increase by 11 percent over the same period – to 71 percent. However, the 30 year forecast increase of 0.55 percent per annum in arable area is only one third of the 40-year historical trend rate of 1.76 percent annually. The assumed slowdown in expansion in LAC is steeper than in other regions of the world and the projected increase in total arable area may be too low, given the areas being opened up in the Cerrados, Llanos, Chaco and Amazon basin.

Water Use and Irrigation

During 2000-2030, the proportion of arable land in LAC which is irrigated is expected to remain constant in relative terms at 11.5 percent (but will reach 22 million ha in absolute terms), whereas in developing countries as a whole the irrigated area is expanding faster than rainfed area – to cover an estimated 29 percent of arable land by 2030. Recently, irrigation efficiency in LAC has been estimated at 26 percent compared with 43 percent in the whole range of developing countries. During the period 2000-2030, only minor increases in water use and efficiency are expected in LAC in contrast to other developing countries, where efficiency will reach 50 percent in 2030.

Fertiliser

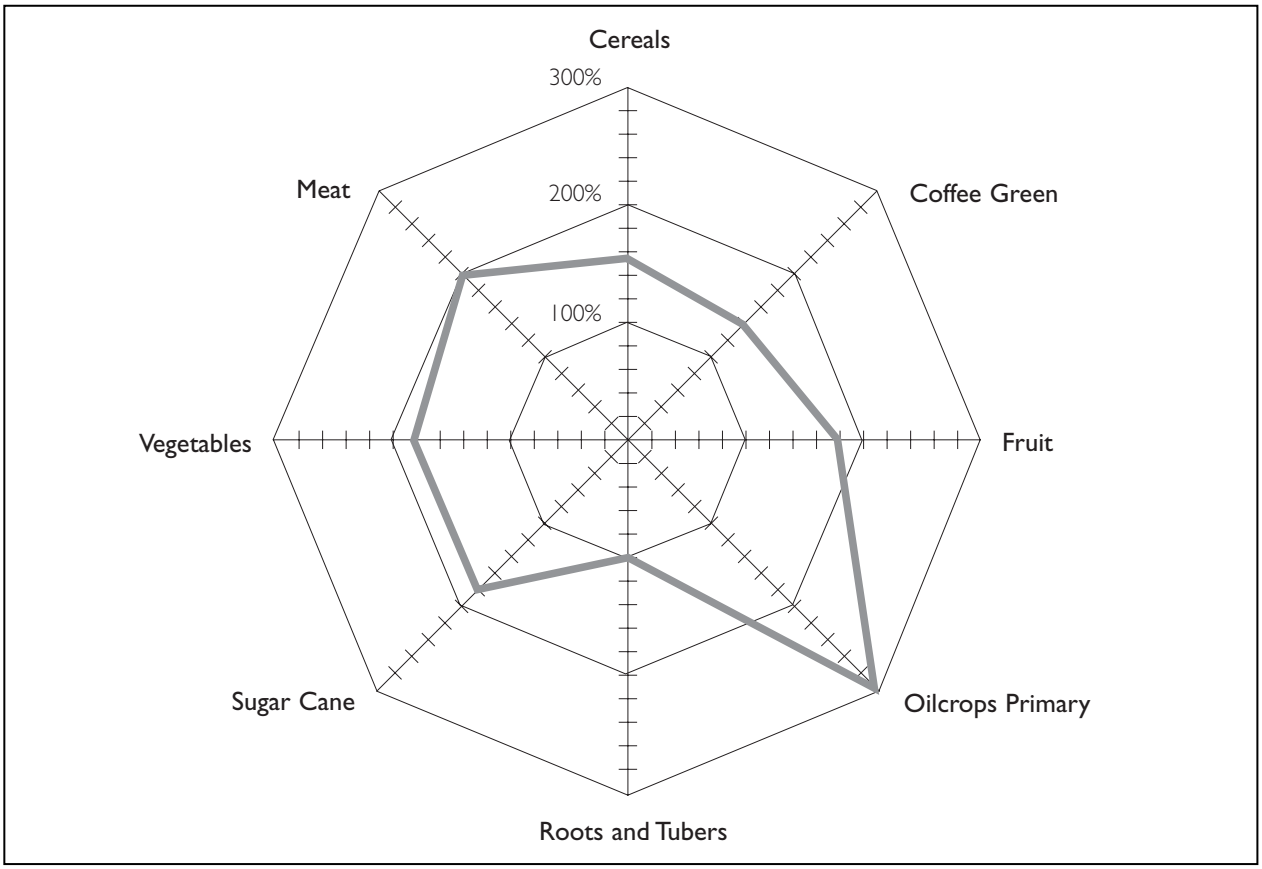
During the past decade, fertiliser consumption in LAC has expanded at 2.1 percent per annum compared with 3.5 percent for the developing world as a whole. In the period 2000-2030, this situation is expected to be reversed. Growth in fertiliser consumption in LAC is estimated to decline gradually to 1.6 percent per annum, but to fall steeply to only 1.1 percent for all developing countries. Due to the expansion of cultivated area, average fertiliser use per hectare in LAC will increase at about one percent per annum, the same average rate as for all developing countries.

Crop Production and Yields

Overall crop production growth to 2030 is projected at 1.7 percent per annum in LAC (1.6 percent per annum in the overall group of developing countries). Rapid increases in cultivated area within LAC will

[19] Evaluation of the Forestry Resources 1990 in Tropical Countries. Forestry FAO Study No 112. Rome, 1995.
[20] World Resources 1998-99, Forest and Land Cover Data Tables. World Resources Institute.

Figure 1: Changes in Structure of Agricultural Production. Latin America and Caribbean Regions: 1970-1995



be offset by slower increases in cropping intensity (an 11 percent increase to 2030 compared with 22 percent for all developing countries). Historically (1961-1997), average crop yields have increased in total by 52 percent in LAC compared with 72 percent in developing countries as a whole, while during 2000-2030 average crop yields in LAC are forecast to increase by a further 48 percent, compared with a 69 percent developing country average. This lag in yield increases reflects the greater expansion in arable area in LAC compared with other regions.

Forecasts for individual crops are briefly summarised below:

- *Maize:* LAC accounts for about 28 percent of developing world production of maize. Yields grew from 1.6 t/ha in 1970 to 2.5 t/ha in 1996 (developing country average of 2.6 t/ha). By 2030, planted area will increase by 30 percent to 38 million ha, yield by 36 percent to 3.4 t/ha and overall production by 77 percent to 131 million tonnes. These are slower increases than in other developing countries.
- *Coffee:* LAC produces about 58 percent of green coffee production in all developing countries while average yields are equal between the two groupings. By 2030, planted area will increase by 31 percent to 7.4 million ha, yields by 43 percent to 0.9 t/ha and overall production by 87 percent to 6.3 million tonnes. These increases are marginally faster than the overall developing country average, and LAC will account for over 60 percent of total future production.
- *Sugar Cane:* The 47 percent LAC share of developing country sugar cane production will decline over the next 30 years to 41 percent, despite increases of 22 percent in area and 29 percent in yield. Total LAC production by 2030 will be 833 million tonnes – a 58 percent increase.
- *Potatoes:* The LAC 14 percent share of developing country potato production will remain broadly stable over the period to 2030. However, a 42 percent projected increase in area and a 24 percent rise in yields will produce an overall 61 percent increase in LAC potato production.
- *Banana:* LAC currently accounts for 43 percent of developing country banana production, but this share will fall to 36 percent by 2030 even though

LAC production rises 36 percent to 32 million tonnes. The average for all developing countries will show major increases in both area (23 percent) and yield (33 percent).

- *Vegetable oils:* Historically, LAC growth in vegetable oils has been concentrated in soybean production in Brazil and Argentina and to a lesser degree in Bolivia, Paraguay and Mexico. This has accounted for more than half of global expansion in area (11 million ha compared with global expansion of 20 million ha during 1961-97). The increase in the area of soybeans has been supplemented by sunflower expansion in Argentina (two million ha compared to a global expansion of five million ha). Global consumption of vegetable oils is expected to increase by one-third (in calorie terms) during the next 30 years, corresponding to an annual increase in production of approximately 2 percent. Although the main increases in production will derive from oil palm, growth in soybean is expected to be strong, with a 73 percent area expansion and a 39 percent rise in yield producing an increase in total output of 140 percent. Sunflower production will increase 122 percent – almost entirely as a result of area expansion. Although consumption in LAC is estimated to grow at the rate of two percent annually, production in LAC is estimated to grow at 2.5 percent per annum, primarily from soybean and sunflower expansion, thus increasing export volumes.
- *Fibre Crops:* Currently LAC produces 3.7 million tonnes of cotton, 10 percent of the world's developing country output, but regional output has been declining strongly in recent years. However, this regional trend is projected to reverse in future and production is expected to increase by 92 percent to 7.2 million tonnes – a stable share of developing country production. Only the category "other fibre crops" is projected to decline in absolute terms over the period to 2030, but these crops are barely significant with an output of fewer than 400 000 tonnes on 326 000 ha of land in 1996.

Livestock

The 348 million cattle population in LAC in 1995-97 constituted 26 percent of the developing world total. Cattle numbers have increased by 1.8 percent per annum in the last 3 decades, compared with 1.3 percent per annum for developing countries as a whole. This growth has slowed considerably in the past decade and is now below that in the rest of the developing world. The population of sheep (88 million) has declined since 1970; the rate of decline accelerating to – 2.8 percent per annum in the past decade. However, the population of goats (38 million) has been increasing at nearly one percent per annum over the same period. The 30-year growth in other types of animals (including pigs and poultry) in LAC has been slower than for developing countries as a whole.

During 2000-2030, the population of cattle is forecast to grow at 0.9 percent annually, which is similar to the growth rate for all developing countries. The population of sheep and goats will increase by 0.7 percent compared with 1.1 percent for the overall group. Pigs and poultry are expected to increase by 0.9 percent and 1.6 percent respectively.

Labour Productivity

From 1970 to 1990, agricultural labour productivity in LAC increased at about two percent annually compared with developing country averages of between 3.5 - 4.5 percent[21]. The slow growth in labour productivity in the region only partly reflects the abundance of land. Growth rates have been particularly low in areas, such as the Andes and Central America, where a higher concentration of small farmers exists.

Trade

Average agricultural tariffs in 1995 (between 10 to 20 percent) were considerably lower than ten years previously (20 to 60 percent). Nevertheless, the position of the different countries and products in respect of their competitiveness is extremely varied.

LAC currently accounts for a significant portion of world trade in a number of specialised commodities including: coffee (Brazil, Colombia, C. America); orange juice (Brazil); bananas (Ecuador, Honduras, Costa Rica); table grapes and contra-seasonal temperate fruits (Chile); vegetables (Mexico); cut flowers (Colombia, Ecuador); pineapple (Costa Rica, Guyana),

[21] Countries such as France, United Kingdom or Germany have shown improvements in labour productivity as high as 6 percent annually for periods of 20 years or more. Indeed, this is also the case for the Argentinean Pampas, Southern Brazil, Uruguay and the low valleys of Colombia.

and shrimp (Ecuador, Honduras). Strong growth is foreseen in products that are currently significant in industrialised country agricultural systems, due to rising land and labour costs (sugar, cotton, citrus juice, vegetables), or to environmental costs that are considered too high (pork, mushrooms, and possibly chickens).

Cereals: During 1995-97, LAC had an annual net trade deficit in cereals of 16 million tonnes and this is projected to increase to 32 million tonnes annually by 2030. This corresponds to a decline in self-sufficiency from 90 percent to 87 percent during the period. This decline is comparable to the situation in other developing countries (SSR from 90 percent to 86 percent) as net cereal imports rise to 270 million tonnes in 2030.

Livestock: LAC is the only developing region with a net positive livestock trade of 874 000 tonnes per annum. In contrast, the developing world as a whole has a current annual net livestock import balance of 412 000 tonnes. LAC livestock exports are expected to triple by 2030 to 2.5 million tonnes per annum, in contrast to the developing world trade deficit in livestock products which is forecast to increase dramatically to seven million tonnes by 2030 (of which poultry accounts for almost four million tonnes).

Dairy: LAC has net imports of 6.3 million tonnes of dairy products, which are expected to grow to 7.5 million tonnes by 2030, in line with population increase. For developing countries as a whole, current net annual imports of 21 million tonnes will rise to 45 million tonnes.

❸ Extensive Mixed (Cerrados & Llanos) Farming System[22]

SYSTEM DESCRIPTION

The South American extensive mixed farming system covers about 230 million ha, of which some 190 million ha, known as the Cerrados, are in Central Brazil, and a further 40 million ha – the Llanos – extend across parts of Guyana, Southern Venezuela and Eastern Colombia. A recently opened area under this system now appears on satellite imagery in the North East of the Amazon basin. The total estimated population of 24 million is approximately 40 percent agricultural[23].

The zone has a sub-humid tropical climate (rainfall of 1 000 - 2 000 mm/year) with a clearly defined dry season. Natural vegetative cover ranges from open grassland through woody savanna to gallery woods along rivers. The Llanos tend to be more humid than the Cerrados. The native vegetation in both areas has been little studied for its potential for fruit, fibre, or pharmaceutical purposes and forestry has been limited to eucalyptus production to supply the paper industry

Total area (m ha)	233
Cultivated area (m ha)	31.5
Range of growing period (growing days/yr)	87% from 210-299
Total population (m)	23.6
Agricultural population (m)	9.6
Typical holding size less than (ha)	100
Dominant tenure pattern	Individual ownership
Soya: Area (m ha)	5.1
Maize: Area (m ha)	2.1
Rice: Area (m ha)	1.8
Cattle (m head)	60.1
Sheep and goats (m head)	1.1

Historically, the frontier savanna areas – with their isolation from the cities of the coast, acidic nutrient-poor soils, and lengthy dry seasons – were judged suitable only for extensive ranching. At the beginning of the 1970s only three percent of the Cerrados was under cultivation. Since then, however, rapid agricultural development has started to occur in the Cerrados and, to a lesser extent, in the Llanos. This was often initiated with upland rice production, which still the dominant crop in the Llanos where soybeans and maize are less important than in the Cerrados. Total cultivated area within the system is now estimated at over 30 million ha including permanent crops. A further 35 million ha is estimated to be under pasture. However, an estimated 40 million ha of the Cerrados have been severely degraded by poor land management. These are predominantly production areas established in the early years of Cerrado settlement, using upland rice and Brachiaria sown simultaneously.

Large farms (>500ha), often with absentee owners, dominate the Cerrados and Llanos and account for approximately ten percent of holdings. The vast majority, an estimated 70 percent of all production units in the Cerrados and probably higher in the Llanos, have ranching as their primary activity. This accounts for 40-45 million ha of pasture and more than 60 million head of cattle across the entire farming system.

Despite the predominance of ranching, there are also a significant number of large mixed and arable farms in the Cerrados zone (soya, maize, rice). Through the use of irrigation (400 000 ha) the Cerrados have come to produce some 20 percent of the national output of beans; a major staple in Brazil.

[22] Prepared by Carlos Spehar, EMBRAPA

[23] Agricultural population is defined by FAO as those active in farming, fishing or fisheries and their dependants. The proportion of non-agricultural population within the system is higher than may be expected due to the presence of Brasilia, which lies within the system.

BOX 1: A TYPICAL CERRADOS FARM HOUSEHOLD

The 50 ha family-operated farm in northern Goias State, in the heart of the Cerrados, was created and registered some 20 years ago, and may well have been purchased from a large rancher with a long-established presence in the region. A large portion of the farm is still dedicated to grazing a herd of 40 beef cattle, but annual cropping of beans (4 ha), maize (4 ha) and rice (2 ha), plus vegetable production for family use, is a key activity. Fertilizers have generated reasonable crop yields, but soil hardpan formation is becoming an increasing problem. The family of six relies almost exclusively on the farm for their income, as there is little off-farm employment available. Casual labor may be hired at peak harvest periods. Marketing and the purchase of inputs is one of the bigger problems faced by the family as the nearest town is some 40 km away, and the roads are not in good condition, especially during the rainy season. Therefore it is not feasible to produce perishable products. Because of the isolation, education and health care are serious concerns for the family.

Coffee production is also expanding in the East Central part of the Brazilian Savanna. These farms are characterised by the 50 percent of holdings that fall within the 10-100 ha size range (see Box 1). These mid-size units, especially those producing coffee, tend to employ considerable seasonal labour. Despite their secondary role to ranching, cropping activities in the Cerrados generate significant contributions to national agricultural output, including 34 percent of soya production, 21 percent of maize and 21 percent of rice. The importance of agriculture is much more restricted in the Llanos.

The role of medium-sized farms appears to be growing in importance in both the Cerrados and the Llanos. Evidence from the Llanos indicates that in the period 1961-97, holdings over 1,000 ha fell by more than a third, while the number of holdings under 20 ha also declined. Similarly, fewer than ten percent of holdings in the Cerrados are under 10 ha, and there is evidence from some states that the number has declined since 1970, suggesting some land consolidation is underway.

Studies of agricultural potential for the Cerrados estimate total land area suitable for cultivation in excess of 100 million ha. The Llanos, with more serious soil suitability problems, could provide perhaps an additional 10-15 million ha. Together, therefore, this represents perhaps three times current cultivated land use. The rapid expansion of agriculture within the frontier savanna system has caused considerable reduction in native biodiversity. Efforts need to be concentrated on diversity studies, and on educating the local population concerning conservation measures.

The overall level of poverty in the system is much less severe than in the semi-arid North Eastern zone which borders the Cerrados. Two-thirds of the farms are owned, while only a small percentage are rented. There are, however, landless labourers – probably coming from unemployed populations in the cities – emigrating into the region and putting pressure on less developed, price-speculative large farms. Some degree of bankruptcy among farmers in the Cerrados has been recorded. The causes include a low level of formal education, lack of infrastructure, inappropriate credit policies, misuse of technology, and need for information on more efficient resource utilisation.

The historically low population density in the savanna zone (3.5 persons/km^2 at the beginning of the 1970s), has meant that infrastructure development has been limited, and costs for transportation and storage have been relatively high in comparison to more settled agricultural areas. The high cost of inputs, low soil nutrient levels, and low land prices, is reflected in low land productivity. Yields of major crops tend to be lower than national averages (80-90 percent for soya and maize, but as low as 50 percent for rice in the Cerrados). Investment in education, training and other Government services within the system has been poor. The recent pressure caused by an influx of landless farmers has increased conflict of interests between large and small landholders.

SYSTEM TRENDS & ISSUES

The current growth of the frontier savanna zones represented by the Extensive Mixed Farming System is expected to continue and even accelerate over the coming years, although growth rate will be linked to international and national demand for soya, beef, cereals and other crops. Total cultivated area can be expected to approach 70 million ha by 2030, or over 100 million ha including pasture. By this time, livestock will no longer be the dominant activity. Land speculation may become a problem. Data from 1995 for the Llanos zone already indicates annual turnover at 12 percent, considerably higher than the national average of 3.5 percent for Venezuela as a whole.

Considerable investment can be expected in transportation systems, storage facilities and social infrastructure. Private sector investment in agricultural processing operations can also be anticipated. These changes are expected to contribute to reduced transaction costs and increased income; facilitating the diversification of production systems and causing an associated increase in off-farm employment which will attract still more immigrants to the system. Given the rate of population growth and migration, it is expected that in the next 30 years, the total population of the system will double. Agricultural populations will probably increase at a slightly slower rate as non-farm activities expand.

Good potential exists for agricultural diversification into such activities as acid-tolerant fruits (pineapple and passion fruit), mango and avocado. Dry-season food crops such as pigeon pea and pearl millet are also expected to expand in the Cerrados. Both of these categories may be attractive, especially to smaller producers. However, as cropping intensities rise, increasing demands for irrigation water will require effective planning and if this is poorly managed, could lead to conflict.

The key trend for annual cropping in the Cerrados is likely to be the adoption of no-till cultivation methods. At present, it is practised over one-third of the cultivated area – or about three million ha – but is expected to grow rapidly. The main advantages of this system include: (a) more timely sowing; (b) improved yields; (c) earlier harvesting that permits a second (cover) crop; (d) conservation of soil organic matter; and (e) reduced production costs. However, not all experiences with no-till agriculture have been successful. Inappropriate herbicide application, lack of suitable technologies for smaller farmers, and poor training of extensionists have all caused problems.

The data in Table 3 illustrate gains in the yield of crops and livestock already under production. These gains are technically feasible over the next thirty years if environmentally sustainable production approaches are widely adopted. In annual grain crops, no-till methods will introduce more flexibility with regard to sowing date and enhance the possibilities of rotating with non-conventional crops. The use of crop–cattle systems will expand in degraded areas and where double cropping is limited by low rainfall, thus opening the way to more diversified annual cropping.

These substantial increases derive exclusively from improvements in production systems, not from assumptions concerning improved varieties. The more integrated systems with better technology will offer both higher incomes and better environmental protection. The strong increases in annual livestock off-take per ha assume the recovery of large areas of degraded pasture lands.

In summary, key issues facing the frontier savanna farming system over the next 30 years include:

- Creation of a wide range of infrastructure to support the accelerating economic development of the zone;
- Achievement of further agricultural expansion without damaging the relatively fragile soils of the savanna zone;
- The ability to reverse degradation of large areas of poorly managed pasture lands;
- The avoidance of conflict between large farmers, the expanding small-farm sector and immigrants to the area.

SYSTEM PRIORITIES

In order to respond to the challenges for frontier savanna zones described above, a series of priorities are indicated:

(i) Formulate and implement special programmes to improve infrastructure, particularly in areas of high agricultural potential which are presently marginal for economic reasons. In addition to roads, farmers and communities throughout the

Table 3. Present and projected yields (t/ha) for main commodities in the Brazilian Cerrados

Commodity	Present	Projected (30 years)	Gain (%)
Soyabean	2.5	3.5	40
Maize	2.5	5.5	120
Field Beans	1.6	3.2	100
Upland Rice (Favourable rainfall)	1.6	2.8	75
Beef	0.05	0.2	300

frontier savanna zone must be integrated by means of modern communications so that new technology is easily accessible and isolation is thereby reduced.

(ii) Validate and disseminate information on integrated production systems and diversification options – especially for smaller farmers – including effective water use, no-tillage methods and integrated crop-livestock systems (see Box 2). To be effective, this requires improved communications with farmers and their participation in adaptive research and trials. Setbacks, solutions and new initiatives should be identified together with the farmers concerned.

(iii) Focus efforts on restoring the estimated 40 million ha of degraded pasture lands – larger than the current toal cultivated area – in order to channel agricultural growth to existing areas and reduce pressure for clearance of new savanna areas.

(iv) Implement effective land planning and financing programmes, combined with the development and dissemination of intensive, but sustainable, technologies appropriate to smaller producers. Facilitate new agro-industries and post-harvest operations (at family, co-operative and corporate level) to create new demand opportunities and off-farm employment.

(v) Expand co-operation with Llanos countries such as Venezuela and possibly even those of the sub-humid savanna zones of Africa to expand the relevance of research and improve the effectiveness of research and field work undertaken.

Specific interventions can be expected to change significantly over the next 30 years. However, innovative technologies and approaches already exist for reversal of degraded pasture lands. These involve the use of degraded land to grow soya – and later maize – undersown with improved pasture species. After several years of relatively high density stocking with cattle the cycle is repeated. While mainly tested on large holdings, the methodology is also relevant to smaller producers and has resulted in dramatic increases in sustainable stocking capacity.

Another specific intervention currently being explored for smaller producers is a rotation of field crops (soya, maize) followed by protein crops such as pigeon pea, pearl millet, quinoa and amaranths, to increase protein availability for livestock. These new crops also open-up possibilities for post-harvest processing in order to supply feed to larger ranchers. The adaptation to no-till cultivation, using equipment designed for small farms, allows the producer to meet the cultivation schedule, grow additional crops, and rotate them to prevent degradation and erosion.

BOX 2: ACHIEVING SUSTAINABLE PRODUCTIVITY INCREASES IN THE EXTENSIVE MIXED FARMING SYSTEM

With more than 100 million ha suitable for agricultural use, the frontier tropical savannas of the Cerrados and Llanos probably offer the world's greatest potential for expansion in arable area in the 21st century. Nevertheless, their sustainable exploitation is constrained by significant soil limitations, which have only partially been addressed by the introduction of minimum and no-till cultivation systems. In particular, the tendency to operate non-rotational systems of production, whether livestock or crop-based, has contributed to serious degradation of soils over as much as 40 million ha of the system and is also starting to cause concern in terms of pest and disease problems.

Research and field trials conducted in the Cerrados have clearly shown the significant benefits arising from mixed crop-livestock production systems, whether due to the introduction of soybean and rotational crops into ranched areas (typical for large farms), or the stocking of dual-purpose cattle in smaller holdings which previously have been largely crop-based. As moisture availability in the savanna grades from the wetter neo-Amazonian areas to drier zones, different crop combinations prove optimal. These include many crops that are still little known in the savanna context, such as castor beans, pearl millet, grain amaranth, kenaf, pigeon pea and quinoa.

The integrated production system has reversed soil degradation and achieved significant yield increases. Field data indicate that beef production can increase 300 percent (on a per ha basis) across the system, while maize and beans outputs rise over 100 percent. Net average incomes per ha for participating farmers have increased from US$200 to US$350.
While larger farmers may need little support for investment, the adoption of mixed cropping technologies among smaller farmers requires assistance. The agricultural potential of the system justifies increased field work in applied research, seed multiplication and integrated pest management systems. Potential may exist for utilisation of these technologies in the Llanos and also in the West African savannas.

4 Dryland Mixed Farming System[24]

SYSTEM DESCRIPTION

The dryland mixed farming system includes two principal areas within Latin America: (a) the North East of Brazil, comprising about 20 percent of the country or 1.1 million km^2; and (b) the Yucatan peninsula of Mexico, extending into the Northern Peten zone of Guatemala, covering about 165 000 km^2. The agricultural population of the system is estimated at about 500 000 in Yucatan and almost 10 million in Brazil. As much as half of the rural population of Brazil live within this system[25]. The rainy season in N.E Brazil extends from November to March with annual precipitation of 400-600 mm in the drier West of the Brazilian system, increasing towards the East to 1 000 mm with a rainy season until August. Precipitation tends to be higher in the Yucatan, with average annual rainfall between 600 and 1 500 mm, mostly falling between June and October. In both regions, soils are mainly shallow and stony with areas of low forest vegetation. Elevations are low to moderate throughout the system. Good quality agricultural land is scarce and there are no erosion control measures. At present, about 0.18 million km^2 of the semi-arid area are subject to severe desertification in N.E. Brazil.

Total area (m ha)	128
Cultivated area (m ha)	18.1
Range of growing period (growing days/yr)	80% from 120-239
Total population (m)	26.5
Agricultural population (m)	10
Typical holding size less than (ha)	5
Dominant tenure pattern	Owned/share-cropped
Maize: Area (m ha)	4.9
Beans: Area (m ha)	4.8
Cassava: Area (m ha)	1
Rice: Area (m ha)	0.4
Cattle (m head)	23.8
Sheep and goats (m head)	20.9

The long dry season, frequent droughts and uncertain patterns of precipitation typical of the system, make farming a highly uncertain process for the vast majority of producers without supplemental irrigation. In both zones, more than 80 percent of farmers practise semi-subsistence production. Crop failure – especially in maize and rice – is common if rains are late. In Yucatan, shifting cultivation is a traditional subsistence practice of the Mayas that is still widely used today. This form of agroforestry is a succession of two components: the cultivation phase (milpa) where maize, beans and squash are grown together, and the resting phase (acahual) where wild brush and trees take over and replenish the soil. Cultivation usually lasts two or three years and fallow between five and twenty years, depending on soil, vegetation and land availability.

Land distribution in the marginal tropical drylands system is strongly bimodal. In N.E. Brazil, there are about two million farmers within the system, cultivating an estimated area of 15 million ha. However, more than half (59 percent) have holdings of less than 5 ha and account for only 6.1 percent of the total arable area (another 22 percent have holdings from 5-20 ha). At the other extreme, only

[24] Prepared by Geraldo Majella B. Lopes (IPA, Pernambuco, Brasil).
[25] The farming system boundaries used in this study have been drawn to exclude much of the heavily urbanised western coastal strip, normally included in definitions of N.E. Brazil. Although this modification has only a limited impact on system agricultural population, it has reduced total system population by half to approximately 26 million. The coastal zone is, instead, included in the coastal plantation and mixed farming system.
[26] IBGE, Censo Agropecuario. 1996. Brazil.

BOX 3: A TYPICAL MARGINAL DRYLANDS FARM FAMILY IN N.E. BRAZIL

With a holding of 3.5 ha, the family of seven produces mostly beans (1.5 ha), maize (1 ha) and cassava (0.5 ha) under a rental or share cropping agreement with a local landowner. Yields are low, and reflect the poor soil quality, lack of soil moisture and low input use (no seed is purchased). Given the high proportion of output going to the landlord, available money is better spent on other things and only one-third of family income comes from cultivation activities. Most farming tasks fall to the wife and children, as the husband is often working off-farm, either as a local labourer or in employment involving seasonal migration. A recent period of labouring on a coastal sugar estate has allowed the family to enjoy the luxury of a milk cow which, together with the two goats, is fed on crop residues and roadside vegetation. There are also a few chickens. The family has never received a visit from an extension officer and the rudimentary schooling and health facilities often stop functioning due to lack of operating budget.

8.2 percent have holdings over 50 ha, but these account for 61 percent of all land[26]. Larger holdings are concentrated very heavily on maize (often for feed), sugar cane towards the coast, and livestock – with 49 percent of farmers registered as producing beef, 55 percent dairy and 40 percent poultry.

In the Yucatan, each ejidatario[27] usually has between three and eight ha under cultivation with an average of 4 to 4.5 ha. Total sown area in Yucatan in 1995 was 1.1 million ha. Just over half (58 percent) of N.E. Brazilian farmers are owners, although this is skewed towards the larger landholders. Share-croppers and tenants account for a further 17 percent, and the remaining 25 percent are informal occupants.

Small producers within the farming system have become poorer in the last few decades. More than 50 percent of rural families in N.E. Brazil live in chronic and severe poverty, with an average family income of only US$366 per annum (compared with an average of US$938 for Brazil as a whole and US$1 744 for the South of the country)[28]. Farmers normally do not use improved seed, fertilisers, pest and disease control or mechanisation. Crop yields are a reflection of this low level of technology and inputs. Average yields for main crops in N.E Brazil are: maize – 1 t/ha; beans – 0.45 t/ha; cassava – 9.9 t/ha, and rainfed rice – 1.59 t/ha. Yields are similar in the Yucatan. Nevertheless, the system accounts for more than 30 percent of Brazilian national production of beans and cassava . In the 1996 Census, 20 million ha of native pasture and 12 million ha of improved pasture were recorded for the N.E. region, only about 15 percent of which was found on holdings of less than 50 ha. These pasture areas are estimated to have increased significantly since the census.

Irrigated agriculture is poorly developed in the region; partly as a result of shortage of water availability, partly due to poor soil conditions, and partly because of investment requirements beyond the reach of most small producers. In Yucatan, there were only an estimated 47 000 ha of irrigated crop production in 1995 – less than 5 percent of the total cropped area – while in Brazil the total is under 400 000 ha. The semi-arid zone has abundant water conservation measures in place, including reservoirs, retention barriers desalinization, etc., but none work well during periods of severe drought. Frequently, installed technologies are not understood or used by those they are supposed benefit.

Infrastructure throughout the marginal drylands system is poorly developed. Public services such as health and education are only available in some locations and are generally insufficiently funded to be operated effectively. Poorly maintained and unsurfaced roads and a low degree of market development add to the problems facing economic progress in the region.

In Yucatan a crisis has arisen, as increasing population pressure has forced a reduction in the fallow period of the shifting agricultural production pattern. As a result, insufficient time is given to the *milpa* land to recover its fertility after the cultivation period. Yields, and the ability to resist drought, have been reduced, lowering levels of food security in rural communities. The rapid growth of tourism in the coastal zones of Yucatan, and its consequent demand for labour, has also had a profound direct impact on the structure, makeup and economic status of the farming system. Many families have migrated permanently to

[27] An ejidario is a member of a community managed, state-owned ejido, or area of land, that bestows inheritable user rights, but not ownership, to its members. Since 1992, however, liberalization of legal controls on ejidos has meant that more and more ejidarios have converted their use rights into private ownership.

[28] ibid

[29] Região Nordeste do Brasil em Números. SUDENE/MIN. 1999. Brazil

the state's new coastal cities such as Cancun and Cozumel [30].

A similar pattern of migration is also occurring in the Brazilian North-East. Because of the marginal nature of the area and the recurrent droughts faced by producers, the rural population has become very dependent on periodic government assistance. Since no long-term solution has been developed, this population represents a migratory time-bomb, with some estimates placing the number of potential migrants at 8 to 13 million.

SYSTEM TRENDS & ISSUES

The key sectors that offer potential for regional income growth are tourism, services and agro-industry. By year 2030, the productive structure of this farming system will probably be more concentrated than today, as many sub-marginal producers will have left. The subsistence farming system on marginal drylands will maintain its low productivity, but a substantial outflow of poorer producers is expected as the economy in the neighbouring Cerrados continues to grow rapidly. There is a low probability that the system will be able to finance its own development, so it will continue to depend on government resources. The population is projected to grow at one percent per annum and will progressively be concentrated in the main cities. Income distribution will continue to be highly skewed and any decrease in poverty will be due mainly to government action programs.

The operating capacity of public institutions is expected to increase, but with continued low linkage to the needs of poorer inhabitants. The public science and technology sector may experience some development as a result of increased resources from central government. However, improved response to small farmer needs, and expanded co-operation with the private sector, is unlikely to occur unless significant measures are undertaken to restructure the organisation and management of research organisations. On the other hand, the organisation and democratisation of society will be stronger.

Drought effects are likely to be aggravated over the years, as climatic instability increases and degradation of natural resources reduces the capacity of the system to resist long dry periods. The impact will be high, further degrading soils and vegetation and increasing population outflow. These negative effects will be mitigated by growing irrigation activities, with 0.5 million ha of new irrigated land creating nearly 0.3 million jobs. Most of this irrigation will be devoted to the production of tropical fruit for export. A key constraint facing the marginal drylands system is the widespread perception that lack of water is a problem solely arising from limited natural resources. In reality, water shortages are as much the result of inequitable land distribution, inappropriate technologies, and poor resource management. Opportunities exist for water-conserving production (e.g. cashew for export), while degradation of soils and vegetative cover arising from sub-marginal holdings contributes to the poor utilisation of available water resources.

Yucatan faces a particular challenge with respect to the continuance of shifting cultivation practices. If fallow periods continue to decline, the only possible outcome will be serious soil and vegetation degradation and drastically lower yields. However, unless out-migration to tourist employment sites and Mexico City etc. occurs at a faster rate than population growth, this situation will inevitably develop.

Other important issues to be considered are:

- reform of the existing system of agricultural land in order to permit consolidation of holdings and increased efficiency;
- control of desertification in the driest areas;
- using ecotourism potential to create employment opportunities.

Technical changes within the *milpa* system are limited to the introduction of external inputs such as herbicides, improved varieties and, to some extent, fertiliser. As soil conditions generally do not allow for mechanisation, the milpa has remained labour intensive and in terms of external inputs, extensive. Modification of management strategies, e.g. growing a diversity of crops, or changing the number of cropping cycles on the same *milpa* plot, is being considered as an adaptation to the changing natural and socio-economic conditions.

SYSTEM PRIORITIES

In contrast to other regions of the world that have already made the transition to modern agricultural

[30] Linkages between Tourism and Agriculture in Quintana Roo, Mexico. Rebecca Torres, UC Davis, unpublished research data.

practices, the marginal dryland farming system has failed to undertake the necessary changes to stimulate a broad and equitable process of agricultural and socio-economic development. It is difficult to believe that even major advances in technology will permit an agricultural population of 10 million people (many of them sharecroppers on holdings of less than 5 ha) to escape from poverty over the next 30 years. If farm populations can be reduced, and a more equitable land distribution achieved, then the possibility exists for increased earnings for those remaining – together with a halt to the ever-increasing degradation of the natural resource base.

Two major strategic approaches to poverty reduction and economic growth can thus be proposed for the marginal tropical drylands system:

(1) Alternative Livelihoods

Provide alternative livelihood opportunities to sub-marginal farm families within the region, including:

- provision of incentives for the creation of agro-industry and other rural occupations, including training of workers and tax benefits;
- assisted relocation of sub-marginal farmers to areas of agricultural expansion (i.e. the Cerrados), possibly including compensation for exit from currently occupied lands and access to finance to buy land in expansion areas;
- provision of skills training and infrastructural improvements to facilitate the movement of people (especially youth and women) into regional urban areas.

(2) Increased Agricultural Incomes

Provide those remaining on-farm with the potential for increased earnings through:

- facilitating land purchase and investment for those producers with some potential for development. This may well exclude those currently in sharecropping arrangements, as they would have no initial land base from which to expand, rendering land purchase a prohibitively costly exercise. Experience in a number of countries has shown, however, that financing land purchase costs alone is not enough. Any programme of this type must also address on-farm investments and working capital requirements;
- dissemination of technologies that improve productivity in relation to moisture constraints, including: development and dissemination of drought resistant varieties and species and encouragement for the replacement of maize; zero-tillage technologies appropriate for small producers; small-scale irrigation where feasible;
- introduction of farming practices that reverse the degradation of the natural resource base, including: the expanded utilisation of legumes and fodder crops (e.g. *Mucuna pruriens and Canavalia ensiformis*); zero or limited grazing systems for small-stock; and, greater attention to the potentials of native vegetation. Land use planning should be given priority to improve the identification of areas under risk. Meteorological research leading to specific drought forecasting all over the region would also be valuable;
- crop diversification, especially into non-traditional products, offers substantial opportunities. Experiences with cashew exports within the system show that such alternatives do exist, and they often bring with them secondary employment in packaging or processing. This is especially the case for the supply of agricultural products to the tourist sector; a major opportunity in the Yucatan and to a lesser extent in N.E. Brazil. Here, the demand from hotels and restaurants for prepared foods (portion controlled, peeled and sliced, juiced etc.) creates significant employment opportunities, but also requires stringent quality control.

In addition to these major strategic approaches, public financing must be shifted away from emergency drought relief and similar programmes into activities that provide hope for future avoidance of these conditions.

5 Mesoamerican Hillside Maize and Beans-Based Farming System[31]

SYSTEM DESCRIPTION

The mesoamerican maize-bean hillside farming system extends over an area of approximately 0.65 million km^2. It occupies the central mountain and hill range that extends north from the Panama Canal and connects to the highland plateaux of Guatemala and Central Mexico. The system is distinguished by: (a) the significant proportion of indigenous population[32]; (b) the central role, both agriculturally and culturally, of maize and beans; (c) the small holding size – typically under 5 ha and in El Salvador, less than 2 ha[33]; (d) the high degree of on-farm consumption of production (over 65 percent in Honduras)[34]; and (f) the importance of seasonal migration of wage labour to lowland agricultural and coffee estates. Coffee, and intensive small-scale irrigated vegetable production (in areas close to roads and urban centres), are important income sources and often critical in determining the degree of poverty within a community.

Total area (m ha)	65
Cultivated area (m ha)	6
Range of growing period (growing days/yr)	70% from 150-299
Total population (m)	78
Agricultural population (m)	13
Typical holding size less than (ha)	5
Dominant tenure pattern	Customary rights
Maize: Area (m ha)	5.5
Coffee: Area (m ha)	1.2
Beans: Area (m ha)	0.5
Cattle: (m head)	14.3
Sheep and goats (m head)	6.6

Hillside lands may extend as high as 3 500 m above sea level in the Guatemalan highlands, but most cultivated land is between 500-2 000 m, with a precipitation of 1 000-2 000 mm/year. The majority of soils in the system are of volcanic origin, and relatively fertile, but on slope lands tend to be thin and subject to erosion[35]. FAO studies from the 1980s estimated severe erosion on as much as 45 percent of all land in El Salvador and 25-35 percent in Guatemala[36]. Forest cover was severely reduced during the 20th century, leaving large areas of contiguous forest only in the most inaccessible areas and in National Parks. A distinctive sub-system in Central Mexico[37] shares the cultural and agronomic elements of the mesoamerican system, but is agroecologically different, consisting of high altitude plateau (2 000 - 3 000 m elevation) with lower temperatures and poorer soils.

The entire system encompasses an estimated agricultural population of some 13 million people, half of them in Mexico[38]. As a proportion of national agricultural population, this ranges from about 50 percent in Guatemala to less than 20 percent in Honduras[39],

[31] Prepared by Aidan Gulliver, Investment Centre, FAO
[32] Indigenous people account for 66 percent of total population in Guatemala and 29 percent in Mexico, the two largest countries in the Mesoamerican system, but are lower in other Central American countries. Within the farming system itself, the proportion of indigenous people would be much higher, and can be estimated at 60-80 percent.
[33] Los Productores de Granos Básicos del Istmo Centroamericano. p.148. CADESCA/European Commision, June 1990
[34] Ibid. p.136
[35] Integrated Crop and Land Management in the Hilly Terrains of Central America: Concepts, Strategies and Technical Options. Integrated Crop Management Series, Vol 2. FAO, Rome, 1999
[36] Cited in: Memorias del Seminario Regional para la Promoción de Sistemas de Producción Agrícola Sostenible para el sector Campesino en los Andes Centrales. p.63. MAG/IICA, Quito, Ecuador, January 1996.
[37] Comprising much of the states of Hidalgo, Tlaxcala, Guanajuato, Queretero, and Mexico.
[38] Conteo de Población y Vivienda, INEGI, Sao Paolo, 1995
[39] Memorias del Seminario Regional para la Promoción de Sistemas de Producción Agrícola Sostenible para el Sector Campesino en los Andes Centrales. p.43. MAG/IICA, Quito, Ecuador, January 1996. Rural populations are adjusted by a factor of 0.85 to reach agricultural populations (relationship derived from FAOSTAT data).

BOX 4: A TYPICAL MESOAMERICAN SYSTEM HOUSEHOLD

Of a total of 3.5 ha, some 1.5 ha are dedicated to maize, with 0.75 ha of beans. A low yielding second harvest may be possible on part of the holding, depending on soils and slope. Coffee, the principal cash crop, occupies 0.5 ha, while tree fruits and vegetables for household consumption and possibly local sale take a further 0.5 ha. The household occupy the remaining space. If the household is wealthy, it may have a cow for milk and draught, plus some chickens. The household head could well be an indigenous woman, especially where there has been armed conflict or extensive out-migration. When there is a male head of household, he will often be seasonally absent providing income from wage labour on the coast. Input use is low (possibly some fertiliser) and there will be no access to formal credit, although itinerant buyers may advance funds to regular clients. There may be a primary school within reach, but probably no year round access by road to the community.

while arable area within the system varies from 40 percent (El Salvador) to ten percent (Panama) of national totals[40]. In 1989, it was estimated that there were 1.4 million producers of basic grains in Central America[41], the vast majority of whom would be included in the mesoamerican system.

Large-scale estates, often controlled by absentee landlords or corporations, are a common feature of the mesoamerican system. Dedicated to the commercial production of coffee, rubber, beef, and more recently cut flowers and foliage, these estates are frequently in excess of 100 ha and are interspersed throughout the system. Commercially-operated family farms are clustered in the more fertile valley areas of the system, and often produce vegetables and dairy products as well as coffee. Most producers control their family parcels under customary arrangements but lack legal title, rendering access to formal credit sources very difficult.

System yields tend to be low; average maize yields are typically 1-2 t/ha[42]; by contrast average maize yields in Sinaloa State, where irrigation is widespread, reach 6 t/ha[43]. Similarly, average yield of beans - 0.6-0.9 t/ha - are lower than the Mexican national averages of over 1 t/ha[44]. Despite low yields, small-scale indigenous producers are important contributors to national output of these crops. In 1999, over 50 percent of the area sown to maize in Mexico was within the mesoamerican system boundaries. In total, some 6-7 million ha of maize are harvested annually within the system[45]. The importance of the system is even more pronounced for coffee, which requires altitudes over 500m for proper development and fruiting. Almost all regional coffee production derives from the mesoamerican system area. However, large coffee estates account for much of that output.

Extensive poverty is a feature throughout the system, with severe poverty reaching levels as high as 80 percent in the Guatemalan Departments of Huehuetenango and Quiché. A regional average of 60 percent was estimated by IICA in 1991[46]. Malnutrition is also widespread, especially in the period before harvest. Returns per unit of land tend to be greater, but population densities also much higher, in areas where coffee production is practised. Increased incomes are thus partially offset by smaller average holding sizes.

Public infrastructure is sparse or completely absent away from local administrative centres, especially in those areas where there has been prolonged armed conflict in recent decades (Chiapas in Mexico, Guatemala, El Salvador and Nicaragua), and many indigenous communities are several hours by foot or animal transport from the nearest road. Similarly, the availability of education, health care and other services is minimal. To compensate, many indigenous communities have high levels of social cohesion, enabling community mobilisation for a wide range of tasks. Community controlled forest areas are also common, but tend to be very fragmentary except in the most isolated areas.

[40] ibid
[41] Los Productores de Granos Básicos del Istmo Centroamericano. p.17. CADESCA/European Commision, June 1990
[42] Yields in the altiplano area of Central Mexico tend to be higher (2-2.5 t/ha) reflecting the greater proportion of commercial production in proximity to major urban markets.
[43] Datos Básicos. Sistema Nacional de Información Agropecuaria. SAGAR, Mexico. 1998
[44] Ibid
[45] Centro de Estaístico Agropecuario, SAGAR, México (1999) and Los Productores de Granos Básicos del Istmo Centroamericano. CADESCA/European Commisión, 1990.
[46] Integrated Crop and Land Management in the Hilly Terrains of Central America: Concepts, Strategies and Technical Options. p.2. Integrated Crop Management Series, Vol 2. FAO, Rome, 1999.

SYSTEM TRENDS AND ISSUES

As a result of fragmentation of holdings, due to inheritance and other causes, their number has increased and the average size has decreased over recent decades. For example, the number of holdings with maize in Guatemala more than doubled from 1964 to 1996, from 321 000 to 667 000 holdings (however not all may be within the system)[47]. This is faster than the rate of population increase. Slower rates of increase were seen in other mesoamerican countries. Although urbanisation rates are also increasing, UN population projections show no significant diminution of rural populations in Mexico and Central America over the next 30 years, suggesting that pressure on access to land – an underlying cause of so much of the civil conflict in the region in the last 20 years – will continue. Given that few small-scale producers have legal title to the resources under their control, pressure may actually increase if powerful outside interests find attractive alternative uses for the land (for production or conservation).

With so little unexploited land still available in the hillside areas of mesoamerica, existing trends are likely to continue: (a) exploitation of ever steeper slopes; (b) intensification of traditional production systems; and (c) diversification of production. Expansion onto steep slopes will generate only short-term gains, as underlying soil structure is difficult to maintain and erosion will increase. In addition, increasing climatic variability resulting in torrential rainfall and flooding, is already believed to be responsible for major damage to many degraded areas. This trend will probably intensify. Conflict over recognition of customary rights to land, and the resolution of such conflicts, will continue to be key issues within the region.

A threat to the viability of the mesoamerican system has arisen from the stagnation and likely downward trend in farmgate prices for basic grains. Not only are international prices falling (and projected to decline further over at least the next ten years according to World Bank estimates)[48], but trade liberalisation has eroded the level of protection that national producers previously enjoyed with respect to international prices. Average yields of both maize and beans are likely to increase over time, perhaps by 50-100 percent, as shown by the existing relationship between population density and yield levels in Central America[49]. Although major breakthroughs in maize yields may well occur in the next 30 years in industrialised countries the reliance of farmers on self-produced seed, plus widespread soil limitations, suggest that such benefits will have little impact on production within the Maize-beans System. In any case, improvements will not be enough to offset any significant decline in prices.

Possibilities for diversification will, however, offer some compensation. National urban populations with increased incomes will demand more high value products, and improved technologies in post-harvest handling – as well as more sophisticated tastes – will continue to expand speciality markets in industrial countries. Many of these products are labour intensive and can be well suited to family labour. Diversification has already occurred in horticultural and fruit production in peri-urban and other favourable areas throughout the mesoamerican system and will likely accelerate over the next 30 years.

Four principal development paths are thus foreseen for small producers within the mesoamerican system:

(i) Those with favourable resource endowments, location, and human capital will probably emerge from poverty as specialist suppliers of export-oriented products, despite their small holding sizes. This trend can already be seen among some groups in Guatemala and Honduras and Nicaragua. Maize and beans will continue to be grown mainly for household consumption; on declining areas but perhaps with dramatically higher yields, as this group will adopt new technologies as they become available. Over time, land markets may develop, leading to consolidation as better producers buy out less successful neighbours to form the nucleus of a commercial family farming sector within the system;

(ii) Others will continue to rely on the farm for their basic sustenance, but will increasingly turn to off-farm employment as a means of earning the income needed to finance basic household expenses (medicine, education, clothes, etc.). This income may also finance greater input use, raising yields significantly. The growth of export-

[47] Los Productores de Granos Básicos del Istmo Centroamericano. p.17. CADESCA/European Commision, June 1990 for 1964-1979 data. 1996 data from: Encuestas Nacionales Agropecuarias, 1995-1996, USPADAS, MAGA, Guatemala.

[48] Global Commodity Markets, Development Economics, Development Prospects Group, World Bank. May, 2000

[49] In 1985 Panamá, with a population density of 28 persons/km2 recorded average maize yields of 0.93 t/ha while El Salvador, with a population density of 265 persons/ km^2 recorded 1.84 t/ha. Other Central American countries fell between these points.

oriented production will create employment opportunities, both as field labourers and in packaging and transport. Expanded tourism will also contribute to employment and, as incomes increase, so will the provision of services. Although this group may slowly emerge from poverty, only those within reach of employment opportunities can participate;

(iii) A third group will consist of heads of household who abandon their holdings and move to urban centres, either alone or with their families. Those left behind will become increasingly reliant on remittances for basic household needs. With a considerable portion of family labour absent and resources scarce, agricultural productivity is not expected to rise significantly in this group and poverty will persist, if not worsen;

(iv) The fourth possible path comprises those who neither benefit from the new developments nor migrate in search of work. This group is likely to comprise those from the most isolated communities, and will account disproportionately for the extension of cultivated area on steep slopes (in search of increased production), risking severe environmental and human loss from flooding and landslides. Agricultural output will bring less and less real income as relative returns diminish and with few resources to purchase inputs, yields will stagnate if not decline. Poverty will worsen for this group, perhaps dramatically.

Throughout the mesoamerican system, public infrastructure and services are likely to continue to improve, especially as post-conflict rural investment programmes yield results. Private sector and civil society participation in rural areas is also expected to increase in importance, as a result of the continuing trend towards privatisation of services such as credit and extension, but also following new opportunities in export-oriented production and processing (cut flowers, fruits, vegetables, colorants, etc.).

SYSTEM PRIORITIES

The mesoamerican hillside basic grains system is characterised by extensive and often severe poverty. Yet focusing attention on increasing yields of traditional products would produce limited poverty alleviation at best and may actually be counterproductive if treated as the only solution. The problem facing producers within the system is not one of insufficient foodstuffs, but rather the need for higher cash incomes to meet household needs. Where no alternative sources of cash exist they are forced to sell output that would otherwise be consumed within the household, hence creating secondary malnutrition.

The strategic question for this group is thus how to promote the adoption of more favourable development paths, and at the same time reduce the environmental damage within the system that would worsen poverty in the long run. No single approach can be applicable to all producers, but all will need to undergo profound changes within the next generation if they are not to condemn their children to even greater poverty than they face now. More than one of the following strategic approaches may apply to any specific producer and their family.

- For those producers occupying degraded or fragile slope land and unable or unwilling to return such land to forest cover, promotion of more sustainable patterns of production that can be readily adopted with few resources, and provide rapidly realizable benefits in output or labour use. Specific interventions include: (a) permanent crops; (b) reduced tillage; (c) higher plant populations; (d) contour cultivation; (e) improved varieties, (f) live barriers; (g) intercropping; (h) dispersed tree cover; and (i) mulching. The benefits of these technologies and the feasibility of their adoption have been clearly demonstrated by a number of innovative projects within the system. However, while such practices can both increase yields and lead to more sustainable use of natural resources, they will have only limited impact on increasing household incomes unless integrated into diversification and marketing programmes, and can only be seen as part of any solution;

- Diversification offers the greatest potential rewards. The cultivation of snow peas and broccoli for export on plots of no more than half a hectare has allowed small-scale producers in the Central Highlands of Guatemala to increase incomes dramatically, while continuing to produce basic grains for household consumption on the remainder of their holdings. More than 20 000 indigenous families have made this transition. Many more opportunities for intensive horticultural and fruit production are being exploited; from Asian vegetables in Honduras to chilli peppers in Belize. However, diversification requires financial capital, initiative, available labour, proximity to transportation systems, and often

access to water for irrigation; a combination unavailable to most producers. It also requires the active participation of traders and brokers who can connect the product to receiving markets.

- Those unable to participate directly in diversification may obtain benefits from associated off-farm employment in packing and transportation. Studies in Guatemala have suggested a direct multiplier effect of 1.3, most of it in the immediate production area. Tourism, services and agro-industry also offer potential. Rural employment creation will require external support to "kick-start" the upward spiral of employment, earnings expenditure, and increased demand for goods and services. Two specific intervention types can be considered in this respect: (a) Support to small and micro-scale local enterprises. This could include accessible financing, improved quality of investment proposals, technical monitoring and management training. While this approach is not new, many of the component elements need improved mechanisms; (b) Facilitation of investment by medium and large agro-industries, by increasing incentives to establish operations in production areas. This could include the targeting of public investment in infrastructure in areas where companies indicate a specific interest in investing, project support for training of staff required by those companies, municipal support in land acquisition, etc;
- No matter what efforts are made, there are likely to be significant populations occupying such degraded or limited land - or so isolated from employment opportunities - that the above options are not available to them. In this case efforts to reduce rural poverty significantly must focus on facilitating a successful exodus of people from these areas. Empirical evidence strongly suggests that the poorest segments of the population do not generally migrate; they lack the resources to do so[50]. An appropriate strategy would be to tackle this problem on two fronts – providing resources for migration and attempting to increase the probability of successful absorption at their destination. Among the options that might achieve these goals are:
  - Provision of start-up capital for migrants through: (a) payments to those willing to transfer their customary rights to land to groups interested in conservation, recuperation of degraded lands, and biodiversity protection, thus taking sub-marginal land out of circulation; and (b) facilitation of financing to more successful producers who wish to buy rights to land that is appropriate for agriculture;

BOX 5: PRIVATE SECTOR SUPPORT FOR SMALL FARMER DIVERSIFICATION

The key role of the private sector in supporting diversification and income generation among indigenous smallholders in the highlands of Guatemala demonstrates the potential for effective co-operation between the private sector and traditional farmers. Although snow peas and broccoli were pioneered in the early 1970s by agribusinesses, within 10 years production of these perishable commodities had shifted entirely to the smallholder sector. Despite little if any external support, by 1996 these crops had grown to provide an estimated US$33 million in additional annual gross income to 21 500 producers; equivalent to US$1 500/family. More than 2 500 further jobs are estimated to have been created in associated post-harvest and marketing activities. Expansion is continuing, as new non-traditional crops such as raspberries gain importance. High labour requirements and the need for intensive management leads to average crop areas of only 0.24 ha per family, ensuring dispersion of benefits, and demonstrating that smallholders can achieve a competitive advantage for this type of product.

It is argued that the rapid expansion of smallholder production, and the high proportion of final price (47%) accruing to the producers, is a direct result of the competitive market created by the many small and medium-scale marketing enterprises active in the non-traditional field. The success of these enterprises, in turn, owes much to generally supportive government policies, and in particular, to a dynamic business support organisation (GEXPRONT). This contributed significantly to reducing the barriers to entry for small enterprises, resolving key marketing bottlenecks and, more recently, brokering private-sector support to producers in applied research and extension. These results suggest that support for the private sector, if leading to more open markets and improved efficiency of operations, may be an effective strategy for supporting diversification among small producers.

[50] See for example, country studies presented at Seminario Latinoamericano sobre Desarrollo del Empleo Rural no Agrícola. (IADB-FAO-ECLAC-RIMISP), Santiago, Chile, September 1999.

- Literacy and vocational training for would-be migrants and their families, to provide basic employment skills of use in destination areas;
- Directing migrant flows away from major metropoli to intermediate cities through assistance to infrastructure and settlement in these preferred areas.

6 Central Andean High Altitude System

SYSTEM DESCRIPTION

The Central Andean high altitude and altiplano farming system encompasses over one million km^2 from Cajamarca in Northern Peru, through Bolivia into Northern Chile as far South as Antofagasta and North-East Argentina to Belen. An estimated 40 percent of the territory of Peru and Bolivia falls within the system boundaries, as well as much smaller portions of Chile and Argentina. At the northern end of the system a series of interwoven ranges dissected by longitudinal valleys make up the Peruvian Sierra. Further south, at about latitude 14° South, the Andes divide into two major ranges, enclosing the plateau or "altiplano" of Peru, Bolivia and northern Chile and Argentina. This vast treeless area is composed of undissected tableland above 3 500 m and is characterised by interior drainage. Some agricultural land reaches 4 500 m[51]. Precipitation is concentrated in a single wet season of variable length and ranges from 150 mm in the western ranges to 1 000 mm per annum in the Eastern ranges. Although the soils, as well as their capability for agricultural production, are extremely diverse their fertility is typically low. All the lands in the system are affected by severe soil erosion.

Total area (m ha)	107
Cultivated area (m ha)	3.2
Range of growing period (growing days/yr)	Less than 179
Total population (m)	16
Agricultural population (m)	6.2
Typical holding size less than (ha)	15
Dominant tenure pattern	Customary rights
Potatoes: Area (m ha)	0.5
Maize: Area (m ha)	0.3
Cattle/Buffalo (m head)	6.1
Sheep and goats (m head)	24.6

Agro-ecologically the zone is extremely complex[52]. The great variation of soil types and the frequent sharp changes in altitude, are accompanied by dramatic changes in temperature, humidity and rainfall. An aridity gradient exists from east to west across the Central Andes as well as from north to south along the length of the chain. Annual mean temperature varies greatly with altitude. Mean daily temperature is generally below 10°C and frost is common, especially during the dry season.

Apart from altitude, other key features that characterise the Central Andean High Altitude system are the overwhelmingly indigenous population, the virtual absence of large holdings – unusual in Latin America – and the low levels of external input use. Most of the system was originally part of the Inca Empire and has retained strong cultural elements inherited from that period, which almost 500 years of latino domination have changed only superficially. The agricultural population of some seven million people, three quarters of them in Peru[53], rely on a subsistence-based mixed production system including potatoes, pre-Colombian Andean crops (e.g quinoa and chenopodium) and barley, maize, and lima bean. Sheep are important in the Peruvian Sierra, while the camelidae (llama, alpaca) dominate further South. Guinea pigs are also of major importance at higher altitudes, fulfilling the role taken by chickens in many other cultures.

[51] The latitude limit to potatoes cultivation is 4 200m at latitude 15° South.
[52] More than 60 biotic zones of the 103 found in the world are represented in the Central Andes and Altiplano near Titicaca Lake.
[53] The system rural population is estimated at 40 percent of total rural population in Peru and 45 percent in Bolivia.

The potential of this farming system for agriculture production is greatly constrained by the topography, the fragility of soils, and by either low temperatures at the higher altitudes or dry conditions at the lower altitudes. The potential for irrigation is reasonable. However, given the topography of the system, much of the water only becomes available on the lower flanks of the western ranges. According to the 1994 Census, almost 60 percent of holdings in the Peruvian Sierra were under 3 ha with 1.5-2.5 ha cultivated (often in scattered parcels), while in the Altiplano they reach 15-20 ha, with 1.5-2 ha cultivated. These small cultivated areas, combined with the poor productivity of such high altitude arid lands, result in endemic poverty, widespread soil degradation and erosion, and out-migration has become an important element of the system. There is an extensive flow of permanent and seasonal migration to the recently opened land on the eastern side of the Andes and to the Amazonian lowlands beyond. Others move to the major metropolitan centres. Nevertheless, despite out-migration, it is estimated that the rural population within the system grew by 1.6 percent per annum during the period 1960-90 – this growth rate is expected to decline in future. The poverty driving this movement of people is severe. In 1997, 68 percent of the total rural population of Peru fell below the national poverty line and this proportion is believed to be higher for Bolivia, although recent data are not available.

The arable area within the system is about 3.2 million ha and represents as much as a third of the available national arable land of Peru and Bolivia. An estimated 1.2 million ha is irrigated, mostly in the arid western section of the system in Peru. On the basis of statistical data from 1997, an estimated 1.2 million farms in Peru[54] and 0.6 million in Bolivia,[55] fall within the system. The total number of farms for the entire system would be over two million. Legal rights over property and other resources are not commonly established. In the Peruvian Sierra, approximately one-third of holdings are legally owned, while two-thirds are held under customary arrangements. There is almost no formal land rental, although there may well be informal arrangements.

The most densely populated areas of this farming system are the Peruvian Sierra with about 32 inhabitants per km^2 and the Bolivian altiplano where in certain parts, such as the areas surrounding La Paz, Cochabamba and Potosi, it can reach 40 inhabitants per km^2. The remaining arid and sub-arid parts of Chile and Argentine are sparsely populated. The average rural population density for the whole farming system is little more than 6 persons/km^2.

In the Peruvian Sierra, typical land use patterns distinguish three major production systems according to altitude: (a) the valley floor where corn, quinoa, chenopodium and potatoes are grown. Where water is available, small-scale traditional irrigation systems may make horticultural production possible; (b) the intermediate slopes, where drier western terraces are dedicated to barley and grains and the better eastern slopes are dominated by tuber cultivation; and (c) the high hills where the cultivation of more frost-resistant crops is combined with pastoral activities.

In the altiplano sub-zone further to the south, the land use pattern chiefly depends on the gradient of rainfall. In the most humid areas agriculture is widespread, while under drier conditions extensive livestock production predominates. Much of the land area is intermediate, with both livestock and crops. In some of the arid and semi-arid areas, such as the "Valles Altos" of Bolivia, extensive degradation of soils has caused major changes in prior production patterns, as traditional crops such as maize become infeasible.

Average system yields are constrained, not only by agro-ecological conditions but also by the limited use of external inputs. In the Peruvian Sierra, less than ten percent of smallholders are estimated to use purchased seed, but nearly 70 percent use organic fertiliser of one form or another. Maize yields typically do not exceed 1.0 t/ha, with quinoa yielding 0.85 t/ha and potato 10.0 t/ha. Other cereals (wheat, barley) average approximately 1-1.2 t/ha, but these yields may reflect the participation of larger producers. Further south, in the altiplano sub-system, yields drop further: potatoes from 4.0-5.0 t/ha; quinoa 0.6 t/ha and wheat and barley about 0.6-0.7 t/ha.

During the mid-1980s and the beginning of 1990s, structural and sectoral adjustment programmes caused major changes in national economies. Tight monetary and fiscal policies, unification of multiple exchange rates, and changes in tariff protection were introduced. Chronic problems of inflation (reaching hyperinflation levels in Bolivia in the early-mid 1980s) were largely resolved and the monetary and fiscal situation improved at the national level. Nonetheless,

[54] 1994 Agricultural Census of Peru
[55] Los Mercados de Tierras en Bolivia. Jorge Muñoz, CEPAL. Series No. 61, October 1999

the immediate impact on the population, especially the poorest segment, was highly negative. Subsequently, however, food production grew at annual rates[56] of three percent and five percent for Bolivia and Peru respectively. Food exports grew at an even higher rate; eight percent and nine percent respectively for the same two countries. Food imports also rose, but at a lower rate, resulting in a net improvement within the domestic agricultural sector. Nevertheless, the evidence suggests that most of these gains have been captured by the modern agricultural sector, bringing little benefit to the producers of the high altitude system.

Public resources devoted to the rural areas have usually been directed primarily toward the modern agricultural sector rather to the traditional sector. The system is characterised by a widespread lack of basic infrastructure in such areas as education, health, roads, and markets. In Bolivia, the proportion of overall public resources devoted to the agricultural sector has not been consistent with the contribution of this sector to the economy. Although receiving only six percent of the total public budget, agricultural GDP was 16 percent of the national total in 1999. The allocation of resources to the agricultural sector is more equitable in Peru, where both expenditures and agricultural GDP are around seven percent.

SYSTEM TRENDS AND ISSUES

Over the next 30 years, a decline in rural population is foreseen for the Andean countries as urbanisation accelerates. Nevertheless, rural populations within the high altitude system are not expected to fall significantly, and pressure on access to land will persist as declining real prices for agricultural products drive producers to expand their cultivated areas and increase stocking levels. The widespread soil erosion occurring on the slopes of the Peruvian Sierra and the altiplano will likely worsen without substantial changes in cropping patterns and natural resource management practices. Strong economic growth nationally, and in the lower valleys and Amazonian lowlands in particular, may accelerate out-migration. Although historically a relatively abundant resource, labour may join humidity, soils and slope as a limiting factor of production if this occurs.

The evolution of land tenure and landholding distribution during this period is an extremely complex matter. It is expected to be mainly influenced by whether or not adequate land registration, financing, and market development for land will be achieved, requiring considerable legislative institutional reform[57]. The high level of concentration of land ownership and use explains the apparent contradiction between the low population/cropland ratio and the persistent high pressure on land.

Although crop yields are low by regional standards, the adoption of available improved technologies requires levels of input use that are not feasible for most producers under current circumstances. Even improved yields, however, could not be expected to decrease poverty dramatically within this system, particularly as they may lead to a reduction in out-migration. In fact, natural resource degradation and possible labour shortages will increasingly challenge current production levels. Also, opportunities for crop diversification are more limited than in other zones, although expansion of irrigation and protected cultivation under plastic tunnels may provide limited opportunities.

The best opportunities for many producers may lie in improved community organisation to benefit from the potential for added value in existing products. Stronger marketing linkages to end-users (supermarkets, institutions, and restaurants) and the processing of raw materials (milk, potatoes and grains) could significantly increase family earnings, while speciality products such as quinoa and camelidae wool may provide profitable export opportunities.

Expanded development of export-oriented agro-industries is anticipated in urban and even some rural areas, but the ability of smallholders within the altiplano and high altitude system to participate in this growth is currently very low. Several factors suggest that this situation will continue despite future growth in the economy. These include, the capital-intensive profile of much economic growth; the small size of the national economies involved; and, continuing population growth. The mitigation of poverty in rural areas will thus depend strongly on the structure of national economic growth[58] and the extent to which the main constraints for rural development can be removed. The chief challenge for small farmers will be to improve labour productivity for the family farm.

[56] The growth rate was calculated for the period 1985-1996 for Bolivia and 1990-1996 for Peru.
[57] The present regulation of the land market was established in Peru by the land reform of 1953, which remains popular among small farmers, but restricts the consolidation of holdings.
[58] In the sense of both the pace of growth and its technological profile (capital or labour intensive).

Key issues that will have to be addressed if poverty reduction is to be achieved and economic growth promoted within the system, include:

- Unsustainable natural resource management practices, resulting in soil degradation and erosion;
- Low prices for agricultural outputs;
- Lack of off-farm employment and income generating opportunities;
- Land fragmentation and restricted land markets;
- Low factor productivity, especially with respect to labour and land;
- Inadequate public sector investment in infrastructure and agricultural services.

SYSTEM PRIORITIES

The extreme agroecological conditions, fragmented landholdings, poor soils and lack of off-farm employment opportunities have resulted in extremely high poverty levels within the Central Andean high altitude system and render the sustainable development of the system both a necessity and challenge.

(1) Unsustainable Natural Resource Management

Soil degradation on the hillsides in the Peruvian Sierra and in the Altiplano certainly compromises the long-term potential for land productivity[59]. Although poverty is recognised as a dominant force affecting soil dynamics in the mountainous areas, the ways in which its action takes place are complex, and in many cases largely unknown. Yet, in general terms, soil degradation in this farming system results from two factors[60]: (a) fragmentation of ownership – due to increases in population and to changes in land use and tenure systems – has led to a reduction in the fallow period and increase in land use intensity without the necessary inputs; (b) out-migration or off-farm activities have reduced labour availability with consequent poor management of soils and cropped areas.

Many erosion control projects using different approaches have been implemented. However, irrespective of any short-run gains, their design has had few if any linkages to institutions involved in, or relevant to, the problem. Furthermore, international and regional experience suggests that, to be successful, erosion control and prevention programmes have to: a) be designed and implemented in an institutional context characterised by significant public investment in agriculture; b) benefit from a decrease in anti-peasant institutional biases; c) gain more equal access to productive assets; and, d) profit from greater decentralisation of economic activity to the rural areas. This general statement can give rise to many opportunities to assist the farming system in control and prevention of soil depletion. These relate to:

- the design and implementation of an integrated national institutional framework for sustainable development, in which natural resource conservation would be considered as an integral part of rural development goals and objectives;
- design and implementation of soil protection and conservation programmes in terms of regional development, including the creation of additional sources of income through employment in non-agricultural activities located in the rural areas.

(2) Low Prices for Agricultural Output

The concentration by small-scale producers on domestic markets has left them exposed to low levels of demand in a number of commodities, and there is strong resistance to price increases based on varietal improvements, post-harvest handling or processing. Yet a number of the products grown within the system have significant potential for international specialist and niche markets. Anecdotal evidence suggests that major increases in prices can be achieved by tapping into these markets for llama and alpaca wool, quinoa, speciality potato varieties and similar products. To take advantage of these opportunities, however, requires the conjunction of a number of conditions:

- Improved organisation of producers to ensure co-ordination and the volume of supply required for export shipments;
- Efficient input supply mechanisms to ensure that producers have access to the correct inputs (including finance) as needed, and do not use prohibited or quality-reducing substitutes;
- Technical assistance to ensure adequate quality control for the product, including appropriate post-harvest handling and packaging;

[59] Morales et al. and Knapp (cited in Brush, 1987)
[60] A third, non-agricultural factor, is mining.

- Effective market linkages to identify buyers and facilitate feedback on variety, quantity, timing and other factors.

Even without major changes in the products generated by small producers within the system, the access of producers to international markets could produce significant increases in income.

(3) Lack of Off-farm Employment and Income

Off-farm employment, and in particular agro-industry, can contribute significantly to rural development in small-farm areas (but can also contribute to poor natural resource management as discussed above). Agro-industry in particular often induces rapid technical change among participating small farmers and constitutes an important source of off-farm employment, as well as contributing to demand for local production. This role of agro-industry is relatively well-known within this farming system[61]. However, the imperfect functioning of markets has traditionally inhibited a broad expansion of small-farm oriented agro-industry. This is particularly true in relation to rural credit[62], land markets, insurance for agriculture activities, information[63], and technology and specialised inputs.[64]

Agro-industries have developed a number of strategies to compensate for the effects of these imperfect market. These include the provision of farmer credit plus technology and inputs, and the renting of land to peasants[65]. Nevertheless, the large-scale development of agro-industry and other related types of rural employment (packaging, transport, etc.) requires integrated action – involving the peasant sector, the private sector and the government – within a framework of specific public policies and programmes. The aim of any related public intervention should be both to reduce the transaction costs of agro-industry and to ensure that the social benefits arising from the links between small farmers and the agribusiness sector will be equitably distributed.

Although it is dangerous to develop recommendations for the content of such programmes and policies outside the context of a specific activity, in

BOX 6: FARMER ORGANISATION FOR INCOME GENERATION, OFF-FARM EMPLOYMENT AND INCREASED VALUE ADDED TO PRODUCTION

The grassroots rural dairy processing industry that has sprung up in the highland areas of the Peruvian Sierra demonstrate the potential for generating added income among poor farmers in the Central Andean farming system. Although conventional agribusinesses play a major role in processing and supplying dairy products, a multitude of small farmers spread over the highland still produce and sell their products on a traditional basis. In 1987, in the Sierras of Chuquibamba District, Peru, a group of 57 farmers, with the support of an NGO, decided to construct their own small-scale dairy plant. Mainly oriented to supply the neighbouring urban areas with cheese and yoghurt, production evolved rapidly from 91 t in the beginning to 639 t annually in 1996. This experience was emulated by other communities and individuals across the region. From 1991 to 1995, 16 additional dairy plants were established in the region, showing classical 'clustering' within a single district. At present, the 17 plants combined process almost 11 000 t of milk annually and provide an estimated US$6.6 million additional annual gross income to 1100 farmers, equivalent to US$0.33 per person/day, an improvement of 17 percent over current family incomes. An estimated 155 further direct and indirect jobs have been created. The investment required to create a job has been as low as US$1 400 per worker.

Although this case highlights many positive aspects and promising perspectives for poverty alleviation among small farmers, a more comprehensive analysis is needed to ascertain the long-run viability of these rural small-scale dairy plants and their competitiveness in liberalised markets for dairy products. The intervention of NGOs has been critical in this experience through the provision of technical and financial assistance, as well as in up-grading human capital among the peasants, but is probably too limited for large-scale replication. To insure the long-term growth of these small farmers' income generation initiatives, improved public policies and services are essential.

[61] Well documented in CEPAL; FAO; GTZ. Agroindustria y pequeña agricultura: vínculos, potencialidades y oportunidades. Santiago de Chile 1998.
[62] The higher production costs of non-traditional agricultural products – the most attractive for export-oriented agro-industry - in relation to the traditional ones, increase both capital needs and risks among participating farmers.
[63] Information related to prices, commercial conditions, quality and quantity requirements of the buyers, seasonality of deliveries, health regulations, etc. This has become an increasingly crucial factor in gaining competitiveness and the cost to access it is high, not only for the individual farmers but even for their organizations.

general they would include the following elements:

- reduce information costs and improve access to information by farmers in order to move toward more sophisticated marketing strategies. Provide a policy framework for the integration of the peasant sector in international markets thus reducing the risks involved in producing non-traditional products. This framework should include a strategy to strengthen technical assistance and to guarantee certain markets;
- contribute to reducing transactions costs arising in the first stage of the linkage between the industry and farmers[66], and assure the equitable distribution of the social benefits of the agro-industrial development, including the creation of rapid, simple and enforceable arbitrage mechanisms to resolve the conflicts that necessarily arise between farmers and agro-industry in their transactions;
- facilitate access to credit and remove the constraints affecting small farmers with regard to enlarging their landholdings;
- reduce the costs of training both to farmers and to agro-industry;
- support farmer organisations.

(4) Land Fragmentation and Restricted Land Markets

A key issue for small farm development is to overcome the negative impact of excessive land division on labour productivity. The central goals are to facilitate the emergence of a medium-scale farm sector, as well as to consolidate the position of the few farms already in this category. It is believed that significant land reform, combined with improved financing availability, will contribute to intensified land use and lead to the consolidation of sub-marginal holdings, as those migrating to other areas sell their holdings to acquire capital.

The first action to be taken is to accelerate the process of regularisation and registration of farm ownership, the lack of which seriously hinders land market development. Secondly, the land market should be mobilised by strategic support to buyers (mainly information and notary services), identification of available land and the provision of more readily-accessible mortgage facilities.

(5) Low Land and Labour Productivity

The Central Andean high altitude system is characterised by very low factor productivity, especially in land and labour. Holdings are relatively large by the standards of many farming systems associated with severe poverty (especially in the Altiplano), but the very poor returns to land and labour leave producers with little benefit for their efforts.

While low productivity is in part a result of unfavourable climatic and soil fertility conditions, it can be argued that the current system fails to utilise effectively those resources that are available. Priority must be given to increasing the productivity of both key factors, through such interventions as:

- Improved mechanisms for availability of key inputs;
- Participatory research and dissemination of cultivation and post-harvest practises that improve labour productivity;
- Participatory research and extension on adapted crop varieties for this high altitude zone (short season, drought tolerant, etc.).

(6) Inadequate Public Investment

The underlying factors to achieve productivity increases are closely related to public investment in infrastructure[67] and services, in improving human capital within the farm population through education and health care, provision of specific government programmes to promote the development of the agro-industrial sector, as well as the completion of the reforms in factor[68] markets. The conditions to achieve these objectives do not yet appear to have been met.

At the root of any strategy for rural development in the farming system is the premise that macroeconomic stability and more appropriate relative prices are not sufficient by themselves to bring about large-scale agricultural productivity growth. These must be complemented by government support, in particular in the form of more effective government investments in agriculture. Greater emphasis should therefore be placed on adequate public resource allocation to agriculture through suitable budgetary adjustments.

[66] Agroindustries generally prefer to be linked to the commercial sector, as transactions costs are lower than those incurred in the small farm sector.
[67] The cost of transportation represents a large part of the food production cost.
[68] Land market reform, which is a sensitive issue for rural smallholders and landless, is unlikely in the medium term future as the necessary preparatory steps (as undertaken in Mexico as part of their land reform process) still have not been started in Bolivia and Peru.

7 Strategic Priorities and Interventions for the Region

The following strategic priorities and interventions derive primarily from a consideration of the four priority farming systems selected for analysis within LAC. Nevertheless, given that the analysed systems contain within their boundaries much of the high concentrations of poverty and growth potential in the region, it is believed that the conclusions presented below will be broadly relevant across the region as a whole[69].

The LAC region offers a sharp contrast between extensive frontier areas with low population densities and significant future growth potential, and established densely-populated systems – many with a high incidence of poverty. Yet these two extremes share a number of common challenges that define a clear strategic focus for the LAC region over the next thirty years:

- sustainable management of natural resources and the reversal of resource degradation, both in established farming systems with high population densities, and in frontier areas where significant growth is anticipated;
- improved access to, and control over, land by poorer rural populations; and
- increased capacity of farming systems, and their smaller producers, to respond adequately to globalisation and market development.

These overall strategic thrusts require specific strategies and interventions in each of the five principal categories outlined in the introduction to this study. Each of these is briefly examined below:

NATURAL RESOURCE MANAGEMENT AND CLIMATE

Many farming systems in LAC are experiencing increasing levels of natural resource degradation. While established, densely populated systems display a wide range of characteristics, there is often an intimate linkage between size of holdings, degree of poverty and extent of natural resource degradation. In the absence of primogeniture or active land markets, fragmentation of holdings is a natural consequence of population growth over time. Without improved technologies to increase yields and improve soil fertility this inevitably leads to soil mining and expansion of cultivation into sub-marginal areas, as farmers seek increased output to feed their families and generate necessary income. Predicted population increases in "poverty" systems, such as the Established Tropical Drylands, the Mesoamerican system and the Central Andes, will only exacerbate these pressures.

Frontier systems with lower population densities face a different set of constraints. Settlement in these systems has been historically sparse due, in part at least, to limitations in agricultural potential. Poor management practices can result in widespread damage and degradation to the natural resource base, as already recognized in the Cerrados.

Although the solution to this problem may lie partly in the other strategic priorities (see below), interventions appropriate to densely populated systems include:

- the development and implementation of effective, community-level natural resource management

[69] The most important exception to the inclusion of regional poverty and growth potential within the analysed systems is that of the dispersed tropical forest system, covering the majority of the Amazon basin and adjacent humid areas. Clearly major economic growth – including agriculture - can be expected to occur within this system over the next 30 years. However, serious natural resource and political constraints render its development highly controversial.

plans, including technical assistance and incentives for adoption (appropriate technologies are discussed below) and an emphasis on demonstrating rapidly realizable benefits from watershed, forestry and other resource management activities;

- moisture conserving technologies in dryer areas to combat the droughts and desertification (e.g. N.E. Brazil and Central Andes), as well as effective watershed protection to protect against torrential rains and flooding in wetter areas (Mesoamerica and Northern Andes). Both impacts are likely to become more common as a result of global climatic changes;
- sub-marginal producers occupying land unsuited to arable production need support to enable them to cease to cultivate these areas. Clearly, this approach will only be effective where alternatives livelihood options are offered. Thus work on income generation relates directly to strengthened natural resource management.

For frontier systems, where population pressure is much lower, intervention priorities include:

- Development of a detailed knowledge base on natural resources and their characteristics within the system, and the linkage of this knowledge base to planning tools, as well as the identification, verification and dissemination of appropriate resource management approaches;
- Research on the development of crop varieties adapted to limitations of frontier zones (e.g. aluminium tolerance, post-harvest characteristics), and dissemination of results;
- Settlement incentives tied to appropriate settlement patterns and land use, including taxation (regional and municipal); land grants; facilitated credit for investment or working capital; eligibility for support services (marketing, extension, veterinary services, etc.).

SCIENCE AND TECHNOLOGY

A number of pioneering projects have shown that a range of technologies already exist and can contribute to improved natural resource management and drought tolerance, including:

- increasing soil organic matter content e.g. by legumes (*Mucuna pruriens and Canavalia ensiformis*);
- no-tillage cultivation, multi-cropping and small-scale irrigation linked to terracing on lower slopes and in semi-arid areas;
- vegetative barriers, contour protection, permanent crops and agroforestry on steeper slopes;
- zero or controlled grazing of livestock, especially goats, with fodder crops and trees;
- integrated management of fragile savanna soils (see Frontier Savanna case study).

However, increased research is needed on short-season and drought-tolerant crops suitable for small producers. More focus is also needed on technologies that increase labour productivity in systems with high levels of poverty. To increase the ability of smaller producers to compete effectively in growing international markets, research will also be needed in such areas as:

- adapting existing and future post-harvest technologies to the needs of smaller producers;
- appropriate IPM and organic cultivation practices and tools (e.g. biological controls);
- field testing of new varieties/species and determining optimal agronomic practices.

Finally, experience in a number of countries suggests that strategic priorities within this category must include a reorientation of research towards a more participative approach, working with small-scale producers and responding to their needs. Achieving this target will require considerable restructuring of national research organisations in many LAC countries, with particular emphasis on disbursement mechanisms for research grants, on field testing procedures, and on staff training in participatory methods.

GLOBALISATION AND MARKET DEVELOPMENT

The globalisation of trade and markets is putting increasing pressure on many traditional farming systems. Imported products increasingly compete in national markets, often undercutting local producers – at least in easily-served urban markets. A rapid transition to free market conditions will increase poverty levels in the short term, as producers struggle to

adapt. Those systems already associated with severe poverty are most seriously affected, as they often lack the human, financial and technological resources needed to adjust. Yet, in all the analysed poverty systems, globalisation and the reduction of trade barriers should also create opportunities for market development and diversification. However, not all system participants are likely to be able to benefit substantially from such changes, due to limitations on human and natural resources and isolation from potential markets.

A number of options appear to be available to producers in systems under pressure, including diversification, off-farm employment and supported exit, but outside assistance is required to facilitate the process. Experience shows that, rather than create direct state-supported interventions, the most effective strategy is to promote an active and competitive private and civil sector in rural areas (see Mesoamerican farming system case study), involving the following possible interventions:

- assist farmers to organise themselves to respond to new opportunities, including training group leaders in commercial management and administration; reduce obstacles to the creation and enforcement of contractual and other linkages to domestic buyers and exporters; promote value-added activities (selection, packaging, processing) through technical and financial assistance for quality standards, brand creation and targeted marketing, and financial support for required investments;
- reduce barriers to entry and costs of operations for small-scale enterprises and organisations active in input provision, marketing, finance, land markets and other services;
- provide infrastructure development and human resource training to meet the needs of larger-scale organisations initiating or expanding processing and other forms of non-farm employment.

One legitimate area of state intervention, however, will be applied research. There is a strong need in all farming systems for improved varietal selection, to strengthen responsiveness of production to market demand, and for field trials of promising diversification crops. Although hybrid genetic material would be acceptable for diversification, it is likely that material capable of on-farm multiplication would be a prerequisite for traditional crops.

POLICIES, INSTITUTIONS AND PUBLIC GOODS

Three key strategic areas are likely to dominate governmental and institutional roles within farming systems in Latin America over the next 30 years: (a) improving access to land and – to a lesser extent – water, in poverty systems and among poverty groups in more wealthy systems; (b) promoting alternative occupations for the rural poor who are not able to gain access to sufficient land and water to ensure an adequate living standard; and, (c) strengthening public goods in rural areas. In all these areas government must inevitably play a major role, although preferably working in co-operation with civil society and private sector groups.

Improving access to resources: For the Mesoamerican and Drylands systems (arguably less so for the Central Andean system), existing severe poverty levels are directly related to problems of access to, and control of, natural resources – primarily land. Across LAC, in many farming systems a small minority of producers occupy large areas of land, which are often utilised only at relatively low intensities, while most producers are confined to smallholdings which are increasingly less viable. Civil conflict has often been a direct result. Effective land policies will also be important in frontier areas (e.g. frontier tropical savannas) where in-migration from neighbouring poverty systems could lead to conflict. Key strategic priorities for LAC include:

- improved functioning of land markets, through acceleration of cadastral and titling procedures, conflict resolution mechanisms, and changes in land tax structures;
- land banks to buy both marginal and large holdings and resell land with the objective of consolidating smaller commercial holdings;
- fiscal disincentives to under-utilised holdings and incentives for sale to land banks;
- supported exit for sub-marginal producers including, where feasible, negotiating the purchase of traditional rights to land;
- enforcement of legislation prohibiting illegal seizure of lands and other resources. This applies not only to powerful interests capturing state land, for example, but also to small producers illegally occupying

private lands and colonists entering indigenous community lands. Where such risks are perceived to exist, land may not be put on the market or offered for rental due to the fear of attracting squatters. This has become a major issue in recent years in the coastal zone of Guatemala, for example.

Supporting alternative livelihoods: Despite the opportunities that may exist for diversification and increasing output value among small-scale farmers, it is not believed that more than a minority can ever escape from poverty by this route. There will inevitably be many marginal and sub-marginal farmers who simply lack the human, financial, locational and natural resource assets to benefit from these opportunities. Two broad alternatives exist: local non-farm employment and outmigration.

Non-farm employment offers a major route for escape from poverty in severely constrained farming systems and, if situated locally, can be successfully combined with continuing subsistence farming operations. Policies, institutional support and public goods can all play a major role in promoting such employment. In some areas, tourism or 'maquila' operations (assembly of clothing, electronics etc. in tax enclaves) provide opportunities, but their importance tends to be confined to specific areas. Natural resource-based industries offer an alternative employment source, but the disadvantages of rural compared with urban areas must first be overcome. National and local governments can cooperate with the private sector in the design of integrated programmes in which larger potential employers (agro-industries etc.) would be offered incentives to offset the perceived advantages of urban operations. Elements might include:

- Improved infrastructure in the area of the plant and its suppliers (roads, electricity, water, and telecommunications). This might include a long- term commitment from the employer to participate in financing the maintenance of infrastructure;
- Provision of training for future staff of the employer, in accordance with the needs of the enterprise;
- Assistance to the employer in supporting supply organisation among raw material providers (crops, livestock, etc.);
- The creation of rapid and transparent dispute arbitration and settlement mechanisms for suppliers and the employer.

However, Mellor[71] argues that the greatest growth in rural employment, and hence the largest impact on poverty, arises from a third source; provision of small-scale services and non-tradable goods[72]. Key interventions are also needed to help reduce transaction and establishment costs for small enterprises:

- Simplification of enterprise registration and approval procedures (hygiene, worker safety, IVA, etc.) for small companies;
- Assistance in preparing realistic business and investment proposals;
- Training in simple accounting and administrative procedures;
- More rapid and flexible financing of investments;
- Priority in connecting basic services (e.g. electricity, telephone, water, etc.).

Outmigration (urbanisation) has been the traditional response for those who are not able to participate in either diversification or non-farm employment. Despite having the most abundant natural resources per capita in the world, LAC also has the highest urbanisation rates, suggesting that this has been a common response. In recent years the tendency has been to focus attention almost exclusively on retaining the rural population in situ, and discouraging out-migration. Yet, if little potential exists for substantial increases in quality of life within the system, this retention policy must be questioned. Indeed, it is timely to identify and implement measures to ensure that any process of out-migration is a positive one, both for those migrating and for those remaining within the system. These would include innovative measures for increasing the human and financial capital of migrants so as to ensure better economic possibilities in the future. Several key interventions are possible:

- targeted out-migration incentives, providing capital to would-be departees handing over of control of any lands currently occupied to conservation

[70] "Agricultural Growth, Rural Employment and Poverty Reduction" John W. Mellor. Presentation at the World Bank Rural Week, Washington, March 2000.
[71] Remittance income from seasonal and long-term migrants can also be important (although recent evidence suggests that it is less important than often believed), but is largely omitted in this discussion because, by definition, it takes the employed out of the poverty area, and hence renders support measures of limited use.

authorities – where sub-marginal for cultivation or even agricultural purposes; facilitation of credit to would-be buyers where the land could consolidate the holdings of a neighbour, etc.;

- in-migration incentives to preferred areas, either rural (where frontier lands exist) or urban, where there is an interest in channelling migrants to specific intermediate cities.

Strengthening public goods. Although infrastructure provision in LAC is increasingly recognised as a private sector activity, rural roads, electrification and small-scale irrigation are still predominantly public goods, and essential for market development in many areas. The withdrawal of the state from many rural institutional activities (banking, extension, marketing) renders support and oversight of civic and private institutions essential.

INFORMATION AND HUMAN RESOURCES

Accelerated rates of change appear inevitable in traditional systems, and the process will require both improved information and human resources. Provision of information by the public sector involves substantial recurring costs and is frequently irrelevant to real market needs, so the service is best provided by private sector buyers and traders. It is necessary, however, to ensure competition in market operations by eliminating barriers to entry and improving rural infrastructure.

Human resource development should focus on actual training needs. Not all rural inhabitants are agriculturists, and besides literacy training this population also needs more utilitarian skills involving sewing, mechanics, welding, cooking etc. Such skills may also assist out-migrants in finding employment at their destinations. Training should also specifically address employee needs in rural areas (whether agro-industry or non-agricultural).

KEY ASSUMPTIONS AND PRE-CONDITIONS

A number of factors, such as the pace of globalisation, climate change or plant genetic improvements, may influence the prioritisation and operationalisation of the above regional priorities:

Pace and Extent of Globalisation

This strategy review adheres to the underlying assumption of the AT 2030 document that globalisation – defined broadly as the dismantling of barriers to trade between countries – will continue to proceed, albeit gradually. However, at least two other possibilities should be considered:

- If globalisation is reversed, and countries shift agricultural and food policies towards support for self-sufficiency, including high tariff barriers for basic grains and other staples, many of the trends foreseen in this regional analysis will change. The opening up of agricultural frontier lands, for example, is a direct response to globalisation of markets for products such as rice, vegetable oils and meat. Changes already underway in the Pampas and Campos zones might be reversed. The predicted shift of small-scale producers, in systems affected by poverty, away from production of basic staples for sale, would also be in doubt since domestic prices for these products could be expected to rise. However, given the high degree of urbanisation in LAC, a shift that benefits rural populations at the expense of urban food costs is unlikely;
- If globalisation is accelerated, the opposite problem may well occur. Farming systems would be unable to respond rapidly enough, poverty would increase rapidly and out-migration to urban areas would further accelerate. In fact, there are many who claim that the current rate of globalisation is too rapid, and poverty figures in LAC suggest that this was the case in the mid-1990s at least. Not only would full globalisation boost the development of frontier lands in LAC, it would also inevitably lead to shifts in cropping patterns as products still protected in industrial countries become exposed to international competition. Major increases in sugar cane, cotton, orange juice, and Mediterranean products (grapes, olives, and tomatoes) could be expected.

Climatic Change

Recent experience has shown how vulnerable considerable parts of LAC are to climatic variations, including hurricanes in Central America, flooding and loss of fisheries in Pacific South America and drought in N.E. Brazil. The AT 2030 report assumes that variability in climatic conditions will increase, and more

recent data indicates the possibility of average global temperature increases of more than 5°C. More worryingly still, the IPCC has concluded that crop yields in tropical and sub-tropical zones will decline as a consequence. However, it is still impossible to predict specific impacts in different geographical regions with any degree of confidence, given that the influence of climatic change is by no means uniform. It is suggested, therefore, monitoring and analysis of geographic impacts be intensified abd that the results be incorporated into rural development planning processes.

Breakthroughs in Genetic Material

The AT 2030 report has assumed substantial, but not revolutionary, changes in genetic capabilities of principal crop species over the next 30 years. In case of major breakthroughs in the modification of plants to meet environmental limitations and pest problems, the proposed strategy may require revision. While improved hybrids or sterile planting material would only be expected to have a major impact on commercial systems, the availability of true-breeding seeds capable of biological nitrogen fixation, greatly improved pest resistance or significantly higher yields, could have a revolutionary impact on the poverty systems. Even here, however, the relative frequency of sharecropping arrangements in N.E. Brazil suggests that not all areas would benefit equally.

Annex: Maps