AGRICULTURAL SUSTAINABILITY ISSUES IN THE NEW ERA OF ECONOMIC LIBERALIZATION*

L. HARLAN DAVIS and REGINALD PIERRE*****

*(**Deputy Director General, Inter-American Institute for Cooperation on Agriculture (IICA), Costa Rica and ***Director of Operations (Caribbean) and Representative, Barbados)*

This paper is divided into four sections: (1) overview of the sustainable agricultural problem in Latin America and the Caribbean; (2) diverse dimensions of sustainable agriculture; (3) development of a new agenda for sustainable agriculture; and (4) research recommendations.

Sections 1 and 2 present an overview of the sustainability problem in Latin America and the Caribbean (LAC) and evaluate the relationships between development policies and sustainable agricultural systems. This issue has special significance for the Region's optimistic growth scenario in the 1990s. Sections 3 and 4 focus on some of the practical matters involved in achieving greater compatibility between growth and sustainable agriculture.

OVERVIEW OF THE SUSTAINABLE AGRICULTURAL PROBLEM IN LATIN AMERICA AND THE CARIBBEAN

During the 1980s, LAC fell into a serious slump along with the regional economy in general. First, basic commodity prices dropped; overall production rates began first to falter, only to tumble to 2.5 per cent by 1986.[1] In the wake of the severe and prolonged crisis, food production did not keep pace with population growth rates in many countries, employment declined and rural poverty increased. By the end of the 1980s, between 30 and 40 per cent of all rural families were classified as landless small producers and their numbers were growing.[2] The future looked bleak.

Land and Rural People

Latin American and Caribbean Agriculture is vastly different from its counterpart in the more developed countries. Agriculture's share in the GDP of the LAC countries is approximately two times greater than that of the developed countries. In the poorest countries of the Region, such as Bolivia, Haiti, Honduras and Paraguay, agriculture's share of the GDP is more than 25 per cent, as compared to 2 per cent in the United States and Germany, 3 per cent in Japan, and 4 per cent in France. While agricultural and forestry products accounted for 29 per cent of exports from the LAC region in 1988, they accounted for only 12 per cent of the exports of the developed countries.

Some 35 per cent of the population of the LAC countries live in rural areas; most work in the agricultural sector. Of these rural inhabitants approximately 102 million are poor and use agricultural practices that may harm the environment. On the other hand, in most of the developed countries, the percentage of the population that earns a living directly from agriculture is very small, and rural poverty is not closely linked to the natural resources issue.[3]

The Latin American and Caribbean natural resources picture is relatively favourable. With only 8.1 per cent of the world population, the Region has 23 per cent of all potentially arable land in the world, 12 per cent of all cultivated land, 17 per cent of all rangelands, 23 per cent of all forests, 46 per cent of all tropical

forests and 31 per cent of all runoff with the potential for stable utilization. It is also one of the most genetically diverse regions in the world; estimates indicate that one hectare of Amazon forest contains more plant species than all of Europe.[4]

These aggregate figures, however, do not show the enormous differences that exist among the different countries of the Region or how important it is for immediate and profound changes to be made in the organization and performance of agriculture in the Region. In some of the countries, the ratio between land area and population is already critical and will become even more so by the year 2000. In general, however, the availability of arable land is not a limiting factor, although in certain areas, including Mexico, Central America and the Caribbean, a very large proportion of the land suitable for farming is already in use. Moreover, the rate of deforestation is extremely high in the Region and on the rise in recent years. Around 2 million km^2 of forest (an area greater than Mexico) have been cut down since 1960, with most of this taking place over the last few years. Some reports indicate that large areas of natural ecosystems, especially in tropical areas have been destroyed.[5]

As a result, the long-term viability of a large number of watersheds that are strategically important for the food security of some countries are at risk, and a serious impact has been had on genetic diversity. It is estimated that every hectare of tropical forest may have between 1000 and 2000 plant species, 250 of which are trees. So little is known about the genetic make-up o these ecosystems that the destruction of a small area of tropical forest can result in the disappearance of a number of plant and animal species whose possible benefit may never be known to mankind.

Desertification is advancing, particularly in rainfed ecosystems, 70 per cent of which are already in the process of degradation. Erosion in the mountainous ecosystem of the Andean zone and Central America affects an estimated 40-60 per cent of potentially arable land. According to some calculations, in the early 1980s more than 2 million km^2 of the Region were affected by moderate to severe erosion.

Overgrazing degrades natural pastures and their capacity to support livestock. This, in turn, creates pressure to clear forests, especially in tropical areas. Nevertheless, this also occurs in sub-tropical and temperate zones, such as in the Pampas of Argentina, where a significant decline has already been noted in the production of natural fodder. In many areas, sedimentation, salinization and alkalinization, resulting from the mismanagement of irrigation systems, have significantly reduced productivity. Finally, the large-scale and growing use of fertilizers and pesticides is polluting water sources and leaving toxic-residues in crops, often exceeding the levels considered safe for human consumption.[6]

This situation is the result, in part, of a long series of poorly formulated agricultural policies and inconsistencies in agricultural institutions which have opened the way for the environmental deterioration now so evident. The situation has been aggravated by steady and unplanned population growth and by the impact of the economic crisis of the 1980s. Deterioration of the terms-of-trade, the pressure to export in order to service a growing foreign debt, and the rise in interest rates resulting from changes in the financial flows to and from the Region, have fostered short-sightedness, making it more difficult to design and execute long-range strategies for sustainable development.[7] The 1980s were costly for the Region.

The New Development Scenario for Latin America and the Caribbean

The tide, however, seems to be turning. There is a wave of optimism about the prospects for development in Latin America. The crisis of the 1980s produced fundamental changes.
Part of the turnaround involved changing from State-dominated economies to free markets, belt tightening, privatization and the adoption of new approaches to control inflation. In 1991, for the first time in many years, Latin America became a net importer of capital. Even normally conservative analysts are upbeat about the prospects for the Region. The United Nation's ECLAC 1991 Economic Overview was highly optimistic; the Inter-American Development Bank (IDB) speaks of the 1990s as a "*Decade of*

Hope".[8]

What does this new optimism imply? More specifically, what does it imply for sustainable agriculture? Before dealing with these questions, let us examine the diverse dimensions of this complicated subject.

DIVERSE DIMENSIONS OF SUSTAINABLE AGRICULTURE

Sustainability means different things to different people, especially in Latin America and the Caribbean. Long before we began to associate sustainability with environmental and conservation issues in Latin America we used the concept in the design and implementation of foreign assistance programs. Projects designed to continue or be institutionalized upon the termination of the foreign aid component were considered to be "*sustainable*" and, therefore, most attractive from the donor's point of view. Even projects that had negative environmental effects but promised permanency were generally deemed sustainable. Many Latin American policy-makers have been conditioned by this experience and, consequently, may think of sustainability in those terms. When taken out of context, the word translated into Spanish "*sostenibilidad*", has little significance in environmental terms.

This is not the forum for an academic debate on the meaning or definition of sustainability. I agree with the widely circulated and accepted view of the Brundtland Commission that defines sustainability as processes that allow us "*to meet the needs of the present without compromising the ability of future generations to meet their own needs*".[9] Obviously, this definition begs many questions, particularly with respect to Latin America and the Caribbean: Whose needs? How are these needs defined? What are the costs and benefits of meeting them?

The United Nations Food and Agriculture Organization (FAO), the Consultative Group on International Agricultural Research (CGIAR) and scholars have all formulated definitions. There really is no consensus.

As an economist I found the practical tools of my discipline useful for understanding this subject. We think of product, or product dominated in monetary terms (income) generated in any given period of time (generally annually), as a fruit of the combination and allocation of the factors of production which include land, labour, capital and management. When annual income increases, we may assume that either additional factors of production have been employed and/or the allocation process has been comparatively more effective and efficient. On the other hand, when incomes decline we can assume that either fewer production factors have been employed and/or the allocative process has been comparatively less effective and efficient. Another possibility is that the production factors are not left intact.

Any economic unit or system that fails either to enhance or leave in place its production (viz., income-generating) base would, in my view, fall into the unsustainable category. Thus, unsustainability can be thought of in terms of human resources, capital or even management factors employed. However, the term has become most widely utilized and applied to land and other natural resources, especially in agriculture. Thus, an unsustainable agricultural system is one that does not leave its basic production or income-generating base intact from one time period to the next.

An unsustainable system may have a negative impact on neighbouring operations or on the economy as a whole. Such effect is generally characterized as a externality. In agriculture, negative externalities occur when individual farming practices cause such problems as soil erosion, siltation, salinization or pollution of streams or rivers which impact nearby farms and the economy as a whole. In addition, governments may promulgate policies or projects which are detrimental to the agricultural resource base, or which encourage adverse farming practices. On the other hand they may adopt policies and undertake projects that encourage the opposite, the generation of neutral or even positive externalities which enhance the natural resource base and allow societies to meet current needs without compromising the future.

The study, analysis and formulation of policy to deal with externalities traditionally falls to the public sector, as actions taken in this domain generally affect society as a whole rather than individual firms or farms. I perceive the

sustainability issue to be in this category. Specifically, with respect to LAC agriculture, I see the problem as one that has been generated in part by well-intentioned but erroneous public policies. While there are other dimensions to this problem, I will focus for a moment on this one.

Policy Issues in Sustainability

A. Agricultural price policy - Since World War II Latin America and the Caribbean have followed an import-substitution model that sought to encourage industry and manufacturing growth. In country after country the agricultural sector has been called on to finance this process, particularly through actions which have deliberately depressed farm product prices in order to maintain cheap food supplies for industry and manufacturing labour. The situation persists even today throughout the Region. I studied and reported on agricultural price policy in one Central American country in the early 1980s and found over a five-year period almost constant prices for rice, corn and beans, while inputs for production of these staples consistently increased. The result was a long-term decline in the price-cost ratio of production.

Such policy dampens profitability in agriculture and reduces the derived demand for land and other production factors. It reduces, too, the returns on investments in efforts to conserve and preserve natural resources as well as interest in their long-term maintenance and enhancement. Careful study of several Latin American countries shows rates of return in many sectors that are relatively higher than they are in farming. Creating the conditions for increased profitability would encourage more rational and sustainable management and use of natural resources and the environment.

B. Differential rates of taxation - Identifying the collecting taxes is a problem throughout the Region. Tangible commodities easily assembled, counted and valued lend themselves particularly to public taxation; these have traditionally been export commodities, such as banana, cocoa and coffee. On the other hand, food crops like rice, corn and beans are more difficult to locate, value and tax. Moreover, from a political point of view, such basic food supplies are obviously a less attractive source of public revenue.

In Costa Rica, for example, taxes on coffee and bananas have been an important source of public funds for many years. As recently as the late 1980s, export taxes on bananas and coffee represented approximately 4.5 and 5.0 per cent, respectively, of all government tax revenues. Banana and coffee account for 45 and 52 per cent, respectively, of all export taxes generated. In addition, there is a local processing tax on coffee. At the same time, there are no export duties on traditional food crops.

Differential taxes on exports depress the relative profitability of these enterprises, creating a two-dimensional problem for the countries of the Region. First, it may discourage production of the export commodities so critically needed to supply foreign exchange. Secondly, from the point of view of this thesis, it may also discourage the production of tree and perennial crops that are more compatible with sustainable systems.

C. Overvalued exchange rates - This, again, has been a problem endemic to Latin America and the Caribbean. Basically, this policy has the same impact as the differential tax mentioned above: when producers get relatively lower returns from their exports than the market would normally dictate, the market signals them to seek alternatives.

D. Agricultural credit policies - The capricious impact of concessionary agricultural credit policies in Latin America has been amply documented by Ohio State University economists. They have shown, for example, that such policies encourage capital-intensive production methods where labour-intensive methods should prevail, mechanization on soils not suited to such practices, and inappropriate or indiscriminate use of pesticides and insecticides.

In this scenario, governments interested in increasing food production and in some cases compensating for effective losses to farmers resulting from price control policy, provide credit at concessionary rates for the purchase of modern inputs (pesticides and insecticides), machinery, hybrid seed and chemical fertilizers. Such concessions may distort the allocation of resources at the farm level and the economy in

general, along the lines mentioned above.

A recent World Bank report by Robert Repetto[10] showed the average rate of subsidy of retail pesticide prices in Honduras at 20 per cent; in Colombia at 44 per cent and, in Ecuador at 41 per cent. These subsidies consist of a mix of concessions granted to manufacturers or mixers, marketers, and farm producers through the credit mechanism.

The irony is that pesticides in most of Latin America are poorly controlled and regulated. In fact, they may be entering the food chain at alarming rates. Recently, several shipments of fresh Guatemalan vegetable destined for the US market were detained because of excessive pesticide residues.

E. Land tenure policies - The number of farm producers, mainly small operators, without land or firm title in Latin America is alarmingly high. Moreover, as rural populations expand, people are pushed into such areas as fragile hillsides and wetlands not suitable for intensive farming practices.

Producers without a real stake in the resources they manage have little incentive to utilize them appropriately for long-term production purposes. Thus, fallow cycles may be sacrificed, cultural practices which cause erosion and soil loss may be followed and investments in terracing and drainage may be foregone in order to maximize short-term returns. Lack of security of expectations may, in fact, be one of the major causes of agriculture-related environmental degradation in Latin America.

Another dimension of this issue is the large number of producers now working on cooperative farms, particularly in Central America. Since the early 1960s, Panama, Costa Rica, Honduras and El Salvador have vigorously promoted the "*asentamiento*" to accommodate the growing number of landless workers. Workers are encouraged to organize and work cooperatively, to maximize returns on any one of several types of enterprises, including rice, corn, beans and livestock. I would hypothesize that sensing no individual or private stake in the enterprise, much like the story of the "*Tragedy of the Commons*", they have no obligation to the long-term conservation of the resource base. It is certainly an issue that requires more research vis-a-vis the sustainability question.

F. Frontier development - The Brazilian Amazon is the best known case, but others exist in Latin America. Let us look at Brazil and the subsidies involved in developing a typical ranch of some 49,000 hectares with some 10,000 hectares of pasture land in the Amazon region. Incentives have included: (1) income tax exemptions extending up to 10 years; (2) provision for offsetting losses against taxable income from other enterprises; (3) provision for accelerated write-offs of buildings, equipment and other depreciating assets; (4) tax credits for investments in approved projects in the Amazon region for up to 75 per cent of the total investment costs; and (5) subsidized credit facilities for capital and operating expenses at real interest rates that were negative, on average, by at least 15 per cent during the late 1970s.[11]

As Repetto notes in his study, "*With these incentives the Brazilian government effectively financed by far the greater share of approved livestock investments through foregone tax receipts granted as credits, and through loan capital that could be repaid in inflated currency. Moreover, the Brazilian government bore a substantial share of operating losses by allowing investors to write them off against other income taxable at a rate of up to 40 per cent. Private investors could shelter outside income by acquiring cattle ranches in the Amazon with very little equity investment and hope to take advantage of rising land prices for an ultimate capital gain*".[12]

He concludes that without these tax and fiscal incentives livestock ranching in the Amazon would not be a profitable enterprise. Further, he notes that because of the rapid encroachment of weeds, along with soil nutrient depletion of converted pastures, 20 per cent of the pastures are estimated to be in various stages of deterioration. Other countries in Latin America are following similar frontier-development policies with similar results.

G. Technology policy - Finally, I would hypothesize that many of the technologies developed to increase small-farm output in Latin America and the Caribbean may create negative environmental externalities and are not

sustainable over the long run. I refer particularly to fertilizer and pesticide use. While evidence in this instance is less clear and compelling, I offer this thought as an area for research and study on sustainable agricultural systems.

Implementation of Existing Sustainable Policies

Following my review of some of the policies that work against sustainability, I would add that even in those instances where governments have put into effect resource-sustainable or resource-enhancing policies they may find themselves unable to enforce them. There are both financial and political considerations involved.

While specialists are being trained in Latin America in natural resource conservation, park management, technology transfer and extension, the few practising in these fields are not adequately trained. They lack the basic tools of their trade, are unsure of their mandate and, in many instances, have reason to question their backing and support. They may have access to little or unreliable technology to promote sustainable systems.

Furthermore, governments sometimes find it politically difficult to deal with small-scale farmers or the rural poor who may be abusing the resource base. One of the well-documented problems of the Panama canal watershed is the encroachment by small-scale, landless farmers on the fragile slopes and hillsides, causing erosion by cutting trees, burning ground cover and planting rice, corn and beans. The government has traditionally found that eviction of these farmers is a highly controversial issue and has commonly failed to take a firm stand against them. The same has been true in other areas of the Region. Lack of enforcement of existing policies and regulations is a substantial problem.

Both the policies and the ability to enforce them, however, are changing. Given the important structural changes of the past three or four years, Latin America appears to be emerging from its prolonged state of economic degradation.[13]

DEVELOPMENT OF A NEW AGENDA FOR SUSTAINABLE AGRICULTURE

What are the prospects for adopting of more sustainable agricultural systems in this new era?

One scenario is that new trade liberalization policies will encourage increased farm exports resulting in greater deforestation, farming of tropical wetlands for new production, greater use of pesticides and more pollution of water and soil resources. This scenario implies a resource-intensive strategy similar to those employed in the past, which will result in further mining of the ecological capital.

The Resource Minimization Strategy

At the other end of the spectrum is a strategy that would minimize the use of new resources and adopt severe measures and regulations to maintain existing resource stocks.[14] This preservation strategy suggests that economic *well-being* is not the same as *well-having* and that nature must no longer be abused for the sake of economic growth.

Some of the extreme aspects of this strategy are actually more concerned with the welfare of non-human species than human beings. Among other things, they argue that (1) resource limitations pose absolute limitations to growth; (2) science and technology are not able to deal with the growth/sustainability dilemma; in addition, they express concerns about the (3) high risks involved in any form of economic change.

For practical and political reasons, the adoption of this strategy would not be acceptable in Latin America. Political leaders would be outraged by the idea of halting the development process altogether in order to minimize the use of new resources in the production process. Also, while not a cultural anthropologist, I would argue that most Latin Americans would place greater value of the human being on non-human or natural capital. A resource-minimization strategy would hardly be viable just when Latin America is emerging from a long period of economic malaise.

The Resources Constraint Approach

Between these extremes and more viable in terms of the political reality of Latin America, is a *maximize-subject-to-constraints* approach.[15] It is suggested that growth policies and strategies be adopted to increase natural incomes; however, these growth policies would be subject to established environmental principles. While this strategy advocates growth constraint, it does not call for a complete halt. In fact, variations on this view suggest that new income can even be generated to finance activities that will help maintain or improve natural resource quality. To borrow an idea again from Lewis, growth has its costs, but it also provides new alternatives and choices heretofore not available.

In Latin America, the challenge lies in managing its new prosperity wisely. New growth will have some cost to the environment, but it will also generate benefits. Furthermore, it should be recalled that growth is not solely the result of incorporating natural and physical resources into the production function. Science and technology have developed substitutes for factors becoming scarce at the margin which have been major sources of growth and development, as many well-established and accepted studies have demonstrated. For example, in agriculture we have high-yielding seeds, new cultural practices and fertilizers to substitute for increasingly scarce land and labour resources. These factors have been generated through the science and technology process and are not incompatible with sustainable systems of agriculture.

Science and technology, however, are not free goods; they cannot always be borrowed from abroad and applied. Science and technology are a function of knowledge and knowledge, in turn, is a function of human capital.[16] Thus, investment in human capital is a key factor not only in economic development but in the development of sustainable agricultural systems.

The new growth scenario can provide new opportunities to deal with these key issues. New income generated from economic growth can provide the wherewithal to design new policies and projects to offset the negative environmental impacts of development. In agriculture the development of new integrated pest management technologies is but one example of these projects. Natural resource enhancement projects which actually increase the stock of ecological capital can be financed. (The clean-up of the Potomac River and the Chesapeake Bay estuary on the United States East Coast are examples.) And new revenues can make greater investments in human capital possible, essential to science and technology development. Let me turn now to the specifics of the policy and research agenda.

Specific Policy Issues

Within the context of the new growth scenario, important policy changes are merging that may ultimately benefit sustainable agriculture. Structural adjustment programs have produced new fiscal, financial and farm policies which could reduce distortion of market incentives at both the micro and macro levels. Controlling inflation, implementing more rational exchange rate policies and lifting differential taxes and tariffs could result in increased returns to agriculture, reduced demand for imported production factors, such as agro-chemicals and machinery, and greater investment in land and natural resource conservation. Perverse farm-level incentives generated by certain sectoral policies including price controls, concessionary credit and settlement schemes may be redirected, resulting in an allocation of natural resource capital in a manner that is more consistent with its real costs and returns. Similarly, privatization might encourage more internalization of externalities. In reality, there are a host of new initiatives under way that could result in more sustainable agricultural systems in Latin America.

Certain sectoral, legal and social policies, however, must be taken into account in order to maximize growth and provide greater environmental protection. These are illustrated in Table 1.

To fully understand the real cost of current approaches, new national accounting systems are required that would discount the gross natural product when resource factors are not left intact in the production processes. Some important work has been initiated in this regard

with finance ministers and development bankers need to take more seriously.[17]

In the final analysis, no one can accurately predict the impact of economic liberalization on the environment. Obviously, research efforts are needed to address this very issue. The following section suggests some of the critical issues IICA believes should be investigated.

RESEARCH AGENDA

Let me now turn to specific components of a research agenda for sustainable agriculture. First, I would argue that priorities at the national and international levels need to be reordered to include issues critical to resource conservation and management. While crop and livestock production - the traditional concerns of research enterprises - must continue to receive attention, the resource base that generates increased production must also be considered. I also believe that many of the biological and physical factors that threaten sustainable systems can be effectively addressed through science and technology. The many social factors that impinge on this subject can only be countered with strong national commitment.

I divide the research agenda into three components: (1) policy priorities; (2) institutional factors, and (3) technology.

Policy

Policy research should contribute to creating an environment that will encourage increased production of food and other products from natural resources, an equitable distribution of the resources and benefits of agriculture and the conservation and sustainable use of resources.

Important issues for policy research related to sustainability include the following:

(a) The impact of economic liberalization on sustainability, including the transformation of natural products resource into new products for domestic and international markets, and determination of the externalities resulting from such transformation. The impact of currency devaluations, reductions in trade barriers and variations in interest rates on natural resources and natural resource management can be important and should be identified in order to guide decision-making on sustainability.

(b) The external debt's impact on natural resources insofar as it creates pressure to boost exports and for the use and transformation of natural resources.

(c) Development policy and project design that permit the internalization of costs derived from the sustainable management of resources.

(d) Mechanisms involving debt for sustainable development, including swaps; their effects on the economy. Until recently, debt swaps have been used in a restricted way, e.g., for conservation purposes. The mechanism needs to be studied for broader applications e.g., debt swaps for sustainable rural development or for reforestation and sustainable management of native forests. The effects of these mechanisms on inflation, employment, debt and marginal clients need to be clarified.

(e) Methodologies for scientific formulation of policies. Methodologies should be developed for an ex-ante analysis of sectoral, sector-related and global policies, from financial, economic and environmental points of view. The ex-post analysis of significant cases can provide guidelines for the evaluation of policies and policy scenarios.

(f) Models for policy decision-making that include economic, political, social and environmental parameters; simulation of the various impacts. Development of such tools would facilitate the ex-ante evaluation of the impact of policies, laws, plans, programs and projects. A complete model would gauge the effects of general and specific actions on the natural resource sector.

(g) Mechanisms and regulations for the conservation and production of goods

and services from tropical forests.

(h) Inclusion of natural resource depreciation in national accounting systems. The countries of Latin America need to study natural resource accounting and ways to include them as complementary accounts in the national accounting system.

Institutions

Some of the main issues to be studied include:

(a) The effect of changes in land tenure regimes and tenure rules on sustainable agricultural and tree-growing practices. How does the lack of security in tenure arrangements restrict or encourage the adoption of sustainable practices?

(b) Granting land to landless peasants as a means of reducing pressure on the agricultural frontier. Studies on this topic should examine the access of local population to shared areas of resources.

(c) Analysis of ways to ensure sustainability in new areas settled under land reform, including the matter of access to forest products, water and crop lands.

(d) Research on the dynamics of management of upland watersheds, including institutional arrangements for hillside agriculture in Latin America.

(e) Research on common property and communal management to better understand how macro-level policies and organizational forms at the regional and local level can hinder or support land-management practices, and how patterns of access to resources may affect land-management options.

(f) Studies on the impact of privatizing land and forest management and on privatizing the supply of goods and services related to agriculture and forestry. For example, what will be the sustainable impact of privatizing the Central American "*asentamiento*".

(g) Research on appropriate mechanisms for promoting inter-institutional cooperation and coordination on intersectoral issues. This type of research is of special importance for organizing activities related to watersheds; at the macro level, it is also important for addressing externalities inherent in policy for different sectors.

(h) Research on technology-transfer systems: the development of integrated technology-transfer systems that encompass animal husbandry, agro-forestry, reforestation and native forest management; holistic agro-ecological approaches that consider both farmed and unfarmed zones of a region (degraded lands, reforestation, water, forests). This type of research should include study of the comparative effectiveness of different forms of technology transfer in different land use systems and the role of local knowledge in extension strategies. It should also include developing a regional concept of rural development that takes poor farmers into consideration and all other kinds of agriculture that could be improved with sustainable practices.

Technology

In addition to the established priorities for technology research, other topics for addressing the sustainability of agriculture include the following:

(a) Agro-ecology - A deeper understanding of the ecology of tropical systems is required for objective management and for developing strategies for sustainable agriculture in Latin America. More needs to be known about soils, biological activities and their potential

(b) Biodiversity should be considered and managed as capital. Urgent aspects involve classifying existing natural ecosystems, their species composition and determining their useful biological and chemical components and economic potential. Also needed is research on management techniques for sustainable of production of the products and services of biodiversity. The potential of tropical forests merits the serious

consideration of all.

(c) Agro-forestry techniques need to be explored. It is clear that sustainable agricultural alternatives will require increased use of shrubs and tree species that provide permanent cover, nutrients and products. Agro-forestry holds potential for important production increases and for the protection and sustainability of soils.

Research on this topic is far behind commodity research on annual crops and a few selected cash-crop perennials, and needs to be rapidly advanced. Silvi-pastoral systems should also be included. The magnitude of potential research application is enormous considering current rates of deforestation.

(d) Management research should investigate the possibilities of replacing external inputs (pesticides, chemical fertilizers) with alternatives that take into account biological and chemical interactions within ecosystems. This includes research on integrated pest management, integrated fertility management, high-technology bionutrification and symbiosis processes that enhance the absorption capacity of plants.

(e) Reforestation - Much progress has been made in reforestation in Latin America, both in large-scale reforestation programs and in social forestry programs. Around 9 million hectares have been planted so far, generating important income for countries like Chile and Brazil. But there are still vast areas and many potential tree and shrub species available for use in reforestation. Most research has been on fast-growing species.

Reforestation also needs to be studied as a means for small-scale farmers and communities to produce bioenergy, food, fodder and wood products. Research should cover species selection, reforestation techniques, silvi-cultural treatments, genetic improvement and vegetative propagation techniques.

(f) Research on management of native forests for other timber and non-timber products. Forests are diverse systems with a wide range of products, many of which are not utilized or are unknown.

CONCLUSION

Latin America and the Caribbean are once again at a crossroad. After decades of boom-and-bust cycles and prolonged economic crises, the countries of the region have taken important first steps to stabilize their economies.

Natural resource capital has been severely eroded during periods of economic mismanagement but there are now opportunities and means to tackle this problem through the new economic agenda. The choices include continuing resource-intensive growth (the hallmark of the past); a resource-minimization strategy which would deemphasize and minimize the use of the natural resource base for any future growth; or a maximum-growth approach subject to the adoption of environmental constraints.

Some of the constraints that might be considered in this latter strategy have been discussed in this paper. I have also suggested a new research agenda for addressing sustainable agricultural issues. In the final analysis, I believe that much is already known about strategies and actions required for sustainable agriculture. What is required at this juncture is national will and commitment to put them into effect.

Footnotes:

* This is a modified and expanded version of a paper at the International Development and Research Centre (IDRC) Conference entitled: "*Research Priorities and Research Capacity on Environmental Issues*", Montevideo, Uruguay, January 27-29, 1992.

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[2] "*America Latina y el Caribe: Pobreza Rural Persistente*", Instituto Interamericano de Cooperacion para la Agricultura, Program Papers Series, Jan. 1990.

[3] "*Toward a Working Agenda for Sustainable Agricultural Development*", Inter-American Institute for Cooperation on Agriculture (IICA), Program Paper Series, Sept. 1991.

[4] G. Gallopin. "*Sustainable Development in Latin America: Constraints and Challenges*". UNDP. 2/3.

[5] United Nations Development Program: "*Action Plan for the Environment in Latin America and the Caribbean*", (First Draft). First Meeting of High-Level Government-Designated Experts to Review the Draft Action Plan for the Environment in Latin America and the Caribbean. Santiago. Chile, July 10-13, 1990.

[6] G. Gallopin, *Ibid.*

[7] G. Gallopin, *Ibid.*

[8] "*Preliminary Overview of the Economies of Latin America and the Caribbean*", 1991, ECLAC, United Nations; and "*Economic and Social Problems in Latin America*", Inter-American Development Bank (IDB), 1991.

[9] *World Commission on Environment and Development*, 1987.

[10] "*Economic Policy Reform for Natural Resource Conservation*", Environment Department. World Bank, May 1988.

[11] Repetto, Robert. "*Economic Policy Reform.*

[12] Repetto, Robert. *Ibid*, P.40.

[13] For one view on the causes of this process. see Luther Tweteen, "The Economic Degradation Process". *American Journal of Agricultural Economics*, Dec. 1989.

[14] Sandra Batie, "Sustainable Development" Challenges to the Profession of Agricultural Economics". *American Journal of Agricultural Economics.* Dec. 1989.

[15] Batie, *Ibid*, p.1085.

[16] G. Edward Schuh: "Economics and International Relations: A Conceptual Framework". *American Journal of Agricultural Economics*, 1963.

[17] Robert Repetto: "Natural Resource Accounting for Countries with Natural Resource-Based Economies", Paper presented to the World Resources Institute. Washington, D.C., October 3, 1986.

TABLE 1.

Type of Policy	General Purpose	Policy Instrument	Expected Impact
1. Macroeconomic	To adjust relative prices	a) Devaluation	I. More profitable to invest in agriculture II. Less profitable to use imported capital (agro-chemicals, etc.)
		b) Low interest rates	I. More profitable to invest in long-term activities
		c) Tariff policies that do not discriminate against agriculture or promote the import of inputs	I. More profitable to invest in agriculture II. Less profitable to use imported capital
	To finance state activity	a) Taxes	I. Resources ensured for implementing policies on sustainability
2. Sectoral	To adjust relative prices	a) Eliminate controls on food prices	I. More profitable to invest in agriculture
		b) Credit for sustainable practices	I. Greater investment in soil conservation, perennial crops, etc. I. More efficient use of water
		c) High fees for irrigation water	I. Less deforestation II. Judicious use of agro-chemicals
		d) Eliminate subsidies for deforestation and agro-chemicals	
		e) Limited road construction in settlement areas	I. Less deforestation in settlement areas.
		f) Direct subsidies for reforestation and management of natural forests	
3. Legal	To reorient the use of resources	a) Land tilting and guarantee of ownership	I. Greater investment in long-term activities
		b) Creation of protected areas and participation of local in management	I. Soil conservation
		c) Laws on genetic heritage	I. Greater investment in conserving genetic diversity
		d) Laws on pesticide use	I. Judicious use of pesticides
		e) Land-use planning	I. Soil conservation
4. Antipoverty	To improve access to opportunities	a) Education	I. Population more aware of environmental problems II. Participation of population in resource management
		b) Job development	I. Less pressure to carry out activities harmful to the environment