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TAC REVIEW OF THE NON-ASSOCIATED CENTRES

LATIN AMERICA AND THE CARIBBEAN: AGRICULTURAL RESEARCH IN THE CONTEXT OF THE AGRICULTURAL DEVELOPMENT CHALLENGE

(Agenda Item 2)

Explanatory Note

At TAC 48, the Committee agreed that as a background to the discussion on a possible expansion of the CGIAR, analytical essays had to be prepared on constraints to increased sustainable production to meet demands for food. The papers were to be prepared by members of the Standing Committee for Priorities and Strategies and both the TAC and CGIAR Secretariats for each of the major developing world regions (sub-Saharan Africa; Asia and the Pacific; Latin America and the Caribbean; and West Asia Northern Africa (WANA)).

Attached is a draft copy of the paper on Latin America and the Caribbean. The paper was prepared under heavy time pressure and has not been discussed by the Standing Committee for Priorities and Strategies. Please consider the contents as rough draft material, only intended to provide some background information to the discussion on non-associated centres.

This paper should not be quoted and its contents not used for any other purpose than the discussions at TAC 49.

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION

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LATIN AMERICA AND THE CARIBEAN:

AGRICULTURAL RESEARCH IN THE CONTEXT OF THE AGRICULTURAL DEVELOPMENT CHALLENGE

This essay attempts to summarize the major challenges to be faced over the next 3-4 decades by the agricultural sector in Latin America and the Caribbean (LA/C). It is largely based on the 1988 FAO study on potentials for agricultural and rural development in the region, and on contribution on forestry by John Spears (World Bank) and on nutrition by Doris Calloway (UC, Berkeley). The objective is to provide the background, from a regional perspective, for the consideration of the relevance of the subject matter represented by the NACs and forestry research for enhancing the capacity of the CGIAR in achieving its goals.

The major challenges relate to the ability of the sector to serve as a major source of economic growth, to help alleviate the extremely high incidence of poverty and malnutrition that prevail in the region, and to do so in a manner that preserves the environment for future generations and provides for the sustainability of production overtime. The first two sections deals with major determinants of the challenge, that is, the present and future context in terms of population growth, employment, poverty and nutrition. The availability of land, forestry and fisheries resources is analyzed in Section 3. Section 4 deals with the major environmental concerns as they relate to agriculture and land use patterns. Section 5 deals with possible sources of production growth and alternative development paths from a regional perspective. Section 6 deals with the productivity challenges in the crop, livestock, fisheries and forestry sector. Some facts in relation to national programs are highlighted in Section 7, and the main conclusions are summarized in Section 8.

1. POPULATION AND EMPLOYMENT

The population in the region increased by nearly 150% during the period 1950-1985. This period was characterized by a strong process of rural to urban migration which resulted in a four fold increase of the urban population (Table 1). The urban share rosed from 41% to 69% of the total. Yet, total rural population increased from 97 to 126 million.

According to the UN medium variant projection, the region's population would increase by 92% between the years 1985 and 2025 (from 405 to 779 million; Table 1). The population in urban areas would increase by 135%, while aggregate rural population is anticipated to remain essentially constant around 124-128 million. This means that the agricultural sector, with about the same labor force, would need to provide food for more than twice the urban population of today; that is, for additional 376 million people. These projections, though probably underestimate the future growth in rural population, highlight the need to double average labor productivity in agriculture over the next 30-40 years.

Projected population growth differs considerably among sub-regions and countries. Sub-regions with highest growth would be Central America (with 161% growth between 1985 and 2025) and the Andean Region (112%). Countries with highest growth are: Honduras (204%), Bolivia (187%), Nicaragua (171%), Haiti (180%), Guatemala (172%), El Salvador (171%), and Ecuador (144%). Countries with slow growth include: Uruguay (28%), Cuba (35%), Chile (52%) and Argentina (55%).

In spite of the decline in the rate of growth of population, the number of people added every year would increase from about 9 million at present to about 10 million around the turn of the century. Net additions to the economically active population (EAP), would increase from about 3.5 million people/year at present to about 4.6 million people/year by 2010 (Table 2). Again, there is wide variations among subregions and countries. In Central America and the Andean Region, net annual addition to the EAP would continue increasing through the years 2020-2025, and in the few fast growing countries well beyond that period. This implies the need to provide every year for additional employment opportunities for an increasing number of people well into the next century.

Overt urban unemployment levels are high in most countries, ranging from 5% to more than 20%. For the region as whole, the number of unemployed increased by nearly 50% between 1980 and 1985 (FAO 1988). Estimates indicate that the incidence of unemployment is significantly higher among-low income groups, and that the proportion of heads of household among urban unemployed tended to increase (FAO 1988). Underemployment levels are also regarded to be extremely high throughout the region.

In addition there has been a considerable fall in real wages since 1980. Between 1980 and 1985 real wages in the region declined by more than 15% (FAO 1988), and in some countries such as Peru and Ecuador as much as 39% (Bianchi 1987). Furthermore, as a result of the stabilization programs the food price index went up faster than the general price index in most countries (FAO 1988).

The combined effect of high and increasing unemployment and underemployment, falling real wages, and relative increases in food prices in most countries have, no doubt, contributed to the aggravation of the poverty problem and of the risk of malnutrition among the low income segments of urban and rural population.

2. POVERTY AND NUTRITION

Estimates from ECLAC (1985) indicate that in 1970 there were in the Region 112 million poor people representing 40 % of the total population. Among the 11 countries included in the study, the incidence varied from 8% in Argentina to 65% in Honduras, where

2/3 of the poor were in destitution (having insuficient income to purchase a minimum food diet). Poverty was more common in the countryside than in the towns, ranging from 19% of the rural households in Argentina to 73% in Brazil and 75% in Honduras (Table 3).

Poverty and agrarian structure

Estimates from a World Bank sample of countries indicate that around 1975-80, 53 % of the rural population in LA/C could be considered as living in poverty (FAO 1987). The aggregation of estimates from various country studies indicate that the number of rural poor might well have increased by 1980 to 82 million representing 2/3 of the total rural population. Half of these were estimated to be in destitution (Table 4). Projections based on present trends indicate that the numbers of poor originating in the rural sector would increase by 27 million by the year 2000, with the consequent deterioration in the environment in both rural and urban areas (FAO 1988).

The root of the rural poverty problem and the reason for its aggravation is the dichotomy which characterizes the Regions's agrarian structure. Two distinct rural socioeconomic sectors have emerged over time: "one, the modern land and capital-owning sector which has managed to accumulate technology and public resources to develop the agricultural enterprises it controls; and the other, the large peasant farming sector, comprising small production units, having little or any kind of service whatever. The quality of land this sector occupies is gradually becoming worse and it is increasingly difficult for it to meet its primary objective --its own subsistance" (FAO 1988).

The medium-scale enterprises that have emerged have not changed much the dual character of the Region's agriculture. Modernization has intensified the existing dichotomy. The bulk of rural employment continues being provided by the peasant sector, with low labour productivity and low incomes. Rural-urban migration was encouraged, thus partially transferring the problem of underemployment to the urban areas. Results of government programs to alleviate rural poverty have been, with a few exceptions, very disappointing. The major ones, i.e., agrarian reform, settlement programs and integrated rural development projects have had limited overall impact in alleviating rural poverty.

According to FAO (1988), two lessons can be drawn from the past experience: (a) a dynamic agricultural sector, while essential, is not sufficient for combating poverty; it is absolutely necessary to promote a style of development where the rural poor play a major role in generating production growth and receive the benefits of that development; and (b) the priority of any economic strategy must be to solve the problem of poverty, since only if the domestic market expands can the growth rate rise in both the sector and the economy.

Food availability and nutrition

Average food availability for direct human consumption has increased from 2520 kcal/caput/day in 1969/71 to 2700 in 1983/85, and is projected to increase to about 2900 by the turn of the century, and to 3400 by the year 2025, a level comparable to current average levels in developed countries (FAO 1987).

Estimates of population at risk of malnutrition (below the 1.4 Basal Metabolism Rate -BMR) for selected countries are presented in Table 5. In the three larger countries the percentage of the population at risk was around 25 %. In three other countries it was around 40%. Percentages for Bolivia and Haiti are considerably higher.

Projections for the year 2000 anticipate a decline of undernutrition at the regional level in percentage terms. The absolute numbers of people at risk would increase, however, from 55 in 1983/85 to 62 million in 2000. About 2/3 of them would be at serious risk (below the 1.2 BMR threshold) (FAO 1987).

These projections, as will be discussed in Section 5, are regarded as being rather optimistic. Yet, they underscore the magnitude of the problem, which is more acute in countries in Central America, the Andean Region, North East Brazil and in the Caribbean. Furthermore, improving food availability is a necessary condition but far from sufficient. Growth and increased employment opportunities are essential. Improved articulation between agricultural policy and food policy is a must. There is a need to better target food intervention programs to the most vulnerable groups in both rural and urban areas. There is a need to improve their articulation with health, potable water, and education programs, as well as their efficiency both at the country and at the micro level. As it will be seen next, there is also a need to help solve noticeable deficiencies in certain minerals and vitamins.

Nutrition and health-related concerns

Deficiencies of certain minerals and vitamins, reflecting poor quality and/or variety of foods (rather than just quantity per se), are widespread and adversely affect the functional performance of large number of people in the region. The most common and devastating deficiencies are those of iodine, vitamin A and the factors need for blood formation, notably iron.

Iodine deficiency is best recognized by the symptom goitre and the mental and physical sluggishness associated with diminished thyroid hormone. Severe deficiency results in increased rates of spontaneous abortion and stillbirth, and cretinism with severe mental retardation, depth, mutism and dwarfing. Iodine deficiency is due to lack of iodine in soil and hence in water and locally grown foods. It occurs mainly in mountainous areas where iodine has been leached from the soil by rain water, and in inundated plains and coastal areas surrounding river estuaries. Deficiency

is most prevalent and severe where there is little commerce and the population subsist on local foods. It is estimated that 60 million people in the region are at risk of iodine deficiency and that there are 250 thousand overt cretins.

Severe vitamin A deficiency results in permanent blindness and even less severe deficiency is thought to be associated with increased morbidity and mortality in childhood. Vitamin A deficiency is rare where food supply contains adequate amounts of performed vitamin A (retinol, found in egg yolks, milk fat and liver). It occurs most commonly in populations where the principal or only source is pro-vitamin A carotenes in dark green and deep yellow vegetables and fruits, consumption of these is low and the diet is also low in fat which is needed for good absorption. The vitamin A supply in the region increased between 1960/65 and 1975/77 but remains below the average daily adult requirement of 750 mcg retinol equivalents (Figure 2). The distribution of mild and severe deficiency is shown in the map (Fig 1).

The lack of absorbable iron, and sometimes of certain B vitamins and other minerals, leads to anemia, which reduces physical work capacity and other functions. Iron deficiency is widespread, especially (but not only) in the less developed countries of the region. It is the most frequent nutritional cause of anemia. The diet is sometimes low in total iron content but often the problem is that the dietary iron is from plant sources and is poorly absorbed. Iron in meat, fish and poultry is highly absorbable and the presence of these foods and vitamin C promotes the absorption of plant-source iron. The supply of iron has fallen between 1960/65 and 1975/77 (Fig 2). Other nutrient deficiencies that contribute to anemia are the B vitamin folacin (found in leafy vegetables, liver, yeast, legumes, etc) and vitamin B-12 (found in animal-source foods). It is estimated that 26% of children, 30% of pregnant women, 17% of other women, 13% of men are anemic, or over 60 million people in the region.

These noticeable deficiencies with strong health implications raise the question of the possible role of agricultural and food policy research in helping increase the supply of the above mentioned minerals and vitamins in the diet, particularly of the more vulnerable groups.

3. RESOURCE BASE

Agricultural land availability

The region is well endowed with crop land per-capita compared to other developing regions, particularly in terms of the agricultural population in economically active age (Table 6). Less endowed subregions are the Caribbean, Central America and the Andean Region, in that order. Per-capita land availability looks even better when pasture land is added to crop land, except

in the Caribbean that is below the average for all developing countries, and Central America that is about the same level.

Sub-regional averages, however mask significance differences among countries. While most of the poorly endowed countries are in the Caribbean, three Caribbean countries are relatively well endowed (Belize, Cuba and Guyana; Figure 3). On the other hand, Peru and El Salvador have much less crop land available per-capita than the other countries in the respective sub-regions.

The land use pattern by land-water classes largely reflects the relative land endowment of the various types. Latin America uses more good rainfall type of land and less of the low and uncertain rainfall type than any other developing region (Table 7). The use of "problem land", however, is higher reflecting the larger endowment of humid tropics and its increased utilization.

The proportions of unused land reserves (78%) is much higher than in WANA (3%) and in Asia (18%), and somewhat similar to the reserves existing in Sub-Saharan Africa (75%; Table 8). This holds for all land classes. The coexistence of high pressure on land (as indicated by the existence of a large peasant sector) and a vast unused reserve is indirect evidence of the little geographic and/or economic accessibility to that reserve. In fact, most countries use proportionally more of their problem and uncertain rainfall land than of their good rainfall land (Figure 4). Lack of infrastructure is a major factor limiting the access to good rainfall land. The only exceptions are Argentina, El Salvador and Paraguay well endowed with such lands and infraestructure to access them.

Potential population supporting capacity (PPSC)

FAO has estimated the PPSC under three assumptions on level of input use. The PPSC estimates indicate the maximum population that could theoretically be fed at an adequate nutritional level from the used and reserved land potential. These estimates represent the absolute theoretical maximum of physical supporting capacity, based on theoretical diets according to calorie/land use efficiency criteria (FAO 1988). As illustrated in Table 9, LA/C is in a much better position to support the projected population for the year 2000 than any other developing region.

The estimates indicate, however, that the Caribbean Islands, Mexico and Central America would face significant socioeconomic pressure on their land resources during the next 40 years. Countries that could not support their population under the low input assumption by the year 2000 are listed in Table 10. Considering that these estimates disregard market, consumer and producer preferences as well as production costs, the situation of these countries (and of Mexico and Peru) must be regarded as critical. To achieve self-reliance, these countries would need to intensify agricultural production through higher level of input use and more efficient use of irrigation. Agricultural research has a critical role to play in making possible to achieve

generalized increases in yield while simultaneously improving input use eficiency and reducing production costs.

Irrigation potential

The potential for irrigation expansion is relatively high (31% in use, 69 % in reserve). Irrigation reserves are above 55 % in all subregions (Table 8), but varies considerable among countries. The Caribbean islands, Mexico and Peru are approaching their irrigation development potential at "affordable costs". As the more easily developed resources are exploited, the marginal cost of irrigation building increases. It is now rising in most countries in the region, but particularly fast in those mentioned above. Programs oriented toward rainfed agriculture are, in general, less expensive forms of increasing output and tend to benefit more farmers than new irrigation schemes.

With international prices of traditionally irrigated crops (e.g., cotton, sugar, rice, wheat in Mexico) on a long-run declining trend, irrigation is becoming profitable for high value crops only (e.g., vegetables, fruits, flowers) or for high yielding cash crops cultivated under high technology and management. These circumstances call for assigning priority to the rationalization of irrigation policies and tariffs, to improving the management of existing irrigation systems, to inducing improvements of water use efficiency at the farm level, particularly in the Caribbean, Mexico, Peru and Central America.

In summary, land is abundant at the regional level in physical terms with respect to population but socially scarce because of land tenure patterns. It is already physically scarce in most Caribbean Islands, in some Central American countries such as El Salvador and Guatemala, and will become increasingly scarce in Mexico and Peru over the next 40 years. Irrigation expansion can play an important role in increasing output but, because of rising costs, priority should be placed in rationalizing irrigation policies and pricing, and improving management of irrigation systems and water use efficiency at the farm level. Improved land use and agricultural policies are essential, but to allow for the required sustainable increases in productivity, agricultural research becomes critical.

Forest resources

Forests in LA/C cover nearly 1.3 billion ha which represents more than 40% of the total forest area in the developing world. About 47% of the total area in the region is covered with some sort of forest or woody vegetation (Table 11,FAO 1988). More than half of this area is found in Brazil.

Some 730 million ha are covered with dense forest (with treetops in contact or overlapping), representing 57% of the total forest area in the region, as well as 57% of the dense forest area in the developing world. Other developing regions are less endowed with dense forests (Table 11).

Three/fourth of the open forest areas are in Brazil, and the rest mostly in the Andean Region (15%) and in the Southern Cone (8%).

Areas in fallow (deforested, temporarily farmed and then abandoned to natural regrow) sum up to 172 million ha. Of these, some 100 million ha are in Brazil, 26 million in Mexico, 32 million in the Andean Region, 9 million in the Southern Cone and about 2 million in Central America and in the Caribbean respectively (Table 12).

Shrubland covers 175 million ha, and are found mainly in Brazil and Mexico which have almost 60 million ha each. Most of these areas are used for extensive grazing (FAO 1988).

In 1980, there were about 6 million ha of forestry plantations in the region, accounting for over 40% of the total in the developing world. About 650 thousand ha are planted each year, which represents less than one tenth of the area which is deforested (FAO 1988).

Undoubtedly, the region is well endowed with forest resources, but the socio-economic pressure on these resources is increasing at a fast pace, both for timber and fuelwood as well as for expansion of crop and grazing land. The annual rise in demand for industrial forestry products between now and the year 2000 has been estimated at 11 to 14 billion dollars (FAO 1988). The high and increasing rate of deforestation (discussed in Section 4), and the already large and increasing area left in fallow, are of serious concern. The concern arises not only because of the environmental implications, but also because of the effect of indiscriminate deforestation on the capacity of the countries to make an efficient use of their land and forest resources to provide for sustained economic growth and employment overtime.

Fishery resources

In the period 1982-86 the region's share of the total world catch was 14%, and reflected an increasing trend after the 1972 sudden collapse of the anchovy catch in coastal Peru. About 64% of the catch in 1982-84 went into the production of fishmeal, which compares with 28% used for that purpose at the global level. The region is a net exporter of fish and fish products, with exports averaging in 1982-86 2.2 billion and imports nearly 0.3 billion dollars. Fishmeal is the main export product, accounting for 45% of the world fishmeal trade (1980-85). Exports of shrimps have increased considerably during the last decade. These have had significant effect on export performance in Ecuador, and to a lesser extent in Mexico and Panama (FAO 1988).

Though fish does not figure large in the overall structure of consumption in relation to other sources of animal protein, average fish protein consumption increased significantly since the early 1960s, but dropped slightly since 1980 as a consequence of the economic crisis (Table 13, FAO 1988). The pattern of

consumption however varies considerably between countries as well as within individual countries (Table 14).

Marine fisheries account for nearly all of the production, though over the last 15 years there has been a notable increase in the output from inland fisheries and aquaculture, which in 1986 represented about 3.5% and 2.0% of the total catch respectively. There are good possibilities to increase marine catches by more than 60% but this, which varies considerably between the different maritime areas and species, depends much on the availability of investment funds for the renovation of fleets, port and processing infraestructure. More important in terms of the immediate potential for improving the nutrition of low income people, is the possibility to expand the canning of abundant, low-priced species at the expense of fish meal production, particularly in Chile and Peru.

Inland fisheries have traditionally played an important role as a source of employment and in the nutrition of the people living in the Amazon river basin. Four countries (Brazil, Bolivia, Peru and Colombia) accounted for nearly two thirds of the total catch in 1985, though in the case of Colombia, some came from the Magdalena and Orinoco river basin (Table 15). Fish farming in reservoirs has increased in Brazil, Mexico and Cuba. Inland fisheries could be expanded nearly five times, though this is constraint by the development of distribution channels, market opportunities and alternative uses of water.

Commercial aquaculture began in the 1940s with the introduction of trouts in rivers and lakes. It gained economic importance when shrimp cultivation got underway in Ecuador. In 1985, Ecuador's cultivated shrimp production accounted for 72% of the region's total and nearly 25% of the world's total. In recent years, Panama, Mexico, Brazil and Costa Rica have also been developing their own shrimp cultivation industries. Many other countries in the region are developing semi-intensive systems of higher value species, mainly shrimps followed by molluscs (Table 16). Among the finfish, the production of trout is expanding fast, though the production of carp, tilapia and indigenous species are also growing in some locations. Small-scale ponds with low-priced species are viable in certain rural areas where supply competition (from marine and river catches, and reservoir cultivation) in nearby markets is low, and there are abundant crop and animal residues.

4. ENVIRONMENTAL CONCERNS

There is a series of environmental concerns that relate to the sustainability of agricultural production in developing countries. The principal ones are listed in Table 17. While most of them are born in socioeconomic circumstances and policies, there is an important role to be played by agricultural research and development institutions. In the words of a scientist, "the role of agricultural research is to offer technical alternatives

to deal with the environmental concerns that arise from perceived constraints to sustainable agriculture; constraints that are borned out of socioeconomic pressures on the environment" (P. Jones, CIAT, personal communication).

Given the complexities of the interactions that give rise to environmental concerns, it is important to acknowledge different levels of analysis and of possible intervention. These vary along a continuum from the gene level through increasing levels of complexity up to the global level, and are illustrated in Table 18. This section attempts to summarize the major environmental concerns in LA/C as they relate to trends in agriculture and land use patterns, with the aim of deriving possible implications for international agricultural research in the region.

Risk of genetic vulnerability

The concern for genetic diversity originates in the increased risk of genetic vulnerability to biological and climatic shocks arising from widespread adoption of similar varieties with a narrow genetic base, and in the simultaneous loss of natural variability and land races. This problem is a relatively serious one for introduced crops such as cotton, soybeans, rice and wheat, and in the case of hybrids of various crops planted by commercial farmers. The destruction of natural habitats of wild members of the crop species and their relatives is a related concern in the case of indigenous crops (CIAT 1989). To diversify material, breeders must have free access to the full genetic range of the crop, including wild relatives. Well-characterized and preserved, pathogen-free germplasm banks are a prerequisite. IARCs have a continuing and critical role to play in this regard.

Need for integrated pest/desease management

The concern for noxious organisms originates in the expansion of monoculture, the increased shipment of seeds and, particularly, in the misuse of biocides. The intensification of cropping, especially in monoculture, can favor the evolution of new biotypes of existing noxious organisms (CIAT 1989). The observed trend in the region toward large areas in monoculture, increased use of nonselective pesticides and macro methods of application (aerial and tractor mounted sprayers) are expected to continue. These have often resulted in overuse and misuse of pesticides, and in substantial increases in production costs. "The frightening use of "pesticides cocktails" (consisting of numerous products combined at excessive doses) is common and results in unnecessary environmental contamination, human health risks, and arthropod resistance to chemical control" (Bellotti et.al. 1989). Integrated pest and desease control approaches are essential to reduce these environmental risks and to help reduce production costs. The successful implementation of a few IPM programs within the region is evidence of the potential benefits that could be derived from this approach (Bellotti et.al. 1989). National and international agricultural research have important roles to play in developing and supporting IPM.

Soil degradation

The widely held concerns for soil degradation refer to the problems of soil erosion, deterioration of its structure, decline in soil fertility, desertification and buildup of toxic elements (such as salinization). Except the latter one, these problems are closely associated to deforestation, and when this occurs in the hillsides and watersheds, it does result in siltation of water catchments and flooding. They are derived from inappropriate land use and cultural practices induced by socioeconomic circunstances prevailing in the region, and further exacerbated by inappropriate policies and by the absence of knowledge on economically viable alternatives at the farm level.

Soil erosion is a generalized problem throughout the region, and a particularly serious one in the hills and mountain slopes utilized by small farmers. In the Caribbean the problem is extremely serious in countries such Haiti, Dominican Republic and Jamaica and is becoming an increasingly serious one in the Windward Islands. Estimates for Mexico in the early 1970s indicate that 51% of the arable land was totally eroded or undergoing accelerated erosion (FAO 1988). About 250 000 ha in the semi-arid highlands of Mexico, that some 10 years ago were in pastures and are now cultivated with beans by small farmers, are undergoing extreme erosion processes (P. Jones, personal communication). The problem is not less acute in Central America were population pressure is rather high, particularly in Guatemala, Honduras and El Salvador. Even in Panama, were population pressure is not as high, soil erosion and silting is affecting the Alajuela reservoir which supplies water to the sluices of the Panama Canal.

The problem of erosion is also extremely serious in the Andean highlands, particularly in Peru, Bolivia, and Ecuador were extremely high population pressure on the land is not only resulting in permanent losses of crop and pasture lands but also increasingly inducing migration to the humid tropics and urban areas. A survey carried out in 1979 in the Tarija Valley (Bolivia) indicated that 34% of the land surveyed was eroded (Morello 1981 cited in FAO 1988). The deterioration of the watersheds in Peru lead to heavy flooding, landslides, and constitute a serious threat to the settlements and the irrigation systems in vast areas of the coast and of the highlands.

These problems are borned out of extreme population pressure by resource poor farmers on marginal lands. Consequently, their solution lies as much on providing them with viable production opportunities elsewhere, as on identifying appropriate technical solutions compatible with the prevailing production and socioeconomic circumnstances in each region, and supporting their adoption through credit, subsidies on conservation practices and technical assistance. On steep sites, reforestation may be the only practical way to control runoff and erosion. On hillsides, possibilities of controlling erosion include agro-silvo and agro-

silvo-pastoral systems, combinations of reduced or zero tillage, the use of erosion control structures, and the use of barrier strips of perennial plants, but these must be custom designed or adapted to the particular environmental and socioeconomic circumstaces of each region (CIAT 1989).

In spite of much lower population pressure on land, the Southern Cone countries have not scaped to the erosion problem. In Uruguay, 35 % of the surface area was undergoing moderate to serious erosion (CEPAL 1974 as cited in FAO 1988). Surveys conducted in the late 1970s and early 1980s show high incidence of erosion in the hills within the Pampean Region (Argentina), the rolling lands of Entre Rios (Argentina), and in Magallanes (Chile) (FAO 1988).

Problems of soil erosion, compaction and soil fertility degradation are of increasing importance in the lowland tropics and subtropics, even in gentle slopes of less than 2% (CIAT 1989). Much of the problem is associated with deforestation, particularly in the humid areas. Fortunately, most of the Oxisols and Ultisols found in these areas are rather deep, and the slopes gentle enough, to allow for effective conservation practices such as no-till planting, minimun tillage, alley cropping, contour rows and terraces (CIAT 1989), but such practices are seldom utilized.

Unlike the situation in temperate zones, 75% of the nutrients in the tropical forest ecosystem are found in the biomass and only 25% in the soil (FAO 1988). The nutrient stock released by clearing and burning the forest last little under heavy storms. Crop productivity depends much on the development of cultivars adapted to acid soils as well as on regular additions of lime and chemical or organic fertilizer. Research has a critical role to play in developing and adapting technological alternatives for allowing sustainable agricultural production in these areas.

Deforestation

Indiscriminate deforestation is perhaps the most alarming problem, because of the associated problems of soil degradation, siltation of water catchments, exacerbation of flooding, and losses of natural habitats of indiginous flora/fauna species.

Estimates around 1980 suggest that the annual rate of deforestation was about 5.9 million ha of dense forest plus 1.1 million ha of other types of forest and shrubland. The regional forest acreage is shrinking by an average of 0.6% per year, but in some countries deforestation rates well exceed that figure: Argentina (3.5%), Costa Rica (3.4%), Nicaragua (2.6%) and Ecuador (2.1%) (Table 19). In addition, about 3 million ha/year are brought under selective logging for timber production (Salcedo and Leyton 1986), totalling nearly 10 million ha affected each year. In contrast, only 650 thousand ha/year are planted, which represents less than one-tenth of the acreage annually deforested in the region (FAO 1988).

The evidence seem to indicate that the rate of deforestation has accelerated in the past few years. This is due to population pressure combined with inadequate land use and land tenure policies. An FAO survey (1988) concluded that about one-third of the deforestation taking place is caused by shifting cultivation. As it has been traditional in the region, resource poor farmers capitalize the only resource they have, their labor, to turn down small areas of forest and burn the biomass to be able to plant subsistence and cash crops. As the residual fertility declines they move on. There is no reliable data on the proportion of the area under shifting cultivation in which the fallow period is below the minimun needed (20 years or more) to maintain soil fertility. However, there are many former forest areas where shifting cultivation have led to visible ecological decline. The problem seem to be even more serious in the case of ill conceived agricultural settlement and livestock ranching schemmes, which presumably account for a larger share of the deforestation taking place.

The problem is particularly serious in the humid tropics and subtropics, where irreversible damage is done because of inadequate information and technologies for sustainable production in this fragile ecosystem. The most seriously affected areas are found in southeast Mexico, Central America, the Andean foothills, and in the Brazilian Amazon. Recent papers by Mihar (1988) and Binswanger (1989) conclude that general tax policies, special tax shelters, rules for public land allocation and the agricultural credit system are all contributing to accelerated deforestation of the Amazon. These policies favor large holdings and reduce the chances of the poor to become farmers.

Deforestation in the highlands and hillsides are of particular concern not only because of soil losses but also because of the resulting siltation of water catchments and exacerbation of flooding. The problem is affecting virtually all the mountainous areas in the region.

Deforestation in arid and semi-arid zones is affecting their precarious ecological balance. Demographic and livestock pressure, though not very high, is enough to upset the balance by removing the protective functions of the forest or woody vegetation. The problem is of increasing concern as it affects large areas in many countries (see section on desertification below).

According to FAO (1988), about 60% of the region's population (some 250 million people) depend on fuelwood as a source of energy for cooking and heating. About 80 million people (normally the poorest) depend exclusively on fuelwood (McGaughey 1988). Acute fuelwood shortages affect a total of 25 million people, whom often tend to use crop residues or animal dung, thus depriving agriculture of an important source of nutrients. The main fuel deficit region include densely populated areas in the highlands of Peru and Bolivia, most of the Caribbean Islands, El Salvador, semi-arid region in Mexico, and the sub-dessert coastal areas of Peru and northern Chile.

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Of particular concern is the risk that unique germplasm and wildlife would become extinct as deforestation proceeds. IUCN and other conservation agencies have identified a number of "hot spot" areas where the risk of specie extinction is more immediate. They include western upland Amazonia, the norwest of Ecuador, the north coast of Brazil, the Colombian Choco, and the lowland tropical forests of Mexico.

All of the above suggests that there is an urgent need to develop an interactive research approach integrating: (a) assessment of negative ecological externalities of ongoing processes, (b) technical feasibility studies of stable land use systems for the various agro-ecological zones and the development of appropriate technologies, (c) economic analysis of alternative strategies to move from existing systems to the envisaged more stable production systems, and (d) studies of the impact of alternative policies on these development paths (adapted from Sere and Jarvis, 1988). The appropriate level of analysis is, obviously, at the country level. However, as there is the possibility of capturing economies of scale in some of these research areas, there is a need to analyze the possible role of international agricultural research and to define the appropriate modalities of operation.

Desertification

The risk of desertification affects about 20% of the area of the region, and the risk is high in about half of that area (FAO 1988). The main causes of desertification are bushfires, deforestation, overgrazing, and cropping of semi-arid zones. This largely manmade problem, is of increasing importance in North East Brazil, the highlands of Bolivia and Peru, and in some Caribbean Island (particularly the Leeward Islands), where it is often associated with small farm agriculture. It is also of increasing importance in northern Mexico, Argentina, Chile and coastal Peru, but mainly associated to commercial crop and livestock enterprises. Their solution need to be based as much on policies designed to decrease the population and economic pressure on these areas, as in the search for land use systems and cultural practices designed to prevent them.

Salinization

Though not a generalized problem, salinization is becoming of increasing importance in certain regions. It is greater in arid and semi-arid zones because of insufficient rainfall to lixiviate the salts. It is also of increasing importance in some irrigated areas due to poor drainage or use of saline water. In Mexico more than 12% of the irrigated area was affected by salinization in 1980 (SARH, cited in FAO 1988). In Peru, salinization affected one third of the irrigated area in the coast (ONERN, cited in FAO 1988). Salinization affected also significant areas in irrigated districts of Haiti and Dominican Republic. Overall, 20% of the area under irrigation in LA/C is either waterlogged or suffers

from excessive salinity, or both, and are bound to go out of production (FAO 1987). Research to develop crop varieties tolerant to salinity can help delay this process, but is costly, only partially effective, and would allow to gain just a bit of time. The solution must be sought through improved drainage at the district level, and water management practices at the farm level to help lixiviate the salt.

In summary, environmental concerns are of increasing importance in the region. The most important ones from a regional perspective, in terms of long-term sustainability of production, are soil degradation (particularly erosion and loss of fertility), indiscriminate deforestation, desertification, narrow genetic diversity of commercial cultivars, increased risk of noxious organism, and salinization of some irrigated areas, in that order. The order of importance varies considerably among countries. Most of these problems originate in prevailing socio-economic circumstances associated to land tenure patterns and limited access to resources by small farmers. Agricultural and socioeconomic/policy research have a critical role to play in providing viable alternatives to help alleviate many of these problems. Their solution, however, will ultimately depend on the adoption of land use and development policies appropriate to the socioeconomic circumstances and resource endowments of each country. Some other problems such as increased risk of genetic vulnerability and of noxious organisms are more R&D related. In these cases, agricultural research has a leading role to play, both at the national and regional/international levels.

5. SOURCES OF OUTPUT GROWTH AND DEVELOPMENT PATHS

Projected crop output growth

Projected increases in crop area, based on the central case scenario of the FAO AT 2000 study, are presented in Table 20. Arable plus permanent crop land is anticipated to increase at a rate of 1.8 million ha/year between 1982/84 and 2000. This is slightly less than the 1.9 million ha/year rate estimated for the previous two decades. More than half of the expansion would take place in Brazil, where the rate is expected to increase. The rate of expansion in cultivated area is expected to be proportionally lower in less endowed countries (e.g. in the Caribbean, Central America, and Mexico). Yet, it is regarded as being considerably high, given their more limited land reserves and the associated environmental concerns.

Cropping intensity is expected to increase from .63 to .66, resulting in a proportionally lower increase in the regional total for fallow land. Land in fallow would decline in Mexico, Central America, the Southern Cone, and in most Caribbean Islands (the exception being continental countries such as Guyana, Suriname and Belize with large reserves).

Harvested lands under irrigation is projected to increase at a rate of 317 thousand ha/year (80% from new irrigation facilities and 20% from land use intensification). These areas are expected to increase by 43% in Mexico and the Southern Cone, 46% in Central America and 50% in the Andean Region. The feasibility of this scenario, however, is questionable on the grounds of the increasing cost of irrigation building, the low international prices for export crops, the reduction in foreign capital inflow and in domestic savings, and the fiscal budgetary restraints (implying low public investment) prevailing in the region.

Crop output growth is normally decomposed in four factors: (a) arable land expansion, (b) increase in cropping intensity, (c) yield increase, and (d) changes in the crop mix (expansion of area of area planted with more valuable crops relative to less valuable ones). Relative past and projected contributions are depicted in Table 21. Past yield contributions include those of cropping intensity, while projected yield contributions include the effect of changes in the crop mix. Increases in yield and in cropping intensity are expected to contribute significantly more than in the past, while the contribution of land expansion to output growth is expected to decline from 63% to 39%.

These projections can be regarded as being rather optimistic in terms of output growth because of two major reasons: (a) demand constraints, and (b) financial constraints to investment in irrigation and infrastructure. The latter ones were already discussed above. Demand constraints are briefly discussed next.

Demand constraints

Demand condition are not expected to be favorable in the coming decade, at least during its first half. The stagnation brought about by the debt crisis, the attempts to stabilize the economies and to introduce structural adjustments to provide for growth, have resulted in increased unemployment and drastic reductions in real wages in most countries (see Section 1). The result has been a reduction of domestic food demand. Furthermore, gross domestic investment in the region fell from 24% of GDP in 1980 to 15% in 1987 (Garramon 1988). Net investment has been often negligible and even negative in many countries. As long as the debt crisis is unresolved, net investment is expected to remain at extremely low levels in the majority of the countries, or at least, in countries representing the majority of the population in the region. Thus, slow growth and high unemployment/underemployment can be anticipated, resulting in a sluggish growth of domestic demand for farm products.

Except for the export of flowers, and off-season/tropical fruits and vegetables (which represent a small percentage of agricultural production), export demand is also expected to have a sluggish growth. A slow growing demand for farm products sets an absolute ceiling to the expansion of farm incomes. It also puts a limit to land expansion which can only proceed on a sustained basis as long as the additional output can be absorbed

by expanding markets with attractive prices. The real increases in food prices that resulted from the stabilization programs implemented in many countries, have been often insufficient to compensate for the increases in production and financial costs. The result is a general lack of market incentives to increase food production. These demand constraints, together with the financial constraints to investment in irrigation and rural infraestructure, cast serious doubts about the feasibility to expand output as anticipated in the above mentioned projections for the year 2000. On the other hand, the projections illustrate the importance of improved technology in making feasible an agricultural based development strategy in the region.

Development paths

FAO (1988) undertook a simulation exercise to assess the payoffs of alternative development paths consisting in intensification of land use (increasing cropping intensity and yields) as compared to bringing new land into cultivation. The results indicate that intensification is a superior strategy in terms of crop GDP growth, both total and per unit of primary factor added. Area expansion would require a much higher investment. To achieve a 10% increase in agricultural output annual investments would need to increase between 16% and 26% in the case of exclusive area expansion, but less than 1% if the investment is oriented exclusively to yield increases. Land expansion is superior only with regard to labor absorption. Intensification is more cost-effective but less employment-effective than land expansion.

Any development strategy cannot ignore the small farm sector that represents around 80% of the production units and provides the bulk of the rural employment. Close to 40% of the regional production for the domestic markets originates in the small farm sector, including family type of farms (Lopez Cordovez 1982). The small farm contribution is more than half in the case of several crops such as cassava, potatoes, beans and maize, and in some countries is as high as 90%. This sector utilizes less capital and imported inputs, and more labor-intensive technologies. Thus, it makes a more efficient use of the socially available resources than the large farm sector. The development of the technological and policy environment conducive to their active participation in the development process represents one of the major challenge faced by policymakers throughout the region. To the extent that this is achieved, food demand and supply would increase simultaneously, thereby providing for growth of the agricultural sector, as well as of the rest of the economy through the various backward and forward economic linkages.

All of the above suggests that the overall agricultural development strategy should seek output growth in a manner that increases simultaneously rural employment and labor productivity, provides for cost reductions, and does not require much capital and imported inputs. This could be achieved through a mix of area expansion, yield increases and increases in cropping intensity and stocking rates; the right mix depending on the specific

conditions of each country. Frontier expansion should be seen as a way to expand employment opportunities. Increases in labor productivity should be achieved through generalized increases in yields and, particularly, land use rates which have higher employment creation capacity (FAO 1988).

The role of technology

Technology generation is essential to: (a) allow for generalized and sustained increases in yield; (b) allow for increased cropping intensity and stocking rates; and (c) make feasible the sustainable (economic and environmentally sound) expansion of crop/livestock areas in selected AEZs within each country. Technology biases should be toward:

-- cost reduction per unit of output (shift of the response functions) through adapted and input responsive cultivars, and through improved crop management practices that allow for increases in input use efficiency, with particular emphasis on technologies tailored to the small farm sector;

-- allowing for increased cropping intensity (double cropping) through earlier planting/maturing varieties and integrated soil, water and pest/disease management practices; and

-- overcoming soil and other environmental (biotic and abiotic) stresses in selected new areas through varietal improvement and integrated crop management practices, so as to allow for production at lows cost and the implementation of viable colonization programs in such areas.

6. RESEARCH AND PRODUCTIVITY

6.1 Crop Productivity

Average yields of most crops are between one-fifth and one-third of their potential. Generalized and sustained increases in yields and cropping intensity can only be achieved through a combination of more intensive use of:

-- irrigation and improved water management;
-- chemical inputs, fertilizer in particular;
-- improved, input-responsive and stress-tolerant varieties; and
-- improved crop management practices.

The appropriate combination of these yield-contributing factors would depend on the particular circunstances of each country, crop, growing environment and group of farmers. Since the four factors are highly interactive, as well as environment and crop specific, there are obvious advantages in integrating R&D efforts at the local level. The role of international agricultural research should be seen more as a source or improved germplasm, new knowledge, methods and principles that could be used as tools by NARDSs.

Irrigation and water management

The irrigated surface is roughly 12% of the harvested area in the region, but the value of crop production is significantly higher. The potential for irrigation expansion is high and cannot be ignored if the goal is to intensify production. The rising cost of irrigation in most countries, and the need to increase the employment and productive capacity of small farms, would call for assigning priority to:

-- rationalization of irrigation policies and water tariffs;

-- improved management of irrigation systems;

-- flood control, drainage and rehabilitation of saline lands (often cheaper and with higher social impact than new irrigation schemmes);

-- small irrigation schemes over large ones (they tend to be more cost-effective, use less foreign input and capital and more local labor, and are easier to operate and manage by farmer's associations);

-- irrigation and supplemental irrigation programs oriented toward the small and medium size farms; and

-- adapting and recommending practices for increased water use efficiency at the farm level.

The more cost-effective strategy would depend on the particular conditions of each country. Thus, policy and water management research need to be conducted at the national level, except where across-border externalities are involved. The justification for international support to policy research lies in its capacity to develop robust but simple methods of wide applicability. The role of international water management research, however, is not as clear and thus merits further analysis.

Fertilizer and soil-related research

Fertilizer use increased considerably in the two previous decades but stabilized, and even declined in some countries, since 1980 (Table 22). In order to reach projected production levels for the year 2000, total fertilizer consumption would need to increase at 4.6% per annum; about three times faster than labor and arable land (FAO 1988). Prevailing demand constraints would make such a high growth rate difficult to achieve. Thus the need to increase fertilizer use efficiency through applied soil-plant nutrition research, fine-tunning fertilizer recommendations, and improved soil management practices. Because of location and crop specificity, the major share of the research burden lies on the shoulder of NARDSs. Areas in which economies of scale in research can or could be captured through international agricultural research and/or networking include:

-- development of germplasm tolerant to soil stresses, particularly to soil acidity and aluminum stress (prevalent in most of the humid lowland tropics and in many intermediate altitude areas throughout the tropics and subtropics) and to drought stress (to allow for double cropping, and increased productivity and stability of yields in drought prone areas);

-- improving the understanding of the chemistry of the various types of acid soils, particularly as it relates to P fixation characteristics and ways to induce leaching of Ca into the subsoil;

-- improving the understanding of soil-plant-organic matter and soil microbiology interactions (e.g., mycorrhizae), in order to derive research methods and crop/system management principles of wide adaptability;

-- development of economical methods to produce nutrients, particularly P but also K and Mg, and fertilizers from indigenous sources; and

-- development of methods and capacities for integrating knowledge on land-water classes, soil-related and socio-economic constraints on selected areas (including frontier areas) to facilitate land-use policy analysis by national programs.

Pesticides and crop protection research

The use of pesticides has increased steadily over the previous two decades and is projected to increase to the year 2000 at about the same rate than crop production (2.6% per annun) (FAO 1988). Chemical weed control offers and opportunity to increase yields and labor productivity in small farm agriculture. The need is for adaptive research to provide for environmentally sound and cost-effective practices.

Integrated pest and desease approaches are essential to reduce environmental risks and help reduce production costs (see Section 4). Large economies of scale can be captured through international agricultural research (conducted within the region), training and networking in:

-- the development of tolerant/resistant germplasm to pests and diseases of generalized economic incidence;

-- the development of simple methods for determining thresholds for economic application of pesticides, particularly for use by small farmers; and

-- the identification of natural enemies and the development of simple methods for the implementation of biological control programs for some crops.

6.2 Livestock productivity

Livestock production is more important in LA/C than in any other developing region. On a per caput basis, by 1982-86 the region had five times the mules, four times the horses, nearly three times the cattle, about twice the milk cows, 50% more chickens and 20% more sheep and pigs than the rest of the world (FAO 1988). Livestock products are important in the diets and absorbe a large share of the family budget of low income groups (Muchnik and Nores 1980). Demand for livestock products tends to grow faster than demand for other staples. Except comercial poultry and swine operations, and cattle in temperate areas, livestock productivity is well below potential.

Ruminant productivity is low because of the interaction of poor nutrition, low mineral intake, and extensive management practices including low use of preventive animal health practices. Improved nutrition, mineral intake, management and animal health are all important to increase animal productivity. Intensification of production, however, would be feasible only if an improved feed resource base is developed at the farm level. Improved pastures, that allow for significant increases in stocking rates and animal performance, have a critical and catalytic role to play. The most effective way to decrease the market pressure on the Amazon and Orinoco forest lands is to improve the comparative advantage of the nearly 200 million ha of acid soil savannas and "cerrados" for crop and animal production. Because of economies of scale and high potential payoffs, international research and networking efforts should continue concentrating in developing improved pastures for these acid soil areas, but because of the potential implications for employment and equity, it should pay increasing attention to improved pastures, cut-and-curry and browsing species suitable for the small, labor intensive, dual-purpose operations so common throughout Tropical America.

6.3 Forest productivity

In relation to almost all potential end uses, the current productivity of forests, open woodland and farm trees in the region is running well below potential. To illustrate with a few examples:

* Despite the fact that the region's rainforest contain about half of the world's plant (and animal) species, less than 20% of those species have been identified. Less than one percent have been chemically screened for potential medicinal properties.

* The natural forests contains up to 300 potential timber species, but less than 10% of these are currently utilized in any significant quantity.

* The average productivity of fast growing industrial plantations of Eucalyptus in Brazil is in the order of 6-8 m3/ha/year compared with potential 30-50 m3.

On one hand there are useful opportunities that await exploitation but, on the other, indiscriminate deforestation is accelerating due to demand pressure for land as well as for timber and firewood. A consistent land use and development policy would seek to exploit such opportunities in a way that decreases the socioeconomic pressure for indiscriminate deforestation. This can be achieved through increases in crop yields, cropping intensity and stocking rates (as discussed above), and simultaneously fostering the development of fast growing industrial plantations and the use of multipurpose trees.

Tree improvement

There is a large potential for increasing the productivity of fast growing multipurpose trees for farm, forestry, fuelwood or industrial usage by simple, more systematic tree improvement research. For example, through selection and the use of fast propagation methods a commercial company in Brazil has succeeded within one generation in increasing yields of its Eucalyptus plantation from 30 m3 to 60 m3/ha/year.

Two examples of the potential of industrial plantations for generating economic activity and employment are worth mention. Brazil's 4 million ha of Eucalyptus and Pine plantations established during the last 15 years already meet 60% of the country's own industrial timber needs and sustain some US$ 600 million a year in foreign exchange earnings. In the State of Mina Gerais reforestation and production of charcoal for the steel industry provides employment for nearly 1.2 million people. This compares with 60 thousand people employed by the steel industry. In the last 20 years Chile has established almost one million ha of fast growing pine plantations which today support an export-based timber, pulp and paper industry generating exports of more than US$ 500 million a year (FAO 1988).

From an ecological and sustainable land use perspective, intensively managed fast growing on-farm fuelwood or industrial plantations such as those of Chile and Brazil play a key role in helping to relieve pressure on the natural forest. For example, the sustainable annual output of 150 million m3 of wood from Brazil's 15 million ha of plantations would otherwise have to be secured by opening up of about 150 million ha of natural forest.

Upgrading the productivity of these and other plantation species by simple tree improvement has potential significance to improve profitability of such industries and to contribute to expanding export trade and generate rural employment. International research networks that provide for interchange of information and germplasm may play a catalytic role in fostering current efforts in both the private and the public sector.

Agroforestry

Similarly, ensuring a supply of improved seed of selected ecotypes of fast growing species such as Leucaena, Sesbania and

Gliricidea is a key to securing farmer's cooperation in on-farm agroforestry research aimed at erosion control, nutrient cycling, production of fuelwood, fodder, building poles and for fencing. CATIE, with headquarters in Costa Rica, has conducted usseful research in agroforestry and watershed management in some ecologies in Central America. Areas in which, from a regional perspective, there exist opportunities for tapping economies of scale through international efforts and networking include:

-- germplasm collection, characterization and conservation of the most promising multipurpose tree species;

-- the development of simple experimental designs and analytical techniques for agro-silvo and agro-silvo-pastoral systems adapted to hillsides, humid, subhumid and semi-arid tropical environments, in that order of priority; and

-- the development of information and seed exchange networks.

6.4 Bananas, Plantains and Vegetables

In terms of value of production bananas and plantain as a group are more important than all root crops put together in Mexico, Central America and Tropical South America (CGIAR 1987). Banana production is particular important in Brazil (18% of world production) and Mexico (5%). Banana exports are important for Ecuador (16% of world exports), Colombia (13%), Costa Rica (13%), Honduras (12%), and also for Brazil, Mexico, and the Winward Islands (Bonte-Friedheim 1988). Most of production for exports comes from medium to large commercial plantations which are often engaged in research and linked to international or subregional research/information networks such as INIBAP and WINBAN in the Eastern Caribbean. Production by small farmers are also important throughout the humid tropics, but mostly for on-farm consumption and sales in nearby markets. The share of small farm production in total banana exports is increasing in several countries. Pest and diseases of increasing economic importance include Black Sigatoka, Sigatoka, banana wilt, banana weevil, and nematodes. Because of their geographic spread and impact on yields, increased international attention through research and information networks would appear to be justified from a regional perspective.

Plantain and starchy banana production is important throughout the tropics, but particularly important in Colombia (11% of world production), Dominican Republic (4%) and Ecuador (3%). Plantain exports are almost negligeable, but of some importance for Venezuela, Honduras, Costa Rica, Dominican Republic and the Windward Islands. Average yield is rather low (7.2 tn/ha) and appear to be stagnant and even declining in some areas. As in the case of many root and tuber crops, per-capita consumption is declining with urbanization. Yet, because of its importance for small farmers and low income consumers throughout the tropics, and because of the possibilities for achieving yield increases

through plant improvement and reducing post-harvest losses, there appear to be merits in increasing international support to research and information exchange networks, with emphasis on the major pest and diseases and reduction in post-harvest losses.

Vegetables production represents more than 3% of total value of agricultural and livestock production in the region (CGIAR 1987). Per-capita consumption in 1984 was 37 kg/per caput/year, or about the same level than in Africa (35 kg), and significantly lower than in Asia (109 kg) and the Far East (47 kg) (Boonma Ch. cited in TAC 1988). In the 1970's, vegetable production increased by 3.7% in Tropical South America and by 5.3% in Central America. Production for exports to off-season markets in temperate countries (particularly to the USA and Canada) has increased in recent years in Mexico, Central America, Chile and some Caribbean Countries (these also have expanding domestic markets due to tourism).

While there is no doubt of the need to foster increase vegetable production and consumption in the region, two major questions need to be answered before embarking in major international efforts in vegetable research and networking in the region. These questions refer to:

-- the possible role of agricultural research in fostering the expansion of production and consumption of selected vegetables that could help alleviate the mineral and vitamin deficiencies, notably iron and vitamin A, which are rather generalized in large subregions (see Section 2);

-- the identification of specific research priority areas where international agricultural research, germplasm exchange and networking could have large impact, and in which there are comparative advantages vis-a-vis the private sector and the existing national programs.

7. NATIONAL PROGRAMS

It is beyond the scope of this essay to analyze the relative strenghts of the national programs in the various fields and their individual perspectives and priorities. Some general facts, however, are worth to be highlighted:

* While investment in agricultural research increased considerably in the 1960's and 1970's, the financial situation of most national programs deteriorated rapidly in the 1980's, jeopardizing their capacity to conduct research and development. [this should be expanded and documented on the basis of data from studies by ISNAR and IICA]

* In relation to the IARCs, Directors of National Programs from 22 countries (CIAT 1988) have recommended to assign high priority to:

-- continued provision of superior germplasm;
-- strategic research and the development of a biotechnology capacity so as to tap new knowledge and support NARSs;
-- environmental concerns which should continue to permeate strategies and activities of IARCs;
-- active participation of NARSs in the design, implementation and evaluation of research networks, both existing and new ones (concern was expressed about the proliferation of networks leading to excessive dispersion of NARSs scarce resources);
-- fostering the sharing, among IARCs and NARSs, of international research and training responsibilities in specific areas to alleviate IARCs, and assist NARSs, especially less developed ones;
-- training in research management and priority setting;
-- training on specialized areas, and new methods and tools;
-- assistance for postgraduate degree studies and assistance in the establishment/strengthening of graduate programs in the region; and
-- providing opportunities for national scientists to expend sabbatical study periods at the Centers.

* There is a need to develop informal but effective consultation mechanisms among donors and NARSs at the regional level, so as to assure adequate dialog on priorities and on the implementation of appropriate mechanisms to support regional institutions and programs (e.g. CARDI, CATIE, networks) so as to provide for relevance and accountability in a cost-effective maner.

8. SUMMARY AND CONCLUSIONS

The combined effect of high and increasing unemployment and underemployment, falling real wages, and relative increases in food prices have contributed to the aggravation of the poverty problem and of the risk of malnutrition among rather large and increasing segments of the urban and rural population.

Although land is abundant at the regional level in physical terms with respect to population, it is socially scarce because of land tenure patterns, socioeconomic pressures and constraints, and environmental concerns. This is evidenced by the rather large proportion of small and subsistence farms, and by the extremely high incidence of poverty and unemployment in agriculture exercising high and increasing pressure on marginal lands. The most important environmental concerns in terms of long-term sustainability of production are soil erosion and losses of fertility, indiscriminate deforestation, desertification, narrow genetic diversity of commercial cultivars, increased risk of noxious organisms, and salinization in some irrigated areas. Besides being socially scarce, land is already physically scarce in the Caribbean Islands, in Central American countries

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(particularly in El Salvador and Guatemala), in Mexico, and in Peru, representing nearly 40% of the region's total population.

The situation calls for an overall agricultural development strategy that decreases the socioeconomic pressure on the most fragile or pressured environments. Output growth should be sought in a manner that increases simultaneously rural employment and labor productivity, provides for cost reductions, and does not require much capital and imported inputs. This can be achieved through a mix of area expansion, yield increases and increases in cropping intensity with emphasis on the small farm sector; the right mix depending on the specific conditions of each country. To allow for the required sustainable increases in productivity it is essential to improve land use and agricultural policies that built on the foundations provided by available and new, custom-designed technologies.

Adaptation of existing technologies and known principles by national programs can contribute to achieve output growth in the short and medium term, but given the nature of the problems to be solved as defined by market, socioeconomic and environmental constrains, the generation of new knowledge and technologies becomes critical. The challenge faced by national programs is that of generating the appropriate technologies to help solve their respective problems through strategic, applied and adaptive research.

From a regional perspective, there is considerable time to be gained and there are some obvious economies of scale that can be captured through collaborative international agricultural research and networking in certain specific areas. Some of these areas fall within the subject matter areas of the non-associated centers and merit further assessment from a global perspective, as well as in terms of the most appropriate operational modes to support them, be it directly or indirectly. Ultimately, the capacity of the CGIAR to achieve its goals will depend on the coherence of its strategy and on the synergy created by the set of activities it supports in the region.

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FIG.1: SPECIFIC DEFICIENCIES

NO CASES RECORDED
SPORADIC CASES
PROBABILITY OF SIGNIFICANT PUBLIC HEALTH PROBLEM
SIGNIFICANT PUBLIC HEALTH PROBLEM

IODINE

VITAMIN A

Map by Dr E. M. DeMaeyer WHO

WORLD HEALTH May 1988

FIGURE 2. Changes in Availability of Vitamin A, Iron and Kcals in Latin America from 1960/65 to 1975/77.

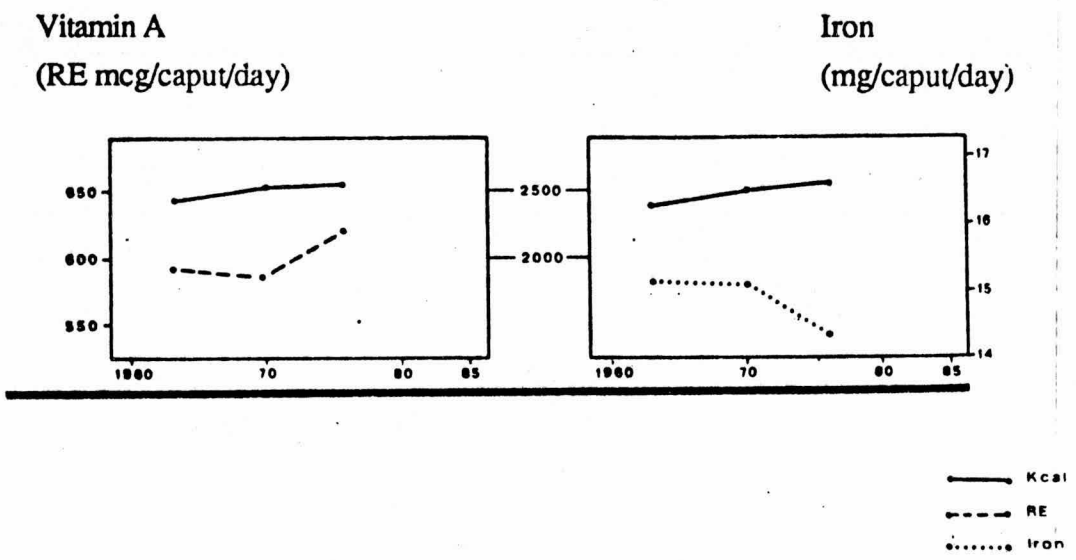


Figure 3. CROP LAND AVAILABILITY IN LA/C COUNTRIES (1983/85)

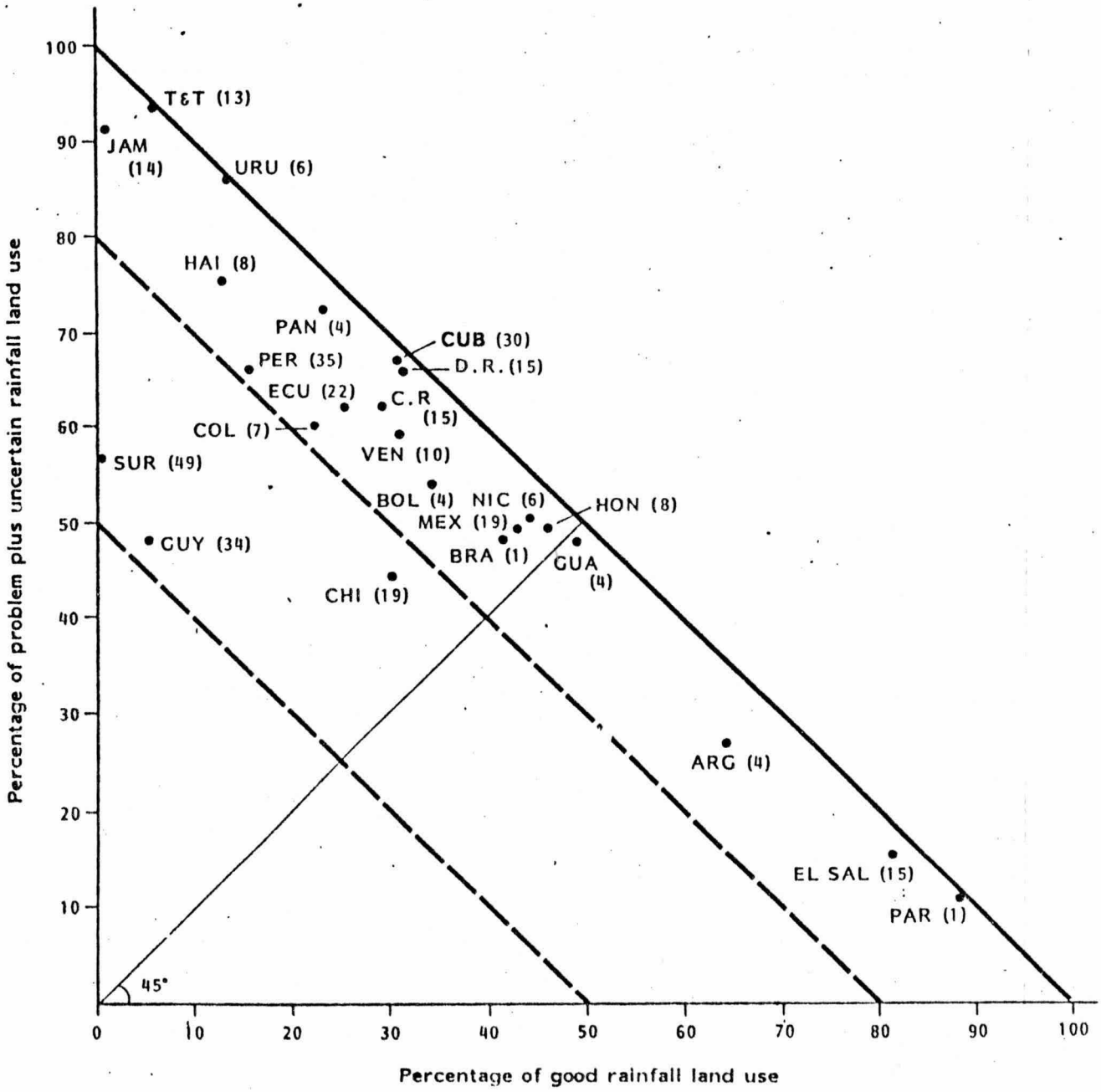
Ha/Person

	< 1.0	1.0 - 2.0	2.0 - 3.0	3.0 - 5.0	> 5.0
> 0.5				Bolivia Paraguay	Argentina Brazil Guyana
0.3-0.5			Belize Honduras Mexico	Cuba Nicaragua	Chile Uruguay
0.2-0.3		Dominica Domin. Rep. Guatemala	Colombia Costa Rica Ecuador Panama	Venezuela	St. Kitts & Nevis
0.1-0.2	El Salvador Haiti Jamaica	Peru St. Lucia St. Vincent	Guadeloupe Suriname	Barbados	
< 0.1	French Gui. Grenada Neth. Ant.	Bahamas Martinique	Ant. & Bar.	Puerto Rico Trin. & To.	

Ha/Economically Active Population in Agriculture

SOURCE: Based on FAO AGROSTAT Data Bank
FAO 1988.

Figure 4. Distribution of LA/C countries by good rainfall and problem plus uncertain rainfall land use, 1983



Note: Figures in parentheses are percentages of irrigated land.
For other types of land, only rainfed use has been considered.

Source: FAO 1988.

Table 1. Population in Latin America and The Caribbean by subregions, estimates and medium variant projections, 1960-2025. *

Year	LA/C			Mexico	Central America	Caribbean	Andean Region	Brazil	South Cone
	Total	Urban	Rural						
	- - - - - - - - - - - - Population (millions) - - - - - - - - - - - -								
1950	161	68	97	27	9	15	30	53	27
1960	215	107	110	37	12	19	41	73	33
1970	280	163	120	51	17	23	55	96	38
1985	401	279	126	79	26	30	81	136	49
2000	541	419	127	109	40	38	114	179	61
2010	636	514	128	128	51	45	137	207	68
2025	773	655	124	154	68	55	172	246	78
	- - - - - - - - - - - - Distribution (percentage) - - - - - - - - - - - -								
1950	100	41	59	16.7	5.6	9.3	18.6	32.9	16.7
1960	100	49	51	17.2	5.6	8.8	19.1	33.9	15.3
1970	100	58	12	18.2	6.0	8.2	19.6	34.3	13.6
1985	100	69	31	19.7	6.5	7.5	20.2	33.9	12.2
2000	100	77	23	20.1	7.4	7.1	21.1	33.1	11.3
2010	100	80	20	20.1	8.0	7.1	21.5	32.5	10.7
2025	100	84	16	19.9	8.8	7.1	22.3	31.8	10.1

* Excludes Puerto Rico and overseas territories as of 1989; number may n sum due to rounding.

Source: UN Population Projections, 1987.

Table 2. Economically active population (EAP) in Latin America and the Caribbean, by subregions, 1950-2025. *

Year/ Period	LA/C	Mexico	Central America	Caribbean	Andean Region	Brazil	South. Cone
			(EAP, millions)				
1950	58	8.8	3.1	6.3	10.4	17.9	10.7
1960	71	11.1	3.9	7.1	12.9	23.3	12.2
1970	91	14.5	5.3	8.1	16.5	31.5	13.8
1980	121	22.2	6.9	10.3	22.5	43.2	16.2
1990	158	30.5	9.5	13.1	30.0	55.0	18.9
2000	200	40.4	13.1	15.9	38.8	67.9	22.3
2010	246	51.0	17.8	18.9	49.2	81.7	25.7
2020	289	60.4	23.5	21.8	59.6	93.1	28.7
2025	308	64.0	26.4	23.0	64.4	97.7	30.0
			(annual increase of EAP, millions)				
1950/60	1.3	.23	.08	.08	.25	.54	.15
1960/70	2.0	.34	.13	.10	.36	.82	.16
1970/80	3.1	.77	.17	.18	.60	1.17	.24
1980/90	3.7	.83	.26	.28	.75	1.18	.27
1990/2000	4.2	1.03	.34	.28	.88	1.29	.34
2000/10	4.6	1.06	.47	.30	1.04	1.38	.34
2010/20	4.3	.86	.57	.29	1.04	1.14	.30
2020/25	3.7	.72	.58	.24	.96	.92	.26

* Includes Puerto Rico; numbers may not add due to rounding.

Source: UN Population Projections, 1987.

Table 3. LATIN AMERICA, INCIDENCE OF POVERTY AND DESTITUTION, 1970

Country	Total Poor /Destitute million		Total Poor /Destitute % Total population		Urban Poor /Destitute million		Urban Poor /Destitute % Urban population		Urban Poor /Destitute % Total poor		Rural Poor /Destitute million		Rural Poor /Destitute % Rural population		Rural Poor Destitute % Total poor	
	Poor	Destitute	Poor	Destitute	Poor	Destitute	Poor	Destitute	Poor	Destitute	Poor	Destitute	Poor	Destitute	Poor	Destitute
Argentina	1.9	0.24	8	1	1.0	0.20	5	1	54	83	0.9	0.04	19	1	46	17
Brazil	46.7	23.8	49	25	19.1	8.2	35	15	41	34	27.6	15.6	73	42	59	66
Colombia	9.4	3.8	45	18	5.0	1.8	15	14	53	47	4.4	2.0	54	23	47	53
Costa Rica	0.4	0.1	24	6	0.1	0.03	15	5	26	30	0.3	0.07	30	7	74	70
Chile	1.6	0.6	17	6	1.0	0.25	12	3	62	42	0.6	0.35	25	11	38	58
Honduras	1.7	1.2	65	45	0.4	0.15	40	15	22	12	1.3	1.05	75	57	78	88
Mexico	17.4	6.1	34	12	6.8	2.0	20	6	39	33	10.6	4.1	49	18	61	67
Panama	0.6	0.38	39	25	0.2	-	29	-	36	-	0.4	-	52	-	64	-
Peru	6.7	3.3	50	25	2.5	0.71	28	8	37	22	4.2	2.59	68	39	63	78
Venezuela	2.8	1.12	25	10	1.6	0.48	20	6	57	43	1.2	0.64	36	19	43	57
Latin America	112.0	-	40	19	47.0	-	26	10	42	-	65.0	-	62	34	58	-

Source: ECLAC "La Pobreza en América Latina: Dimensiones y Politicas", 1985. Tables 3, 7, 8 and 9

FAO 1988

Table 4. ESTIMATED RURAL POVERTY IN 1980

	Poor (%)	Destitute	Total Rural Population (000s)	Total Rural Poor (000s)	Total Destitute (000s)	Rural Poor as % of Total Population
A. MEXICO	68 a/	26 a/	23,348	15,877	6,070	21
B. SUB REGION, C.A.	75	52	13,014	9,773	6,712	
Guatemala	84 b/	52 b/	4,253	3,573	2,212	46
Honduras	80 b/	70 b/	2,359	1,887	1,651	47
El Salvador	76 b/	55 b/	2,913	2,213	1,602	44
Nicaragua	80 b/	50 b/	1,291	1,033	646	36
Panama	67 b/	38 b/	967	648	367	32
Costa Rica	34 b/	19 b/	1,231	419	234	19
C. SUB-REGION CARIBBEAN	78	84 c/	9,266	7,217	3,777	
Haiti	95 a/	86 a/	4,381	4,162	3,768	80
Jamaica	51 c/	n.a.	1,090	556	n.a.	25
Dominican Rep.	75 a/	n.a.	2,751	2,063	n.a.	36
Trinidad & Tobago	40 a/	n.a.	940	410	n.a.	34
Grenada	25 c/	9	104	26	9	24
D. SUB-REGION ANDEAN	69	31	24,778	17,089	7,725	
Colombia	67 c/	23 a/	9,226	6,181	2,122	23
Ecuador	65 d/	20 a/	4,279	2,781	856	31
Peru	68 d/	39 a/	5,720	3,890	2,231	21
Bolivia	86 c/	74 a/	3,102	2,668	2,295	48
Venezuela	64 c/	9 a/	2,451	1,569	221	11
E. BRAZIL	73 c/	43 a/	39,398	28,761	16,941	23
F. SUB-REGION SOUTHERN CONE	31	9	9,313	2,879	836	
Paraguay	63 c/	29 a/	1,847	1,164	536	34
Chile	56 c/	11 a/	2,106	1,179	232	10
Argentina	10 a/	1 a/	4,890	489	49	2
Uruguay	10 a/	4 a/	470	47	19	2
Total	69 ↑	37 e/ ↑	119,117	81,596	42,091	22.5

Source: a/ Chateauneuf, et al. (1983)
b/ Peek, P., PREALC, 1985
c/ Urzua, R. (1984) CEPAL/FAO; ESH
d/ FAO Dynamics of Rural Poverty (1986)
e/ On basis of countries with information

FAO 1988.

Table 5

SELECTED COUNTRIES: ESTIMATIONS FOR MALNUTRITION AROUND 1980

		Percentage of pupulation with an energy intake below 1.4 BMR a/
Argentina	(1982)	5.6
Brazil	(1984)	24.2
Chile	(1982)	12.5
Colombia	(1982)	24.8
Guatemala	(1979-1981)	38.7
Honduras	(1982)	41.3
Mexico	(1977)	25.5
Panama	(1982)	13.1
Peru	(1978)	40.5
Venezuela	(1982)	12.7

Source: FAO on the basis of Statistical data on income distribution. ECLAC Income Distribution series. For Brazil - Republica Federativa do Brasil, "Programa do Açao Gobernamental".

FAO 1988.

Table 6.

AGRICULTURAL LAND AVAILABILITY PER CAPUT OF TOTAL POPULATION AND OF ECONOMICALLY ACTIVE POPULATION IN AGRICULTURE IN 1983/85
(Ha/Person)

	Crop Land (1) Per Caput of		Crop and Pasture Land (2) Per Caput of	
	Total Population	Econ.Act.Pop. in Agricul.	Total Population	Econ.Act.Pop. in Agricul.
Andean	.23	2.5	1.5	16.1
Brazil	.55	5.5	1.8	17.5
Caribbean	.21	1.7	.4	3.4
CARICOM	.25	2.0	.6	4.9
Islands	.20	1.6	.4	3.0
Centr.Amer.	.26	1.9	.8	5.7
Mexico	.31	2.9	1.3	11.5
Southern Cone	.91	17.1	4.7	87.4
Total LA/C	.44	4.4	1.8	18.0
Developed Market Economies	.49	15.3	1.6	48.9
W. Europe	.25	6.5	.4	11.3
N. America	.90	74.5	1.9	159.2
Developing Market Economies	.28	1.4	.9	4.3
Africa	.35	1.3	1.8	6.7
Near East	.35	2.4	1.5	10.2
Far East	.20	.9	.2	1.0

SOURCE: FAO AGROSTAT Data Bank. FAO 1988

Notes: (1) Arable plus permanent crops lands.
(2) Arable plus permanent crops plus permanent pasture lands
(3) Non-LA/C country groups as defined in Country Notes of FAO Production Yearbooks.
(4) The economically active population in agriculture includes those active in forestry, fisheries and livestock as well as crop production.

Table 7. DISTRIBUTION OF ARABLE LAND IN USE BY LAND-WATER CLASSES (1982/84)

Region/Country	Low Rainfall	Uncer. Rainfall	Good Rainfall	Problem Land	Flooded Land	Desert Land	Total Land
Andean							
Arable Land (000 Ha)	1671	3621	4999	7654	1263	906	20114
% of Class in Total Land	8.3	18.0	24.9	38.1	6.3	4.5	100
Brazil							
Arable Land (000 Ha)	2456	6546	34889	32593	6025	0	82509
% of Class in Total Land	3.0	7.9	42.3	39.5	7.3	.0	100
Caribbean (1)							
Arable Land (000 Ha)	81	1339	1474	2710	431	0	6035
% of Class in Total Land	1.3	22.2	24.4	44.9	7.1	.0	100
Central America							
Arable Land (000 Ha)	0	0	2882	2995	220	0	6098
% of Class in Total Land	.0	.0	47.3	49.1	3.6	.0	100
Mexico							
Arable Land (000 Ha)	1079	6092	9316	4376	181	2690	23734
% of Class in Total Land	4.5	25.7	39.3	18.4	.8	11.3	100
Southern Cone							
Arable Land (000 Ha)	4082	5325	34708	10498	551	1253	56417
% of Class in Total Land	7.2	9.4	61.5	18.6	1.0	2.2	100
Total LA/C							
Arable Land (000 Ha)	9369	22923	88268	60826	8671	4849	194907
% of Class in Total Land	4.8	11.8	45.3	31.2	4.4	2.5	100
Sub-Saharan Africa							
Arable Land (000 Ha)	42651	41464	55755	55644	5072	729	201315
% of Class in Total Land	21.2	20.6	27.7	27.6	2.5	.4	100
Near East and North Africa							
Arable Land (000 Ha)	24051	11345	17428	14613	17309	6920	91666
% of Class in Total Land	26.2	12.4	19.0	15.9	18.9	7.5	100.0
Far East							
Arable Land (000 Ha)	42705	54460	46473	71026	53604	11760	280028
% of Class in Total Land	15.3	19.4	16.6	25.4	19.1	4.2	100

SOURCE: FAO AT 2000 Data Bank. FAO 1988.

Notes: (1) Only seven countries: Cuba, Domenican Republic, Guyana, Haiti, Jamaica, Surinam and Trinidad and Tobago.

(2) Rainfed and irrigated land use included in all classes. Desert land is all irrigated.

(3) Land-water classes as follows: (i) low rainfall: rainfall providing 1-119 growing days, land quality very suitable, suitable or marginally suitable; (ii) uncertain rainfall: rainfall providing 120-179 growing days, soil quality very suitable or suitable; (iii) good rainfall: rainfall providing 180-269 growing days, soil quality very suitable or suitable; (iv) problem lands: lands with excessive moisture and/or unsuitable soils. Rainfall provides more than 269 growing days, soil quality is very suitable, suitable or marginally suitable. Also included is the part of the 120-269 growing days zones where soil is only marginally suitable; (v) flooded land: land under water for part of the year and lowland non-irrigated paddy fields (gleysols); (vi) desert lands: non-suitable for agriculture unless irrigated.

(4) Non-LA/C country groupings as in FAO AT 2000 study.

Table 8 ESTIMATED LAND RESERVE AND CROPPING INTENSITY BY LAND CLASS (1982/84)

Region/Country	Low Rainf.	Uncer. Rainf.	Good Rainf.	Probl. Land	Flood. Land	Total Rainfed	Irriga. Land	Total Land
Andean								
% Reserve in Land Class	65	61	53	92	97		76	88
% Cropping Intensity						48	81	53
Brazil								
% Reserve in Land Class	75	68	65	90	90		77	84
% Cropping Intensity						59	85	60
Caribbean								
% Reserve in Land Class	62	58	34	88	82		65	80
% Cropping Intensity						73	105	81
Central America								
% Reserve in Land Class	0	0	42	76	93		71	70
% Cropping Intensity						76	103	78
Mexico								
% Reserve in Land Class	46	40	20	72	93		57	48
% Cropping Intensity						57	123	70
Southern Cone								
% Reserve in Land Class	65	35	15	82	83		67	55
% Cropping Intensity						62	101	64
Total LA/C								
% Reserve in Land Class	67	55	48	88	92		69	78
% Cropping Intensity						60	102	63
Sub-Saharan Africa								
% Reserve in Land Class	36	61	67	86	93		82	75
% Cropping Intensity						54	84	54
Near East and North Africa								
% Reserve in Land Class	2	2	0	3	0		29	3
% Cropping Intensity						62	98	68
Far East								
% Reserve in Land Class	2	7	18	33	16		49	18
% Cropping Intensity						101	129	108

SOURCE: FAO AT 2000 Data Bank . FAO 1988

Notes: (1) Reserve = Estimated potentially cultivable land not being used;
% Reserve in Land Class = Reserve * 100/(Reserve + Used Land)

(2) % Cropping Intensity = Harvested Land * 100/ Arable Land.

(3) Non-LA/C country groups as defined in FAO AT 2000 study.

Table 9.

POTENTIAL POPULATION SUPPORTING CAPACITY IN YEAR 2000

COUNTRY/ REGION	Projec. Popul. 2000	Potential Populat. Suppor. Capac. 2000 ---Input use---			Ratio (year 2000) Potential Population/ Projected Population		
		Low	Int.	High			
	(1)	(2)	(3)	(4)	(2)/(1)	(3)/(1)	(4)/(1)
Andean	122	440	1293	3175	3.6	10.6	26.1
Brazil	213	649	2995	7119	3.1	14.1	33.5
Caribbean	45	130	410	832	2.9	9.1	18.4
CARICOM	7	33	125	298	5.0	18.9	45.2
Islands	43	48	75	163	1.1	1.8	3.8
Central Amer.	40	59	150	410	1.5	3.8	10.3
Mexico	132	183	322	696	1.4	2.4	5.3
Southern Cone	57	249	675	1436	4.4	11.9	25.4
Total LA/C	608	1711	5845	13669	2.8	9.6	22.5
Africa	678	1054	4109	11690	1.6	6.1	17.2
Near East	361	378	618	1500	1.0	1.7	4.2
Far East	1845	2384	4148	5947	1.3	2.2	3.2

Source: Adapted from FAO/UNFPA/IIASA (1982). FAO 1988.

Notes: (1) Population expressed in million persons.
(2) Columns 2, 3 and 4 are the potential population supporting capacities of land in year 2000 under low, intermediate and high input use assumptions.
(3) Non-LA/C country groups as defined in country notes of FAO Production Yearbooks.

Table 10.

POTENTIAL POPULATION SUPPORTING CAPACITY RATIOS OF LA/C POOR LAND RESOURCE COUNTRIES

Country	Level of Input Use		
	Low	Medium	High
Antigua	.3	.8	2.6
Bahamas	.8	9.6	10.0
Barbados	.1	.4	.9
Domi. Repu.	1.0	1.7	3.1
El Salvador	.4	.6	1.7
Guatemala	.9	2.0	6.1
Guadaloupe	.3	2.5	4.3
Haiti	.4	.7	1.2
Jamaica	.8	1.6	3.2
Martinique	.2	1.0	2.5
Neth. Antil.	<.01	<.01	<.01
Puerto Rico	.6	.9	1.5
Tri & Tob.	.6	2.1	3.3
Windward Is.	.5	1.8	5.2

Source: FAO/UNFPA/IIASA (1982) . FAO 1988.

Note: Countries listed are those with ratios of potential population supporting capacity to projected population in year 2000 less than one at the low input level.

Table 11 AREAS WITH NATURAL WOODY VEGETATION, 1980
('000 hectares)

	Total area	Dense forest		Open forests	Total	Forest cover as % of total area	Other land with woody vegetation		Total area with woody vegetation	Plantations
		Broadleaf	Coniferous				Shrubs	Fallow		
AFRICA	2 832 737	215 749	3 610	488 554	707 913	25	447 084	169 856	1 324 853	3 937
LATIN AMERICA AND THE CARIBBEAN	2 018 467	704 757	26 859	207 242	938 858	47	175 091	171 972	1 285 921	6 215
ASIA	1 461 648	281 072	9 772	29 903	320 747	22	53 908	76 604	451 349	5 116
PACIFIC ISLANDS	53 387	37 804	524	4 374	42 702	80	729	1 508	44 939	88
TOTAL	6 366 239	1 239 382	40 765	730 073	2 010 220	32	676 902	419 940	3 107 062	15 356

SOURCE: FAO, Forestry Data Bank
FAO 1988.

Table 12. AREAS WITH WOODY VEGETATION IN LATIN AMERICA AND THE CARIBBEAN, 1980

('000 hectares)

	Total area	Dense forest		Open forests	Total	Forest cover as % of total area	Other land with woody vegetation		Total area with woody vegetation	Plantations
		Broadleaf	Coniferous				Shrubs	Fallow		
ARGENTINA	273 669	42 740	1 760	-	44 500	16	16 500	0	61 000	600
CHILE	74 880	7 180	370	-	7 550	10	4 000	4 550	16 100	818
PARAGUAY	39 730	4 070	-	15 640	19 710	50	8 250	4 480	32 440	3
URUGUAY	17 362	490	-	-	490	3	120	0	610	140
SOUTHERN CONE	405 641	54 480	2 130	15 640	72 250	18	28 870	9 030	110 150	1 561
MEXICO	192 304	26 570	19 680	2 100	48 350	25	59 500	26 000	133 850	159
COSTA RICA	5 066	1 638	-	160	1 798	35	120	-	1 918	3
EL SALVADOR	2 072	101	40	-	141	7	293	22	456	1
GUATEMALA	10 843	3 785	657	100	4 542	42	1 505	-	6 047	15
HONDURAS	11 189	1 855	1 942	200	3 997	36	1 220	680	5 897	-
NICARAGUA	11 875	4 170	326	-	4 496	38	210	1 370	6 076	1
PANAMA	7 599	4 165	-	-	4 165	55	0	124	4 289	4
CENTRAL AMERICA	48 644	15 714	2 965	460	19 139	39	3 348	2 196	24 683	24
DUTCH WEST INDIES	96	0	-	-	0	0	7	0	7	0
ANTIGUA AND BARBUDA	44	9	-	-	9	21	16	-	25	-
BAHAMAS	1 007	0	-	-	0	0	-	0	0	-
BARBADOS	43	0	-	-	0	0	5	0	5	-
BELIZE	2 280	1 257	97	92	1 446	63	49	525	2 020	3
CUBA	11 086	1 255	200	-	1 455	13	305	700	2 460	157
DOMINICA	75	41	-	-	41	55	14	-	55	-
GRENADA	34	5	-	-	5	16	1	-	7	-
GUADALUPE	176	89	-	-	89	51	-	-	89	4
GUYANA	19 685	18 475	-	220	18 695	95	115	200	19 010	1
FRENCH GUYANA	8 915	8 900	-	70	8 970	101	10	75	9 055	-
HAITI	2 756	36	12	-	48	2	53	43	144	1
CAYMAN ISLANDS	26	0	-	-	0	0	6	0	6	-
BR. VIRGIN ISLANDS	15	3	-	-	3	22	2	-	5	-
VIRGIN ISLANDS OF THE U.S.	34	0	-	-	0	0	-	0	0	-
JAMAICA	1 083	67	-	-	67	6	227	159	453	13
MARTINIQUE	106	0	-	-	0	0	-	0	0	-
MONTSERRAT	10	3	-	-	3	25	1	-	3	-
PUERTO RICO	886	246	-	-	246	28	12	-	257	38
DOMINICAN REP.	4 838	444	185	-	629	13	54	267	950	6
ST CHRISTOPHER-NEVIS	36	5	-	-	5	15	11	-	16	-
ST LUCIA	61	8	-	-	8	13	29	-	37	-
ST VINCENT	34	12	-	-	12	34	1	-	13	-
SURINAM	16 147	14 830	-	170	15 000	93	25	270	15 295	8
TRINIDAD AND TOBAGO	513	208	-	-	208	41	6	57	271	16
TURKS AND CAICOS IS.	43	0	-	-	0	0	404	-	404	-
CARIBBEAN	70 029	45 893	494	552	46 939	67	1 353	2 296	50 588	247
BOLIVIA	108 439	44 010	-	22 750	66 760	62	9 000	3 050	78 810	26
COLOMBIA	103 870	46 400	-	5 300	51 700	50	5 500	8 900	66 100	95
ECUADOR	27 684	14 230	20	480	14 730	53	1 050	2 420	18 200	43
PERU	128 000	69 310	370	960	70 640	55	3 150	5 510	79 300	84
VENEZUELA	88 205	31 870	-	2 000	33 870	38	2 120	11 950	47 940	120
TROPICAL LATIN AMERICA	456 198	205 820	390	31 490	237 700	52	20 820	31 830	290 350	368
BRAZIL	845 651	356 280	1 200	157 000	514 480	61	61 200	100 620	676 300	3 855
TOTAL	2 018 467	704 757	26 859	207 242	938 858	47	175 091	171 972	1 285 921	6 215

SOURCE: FAO, Forestry Data Bank

FAO 1988

Table 13. Consumption of Animal Protein in LA/C
(% of total grams per person per day)

	1961/63	1969/71	1978/80	1982/84
Meat and offals	57.3	52.4	47.5	44.8
Poultry	3.3	5.2	8.8	10.3
Milk	28.0	30.3	29.2	30.1
Eggs	4.2	4.8	5.6	6.1
Fish, seafood	7.1	7.6	8.8	8.6

Source: FAO Food Balance Sheets. FAO 1988.

Table 14.

Latin America and Caribbean: Annual Consumption of fish and fish products by selected countries
(kgs live weight equivalent)

	1961/63	1969/71	1979/81	1982/84
Brazil	5.0	6.7	6.8	6.2
Mexico	2.7	3.9	10.5	9.9
Argentina	4.2	5.2	6.4	5.7
Chile	12.1	14.4	21.8	18.7
Paraguay	NA	0.8	1.0	1.1
Uruguay	3.5	3.7	16.9	11.3
Bolivia	0.6	1.3	3.0	1.6
Colombia	2.6	2.5	4.3	3.3
Ecuador	6.2	6.1	13.0	14.2
Peru	19.4	13.9	29.4	20.0
Venezuela	10.7	10.6	12.0	11.8
Costa Rica	2.6	3.0	6.8	2.8
El Salvador	1.5	2.6	2.2	1.4
Guatemala	0.4	0.4	0.8	0.5
Honduras	0.4	1.6	1.4	1.0
Nicaragua	1.1	2.4	0.9	1.0
Panama	17.2	8.1	16.8	14.4
Antigua & Barbuda	NA	NA	NA	26.0
Barbados	32.7	23.6	29.6	33.6
Belize	9.0	9.0	7.8	7.0
Dominica	NA	NA	NA	19.6
Grenada	19.6	34.4	34.4	19.4
Guyana	23.6	27.1	24.6	28.4
Jamaica	35.9	30.0	19.1	17.0
St. Kitts & Nevis	NA	NA	NA	33.8
St. Lucia	NA	NA	NA	16.9
St. Vincent/Grenadines	NA	NA	NA	11.2
Trinidad & Tabago	20.3	12.2	13.2	16.2
Bahamas	NA	NA	NA	14.1
Cuba	8.0	16.0	16.4	20.1
Dominican Rep	7.7	7.9	8.4	6.8
Haiti	1.1	1.3	2.9	3.7
Suriname	29.7	26.4	18.1	14.1

Source: FAO Food Balance Sheets. FAO 1988.

Table 15. Inland Fisheries: Catches in Selected Countries (1965-86)
(000 tons)

	1965	1970	1975	1980	1985	1986
Brazil	94.5	93.5	173.4	187.6	211.1	215.0
Mexico	5.1	7.2	17.8	9.8	113.0	93.0
Colombia	25.9	33.2	42.0	46.9	47.3	54.9
Peru	0.8	2.0	6.6	12.5	27.6	28.2
Cuba	0.1	0.4	1.7	6.3	16.9	16.1
Venezuela	14.5	3.8	7.6	15.9	15.3	16.0
Others	19.4	11.4	22.4	22.4	27.4	34.8
Total	160.3	151.5	271.5	301.4	458.7	458.0

Source: FIDI/FISHDAB. FAO 1988.

Table 16. Aquaculture Production in 1985 by Selected Countries 1/
(000 tons)

	Fish	Molluscs	Crustaceans	Seaweeds	Total
Mexico	86.3	42.7	4.3	-	133.3
Brazil	79.8	-	1.2	0.4	81.4
Ecuador	-	-	30.2	-	30.2
Cuba	15.1	1.1	0.9	-	17.1
Chile	1.1	1.5	-	4.9	7.5
Peru	0.6	3.6	0.6	-	4.8
Panama	0.4	-	2.6	-	3.0
Others	3.4	0.4	2.3	-	6.1
Total	186.7	49.3	42.1	5.3	283.4

Source: ADCP. Data supplied by governments. FAO 1988.

1/ These data are provisional and subject to revision mostly downwards due to the different criteria used by countries in providing information.

Table 17. Environmental concerns related to agriculture in developing countries.

Concerns	Related to Excessive Deforestation	Inappropriate Cultural Practices	Excessive Genetic Uniformity	Misuse of Chemical Inputs
Global warming (CO_2,.)	*			*
Air/water/food pollution		*		*
Build up of noxious organisms			*	*
Reduction of genetic diversity/species	*		*	
Soil erosion	*	*		
Deterioration of soil structure		*		
Decline in soil fertility	*	*		
Desertification	*	*		
Salinization		*		
Build up of toxic elements				*
Silting of water catchments	*	*		

Table 18. Possible levels of intervention in relation to environmental concerns and socioeconomic factors or constraints.

Possible levels of intervention	Environmental (biotic/physical) concerns *	Socioeconomic factor or constraints **
Gene	A,B	1
Plant	B,C,D,	1,2,3
Crop	B,C,D,E,F	1,2,3,4
Farm	C,D,E,F	3,4,5
AEZ	C,D,E,F,G-Z	4,5,6
Country	D,E,F,G-Z	4,5,6,7,8-n
Region	F,G-Z	7,8-n
Global	G-Z	8-n

* Environmental concerns:

A: narrow genetic diversity
B: build up of noxious organisms
C: salinity
D: decline in soil fertility
E: air/water/food pollution
F: soil erosion
G-Z: deforestation, greenhouse effect, CO2, acid rain, ...

** Socioeconomic factors/constraints

1: farmer/consumer preferences
2: farmers' practices/management ski
3: farm labor and financial resource
4: land tenure
5: markets and demand
6: transport and infrastructure, agricultural and land use policy, organization of NARDSs
7: trade policy, regional agreements organization of regional networks
8-n: CGIAR, GATT, multilateral agreeme on environment, fisheries, trade wild animals and skins, ...

Source: adapted from CIAT 1989, Report of the Task Force for Natural Resource Management and Sustainable Agriculture.

Table 19. ANNUAL CHANGES IN FOREST AREAS (1980)

(1000 ha)

	Annual changes					
	Dense forest					
	Broadleaf	Coniferous	Open forest	Total	Percentage of Deforested Forest Area	Plantations
ARGENTINA	-1550	0.0	.	-1550	-3.5	40.0
CHILE	-50	0.0	.	-50	-0.7	74.2
PARAGUAY	-190	.	-22	-212	-0.8	0.5
URUGUAY	0	.	.	0	0.0	0.0
SOUTHERN CONE	-1790	0.0	-22	-1812	-2.3	114.7
MEXICO	-470	-125.0	-20	-615	-0.6	22.2
COSTA RICA	-65	.	0	-65	-3.4	0.4
EL SALVADOR	-4	-0.5	.	-4	-1.0	0.1
GUATEMALA	-72	-18.0	0	-90	-1.5	8.0
HONDURAS	-48	-42.0	0	-90	-1.7	.
NICARAGUA	-105	-16.0	.	-121	-2.6	1.0
PANAMA	-36	.	.	-36	-0.9	0.4
CENTRAL AMERICA	-330	-76.5	0	-406	-1.8	9.9
DUTCH WEST INDIES	0	.	.	0	0.0	.
ANTIGUA AND BARBUDA	0	.	.	0	0.0	.
BAHAMAS	0	.	.	0	-	.
BARBADOS	0	.	.	0	0.0	.
BELIZE	-9	0.5	0	-8	-0.6	*
CUBA	-2	0.0	.	-2	-0.1	11.5
DOMINICA	0	.	.	0	0.0	.
GRENADA	0	.	.	0	0.0	.
GUADALUPE	0	.	.	0	0.0	.
GUYANA	-2	.	*	-2	*	0.1
FRENCH GUYANA	*	.	0	*	*	0.1
HAITI	-1	-0.6	.	-2	-1.8	0.2.
CAYMAN ISLANDS	0	.	.	0	0.0	.
BR. VIRGIN ISLANDS	0	.	.	0	0.0	.
VIRGIN ISLANDS OF THE U.S.	0	.	.	0	-	.
JAMAICA	-2	.	.	-2	-0.7	0.7
MARTINIQUE	0	.	.	0	-	.
MONTSERRAT	0	.	.	0	0.0	.
PUERTO RICO	0	.	.	0	.0.0	.
DOMINICAN REP.	-3	-1.5	.	-4	-0.6	0.5
ST CHRISTOPHER-NEVIS	0	.	.	0	0.0	.
ST LUCIA	0	.	.	.	0.0	.
ST VINCENT	0	.	.	0	0.0	.
SURINAM	-3	.	*	-3	*	0.1
TRINIDAD AND TOBAGO	-1	.	.	-1	-0.3	0.5
TURKS AND CAICOS IS.	0	.	.	0	0.0	.
CARIBBEAN	-22	-1.6	*	-24	*	13.7
BOLIVIA	-87	.	-30	-117	-0.2	1.4
COLOMBIA	-820	.	-70	-890	-1.6	8.5
ECUADOR	-340	*	*	-340	-2.1	4.5
PERU	-260	-10.0	*	-270	-0.4	6.4
VENEZUELA	-125	.	-120	-245	-0.7	18.0
TROPICAL LATIN AMERICA	-1632	-10.0	-220	-1862	-0.7	38.8
BRAZIL	-1360	-120.0	-843	-2323	-0.4	448.6
TOTAL	-5604	-333.1	-1105	-7043	-0.6	647.9

* = negligible

SOURCE: FAO 1988.

Table 20.

PROJECTED INCREASE OF CROP LAND
FROM 1982/84 TO 2000

Region/ Country	Type of Land			
	Ara.& PC	Harvest.	Fallow	Irrigated
Andean				
000 Ha	4502	3502	1000	1104
Percentage	22.5	33.0	10.6	50.1
Brazil				
000 Ha	20448	14599	5849	301
Percentage	24.8	29.3	17.9	13.8
Caribbean				
000 Ha	829	633	196	252
Percentage	13.7	13.0	16.7	16.7
Central America				
000 Ha	1105	1283	-178	225
Percentage	18.1	26.9	-13.5	46.2
Mexico				
000 Ha	1465	2738	-1273	2339
Percentage	6.2	16.6	-17.6	42.7
Southern Cone				
000 Ha	7990	8365	-375	1172
Percentage	14.2	23.2	-1.8	43.1
Total LA/C				
000 Ha	36337	31120	5217	5395
Percentage	18.7	25.4	7.2	37.0

Source: FAO AT 2000 Data Bank. FAO 1988.

Notes: (1) Caribbean: only Cuba, Dominican Republic, Guyana, Haiti, Jamaica, Suriname and Trinidad and Tobago included.

(2) Irrigated refers to harvested area under irrigation. Increase in this area may come from irrigating previous rainfed arable land, in which case the arable land area does not increase, or from irrigating areas which were not arable before (e.g. desert or forest lands), in which case arable land increases. Expansion may also come from higher cropping intensity.

Table 21. SOURCES OF GROWTH OF CROP OUTPUT IN 1961/83 - 1984/86 and 1982/84 - 2000 (Percentages)

Region/ Country	1961/63 - 84/86			1982/84 - 2000		
	Harves. Area	Yield	Crop Mix	Arable Area	Yield	Cropping Intensity
Andean	55	51	-6	47	35	18
Brazil	81	33	-13	48	45	7
Caribbean	41	45	14	43	59	-2
Cent. Ame.	43	53	4	46	35	19
Mexico	41	66	-7	10	75	16
South. Cone	45	46	10	36	44	20
Total LA/C	63	44	-7	39	49	12

Source: Computed from FAO AT 2000 and ICS Data Banks. FAO 1988.

Notes: (1) FAO, Geary-Khamis, 1979-81 international commodity prices have been used in all calculations.
(2) The crop mix effect has been calculated using a Fisher-type index.
(3) Only Cuba, Dominican Republic, Guyana, Haiti, Jamaica, Suriname and Trinidad and Tobago included in the Caribbean for period 1982/84 - 2000.

Table 22. AVERAGE ANNUAL FERTILIZER CONSUMPTION (TOTAL N,K20,P205) PER HECTARE OF ARABLE LAND AND LAND UNDER PERMANENT CROPS

COUNTRY	62-66	67-71	72-76	77-81	82-86
	Kg/Ha				
BRAZIL	5.3	14.2	32.5	49.2	41.2
MEXICO	12.8	22.7	38.1	49.7	68.9
ARGENTINA	1.1	2.3	2.2	3.0	4.0
CHILE	24.9	29.5	28.7	21.7	31.1
PARAGUAY	1.5	4.6	2.3	3.1	4.7
URUGUAY	25.6	45.9	48.1	49.3	37.6
SOUTHERN-CONE	5.0	7.2	7.1	6.9	8.4
BOLIVIA	0.8	1.3	1.5	1.3	1.7
COLOMBIA	26.6	30.2	46.0	57.4	67.5
ECUADOR	6.1	16.3	19.3	30.3	31.5
PERU	35.7	28.8	37.2	37.0	24.0
VENEZUELA	8.3	15.4	34.1	53.0	84.2
ANDEAN	17.8	20.7	30.2	38.6	45.5
COSTA_RICA	59.8	97.6	124.2	147.7	162.8
EL_SALVADOR	64.9	95.8	152.5	124.0	95.6
GUATEMALA	13.1	21.9	37.8	54.6	50.2
HONDURAS	5.8	13.9	13.9	14.5	17.0
NICARAGUA	12.6	21.9	30.4	37.7	43.2
PANAMA	17.5	32.5	45.6	49.3	49.4
CENT-AMER	21.1	34.9	49.9	54.9	53.7
ANTIGUA	0.0	0.0	0.0	0.0	0.0
BARBADOS	227.1	169.2	153.3	163.6	134.8
BELIZE	20.6	47.8	39.5	28.1	42.7
DOMINICA	0.0	0.0	305.9	212.9	143.7
GRENADA	0.0	0.0	0.0	0.0	0.0
GUYANA	24.2	27.8	36.8	21.5	28.0
JAMAICA	56.9	92.6	77.4	60.8	54.7
ST_KITTS	64.1	120.3	220.0	154.3	188.6
SAINT_LUCIA	50.3	166.7	287.1	89.3	98.2
ST_VINCENT	75.4	126.7	229.4	229.4	232.9
TRINIDAD&TOB	71.3	82.4	78.1	63.7	52.0
CARICOM	47.4	63.2	67.9	50.3	49.4
BAHAMAS	66.7	116.7	160.3	146.7	93.6
CUBA	115.6	164.8	96.8	155.3	178.6
DOMINICAN_REP	11.1	27.8	64.7	41.6	37.5
HAITI	0.2	0.3	1.6	3.8	3.7
SURINAME	30.9	58.5	92.3	71.5	173.2
NON-CARICOM	61.5	97.8	73.8	101.6	114.4
LAC	10.4	18.0	28.5	39.1	40.1

SOURCE : FAO 1988.