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AND LAND USES IN THE SOUTH AMERICAN REPUBLICS

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THE CONSERVATION OF RENEWABLE NATURAL RESOURCES AND
LAND USES IN THE SOUTH AMERICAN REPUBLICS

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by

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THE CONSERVATION OF RENEWABLE NATURAL RESOURCES AND LAND USES IN THE SOUTH AMERICAN REPUBLICS

The South American continent represents such a wide variation of physiographic, climatic, and cultural conditions that it is practically impossible to deal with the continent as a whole. The Amazon Basin is the world's largest rain-forest basin; the Andes Mountains are the second highest mountain range in the world; the extremely-arid western coastal belt contains one of the few areas of the world where rainfall is entirely absent; annual rainfall in parts of Western Colombia and Southern Chile is more than 200 inches; and the wind-swept, semi-arid plains of Southern Argentina are essentially uninhabitable to human beings.¹ Extreme cultural and physical diversity even exist within most of the political entities of the continent.

I. SUPPLY OF RENEWABLE NATURAL RESOURCES

The amount of land in South America that lends itself readily and safely to cultivation is relatively scarce when the aggregate is considered. Deficient or erratic rainfall imposes limitations upon vast acreages; the great expanse of land in the Amazon Basin and other super-humid areas receive torrential rains which result in rapid

¹Preston James, Latin America (3rd Edition; New York: The Odyssey Press, 1959), pp. 23-34.

leaching once the selva vegetation is removed. On the basis of present technology, it is estimated that only about 16.6 per cent of the total land area in South America is productive or potentially productive land for agriculture.² Of this land, only about 40 per cent is presently being used. One of the more favorable aspects of the situation in South America is the ratio of productive land per capita as compared to that of Asia or Europe. It was estimated in 1950 that South America, as a whole, had 1.9 acres of arable land per capita, ranging from less than 0.2 acres per capita in Bolivia to about 15 acres per capita in Uruguay.³ (See Table No. I.)

Table No. I. Land Resources of South America⁴

	Thousands of Acres of Arable Land	Acres of Arable Land Per Capita	Thousands of Acres of Perma- nent Pasture	Thousands of Acres of Forests	Thousands of Acres of Built-on and Waste Lands
Argentina	74,100	4.6	285,000	120,100	213,800
Bolivia	840	0.2	---	---	263,160
Brazil	46,400	1.0	326,000	975,000	680,300
Chile	14,530	2.6	16,750	40,400	111,320
Colombia	5,230	0.5	65,000	178,000	32,770
Ecuador	2,960	0.9	3,750	32,400	28,890
Paraguay	3,830	3.0	---	20,700	75,690
Peru	3,890	0.5	33,500	173,000	97,610
Uruguay	35,200	15.1	---	1,118	9,882
Venezuela	49,400	10.8	74,100	90,300	11,200
South America	205,000	1.9	847,000	1,738,000	1,518,300

²Robert R. Doane, World Balance Sheet (New York: Harper and Brothers, 1957), p. 37.

³J. C. Weaver and F. E. Lukerman, World Resource Statistics (2nd Edition; Minneapolis: Burgess Publishing Co., 1953), pp. 2,3.

⁴Ibid., p. 3

The area under cultivation in South America is rapidly expanding, but there is also widespread abandonment of land in many areas as a result of soil erosion and fertility depletion. It is estimated that about one-fourth of the land under cultivation, present and past, has either been ruined or seriously damaged for further practical cultivation.⁵ The destruction of the renewable natural resource base has been especially serious in the more densely populated areas of the Andean region. For example, it has been estimated that the Magdalena River, which extends for a thousand miles through nearly the entire length of Colombia, dumps the equivalent of 250 to 300 hectares of fertile land per day into the Caribbean Sea during the rainy season.⁶

Patterns of Land Use

Apparently, it does not follow that all societies automatically learn the principles of resource conservation and soil fertility practices as population growth exerts pressure on the renewable natural resource base. There seems to be little evidence of such learned practices being applied to the land in many of the populous areas of the Andes or around some of the population centers in the Brazilian Highlands in spite of the fact that the local renewable natural

⁵U. S. Department of State, Proceedings of the Inter-American Conference on Conservation of Renewable Natural Resources (Denver, Colorado, September 7-20, 1948), p. 349.

⁶International Bank for Reconstruction, Bases de un Programa de Fomento para Colombia, por Larchlin Currie (Bogotá: Banco de la Republica, 1951), pp. 83-84.

resource bases have been largely destroyed.

The system of agriculture employed by most of the Indian cultures which had surpassed the hunting and fishing age during Pre-Columbian times was that of shifting cultivation or "milpa." The exceptions to this rule in South America were the Sedentary Chibchas of highland Colombia and the Incas of the highlands of Peru, Ecuador, Bolivia, and northern Chile.⁷ Through the use of terracing, irrigation, fertilization and other practices, these Indian civilizations were able to develop a sedentary agricultural economy capable of supporting many more persons per square mile than the traditional system of shifting cultivation or migratory hunting and fishing. These societies had learned soil conservation and fertility practices, but there remains a doubt as to the cause and effect relationship of these practices and their support of a greater population density.⁸ In other words, there is some question as to whether the local population densities in these societies became so great that the people were forced to abandon shifting cultivation in favor of sedentary agriculture or, whether sedentary agricultural practices were gradually learned and transmitted in these societies before their population pressures became so great. This question involves not only the relevant physical environment, but the cultural environment as well.

⁷James, Op. Cit., pp. 13-17.

⁸United Nations, Food and Agricultural Organization, "Soil Erosion Survey of Latin America," Journal of Soil and Water Conservation, (Vol. IX, No. 4, 1954), pp. 160, 161.

Shifting Cultivation. An important point to recognize at this stage of the analysis is that the patterns of land use in South America generally reflect an abundant supply of renewable natural resources. This fact is exemplified by the widely practiced patterns of shifting cultivation, plantation agriculture, and extensive grazing on potential cultivable lands. Shifting cultivation may be advantageous when plenty of new and suitable land for exploitation is available. On the other hand, the removal of natural vegetation, the cultivation of steep slopes, and occurrence of torrential rains result in the ultimate depletion of the renewable natural resource base.⁹ An interruption of the natural vegetal succession is effected when man clears, burns, and cultivates the land between the periods of forest fallow. The length of these fallow periods depends upon the density of the local population and the amount of land available for shifting cultivation.¹⁰ As population pressures intensify in a given locality, the fallow period generally becomes shorter with the consequence of a general degeneration of the forests and the soils.

Forests are capable of building and maintaining a forest soil in perpetuity through the physiological processes of translocation, circulation, and the return of organic matter to the soil, but the

⁹F. Benham and H. A. Holley, A Short Introduction to the Economy of Latin America (London: Oxford University Press, 1961), pp. 23, 24.

¹⁰Charles J. Taylor, Tropical Forestry (London: Oxford Univ. Press, 1962), pp. 51, 52.

removal of forests results in rapid physical and chemical changes in the soil. This is particularly true of lateritic soils, the dominant soil group in the tropical parts of South America. As the fallow periods are shortened on these soils, they develop an impermeable layer which is quite unfavorable to plant growth. In addition, leaching rapidly lowers the fertility status of these soils when the natural vegetation is removed.¹¹ This gradual destruction of the topsoil in tropical regions is accelerated by the hot sun and heavy rainfall in many areas. Sheet erosion on lateritic soils often causes the formation of an erosion pavement which is more or less impenetrable to plant roots and permits little or no water infiltration.¹²

Plantation Agriculture. Plantation and subsistence types of sedentary agriculture have also led to a great destruction of the resource base in South America. The former type of agricultural system produces commercial agricultural exports such as coffee, cotton, sugar, cacao, and bananas, and is usually organized into large scale producing units. Since the production of these commodities is quite sensitive to price fluctuations in the world market and demands large quantities of labor, there has been a considerable amount of instability inherent in this system. When the prices of the commodities are high, the renewable natural resource base suffers from over-exploitation, whereas

¹¹Ibid., pp. 5-7.

¹²Ibid., pp. 7-10.

low prices usually result in shifting land uses, often to a less satisfactory use. The sugar cane plantations in Northeastern Brazil illustrate this point. High export prices resulted in the clearing of vast acreages of land for sugar production and the subsequent destruction of much of the area. Later, when prices declined and gold and diamonds were discovered in Minas Gerais, much of the land was diverted to pastoral estates or was fragmented and exploited by the traditional wasteful and inefficient methods.¹³

Subsistence Sedentary Agriculture. In many regions of South America the population pressures have become so great or productive land has become so scarce that shifting cultivation is no longer possible. Hence, under these circumstances, families are forced to plant their subsistence crops on the same piece of land year after year. If the land is not capable of supporting such an intensive type of cultivation without conservation and fertility practices, it is depleted very rapidly. When this occurs, the only alternative for the occupants is migration from these devastated areas, as has been the case in many parts of Colombia.

Matching Resources With Population Needs

Matching the renewable natural resources with the needs of a rapidly expanding population is an especially difficult problem for the

¹³James, Op. Cit., pp. 415-421.

South American republics. Most of the republics are experiencing a high growth rate of population while, at the same time, the renewable natural resource base is declining. Moreover, the desires for a higher standard of living further complicate this situation. While the exploitation of resources by an individual for his own economic interests need not imply poor land use, the long-run effects for the individual and society, as well, are typically overlooked. The lack of security in land tenure and in future economic returns, the traditional deinvestment patterns of land exploitation, the lack of knowledge of conservation and fertility practices, and the emphasis upon centralized government are important counterforces to long-run planning periods.

Agricultural Productivity. The present status of agricultural productivity in most parts of South America imposes severe limitations upon economic development. The lack of diversification in many countries results in a very unstable element in the economies of those countries. At the same time, many of the countries are importing a large amount of staple foods. A reorganization of land uses within these countries could have the effect of relieving some of the pressure upon single commodities and reducing or eliminating the necessity for importing staple foods.

The application of technology such as conservation and fertility practices could result in similar benefits. The development of forest, fish, water, and wildlife resources could have supplementary and complementary effects upon agricultural productivity, but thus far, the exploitation of these resources has been destructive in many cases

and limited in others. The tradition of centralized governments places strong emphasis upon the urban centers, thus resulting in few investments in the agricultural hinterland. In the Andean Region, the early Spanish conquistadores acquired the valley floors and gentle mountain slopes for the grazing of their livestock and forced the Indians and later-appearing mestizos to conduct their intensive agriculture on the steeper mountain slopes.¹⁴ This situation resulted in the severe depletion of the renewable natural resources as well as the lowering of agricultural productivity in that region.

Declining Land Resource Base. Many regions of the South American continent have a very limited potential land resource base-- accelerated soil erosion has practically devastated vast areas of the Andean Region and the Brazilian Highlands; forest reserves have been nearly eliminated in Uruguay; and droughts in Northeastern Brazil render vast acreages useless. Since early mining operations required timber resources for fuel and shafts, large forest tracts were destroyed. Impoverished forms of vegetation succeeded and this secondary vegetation was often overpastured or trampled by the pack animals around the mines.¹⁵ The forests around most of the population centers

¹⁴T. Lynn Smith, "Land Tenure and Soil Erosion in Colombia," Proceedings of the Inter-American Conference on the Conservation of Renewable Natural Resources, Op. Cit., pp. 156, 157.

¹⁵Carl O. Sauer, Article in Man's Role in Changing the Face of the Earth, an International Symposium for the Wenner-Gren Foundation for Anthropological Research and National Science Foundation, William L. Thomas, Jr. (Ed.), (Chicago: University of Chicago Press, 1955) pp. 63, 64.

of South America have been largely destroyed for firewood and charcoal. As previously mentioned, the cultivation of unsuitable land with traditional methods of agriculture has resulted in the further destruction of the renewable natural resource base. Although about 30 per cent of the vegetation of South America is composed of savanna, steppe, and prairie grasses, much of these areas have been overgrazed and plowed until devastating effects have resulted.¹⁶ Wildlife resources have been drastically limited in many areas by the widespread consumption of forests, uncontrolled hunting, the introduction of harmful species, and the lack of aesthetic values for nature among the people.¹⁷

A common fallacy of many development economists is the overestimation of resource potentialities. For example, it is estimated that Brazil has about one-tenth of the world's forest reserves or about 22 acres of forests per capita.¹⁸ However, on the basis of present technology and transportation economies, only about 40 per cent of these forest reserves are accessible. Moreover, only 3.5 per cent of them are softwood, the more important type of wood in the industrialized parts of the temperate zones.¹⁹

¹⁶U.S.D.A., Foreign Agricultural Service, Agricultural Geography of Latin America, (Miscellaneous Publication No. 743; Washington: U. S. Government Printing Office, 1958), p. 19.

¹⁷Abelardo Moreno and Ramona Fernández, Article in Proceedings of the Inter-American Conference on the Conservation of Renewable Natural Resources, Op. Cit., pp. 488-490.

¹⁸Agricultural Geography of Latin America, Op. Cit., p. 3.

¹⁹Weaver, Op. Cit., p. 78.

Soils are likewise often overestimated. The predominant soils in the humid tropics are Latosols. They cover most of Brazil, Venezuela, Colombia, Ecuador, Bolivia, and Peru, except the mountainous parts. Typically, Latosols are fairly old soils, highly weathered, reddish in color, highly leached, and they have a low cation exchange capacity, and a high phosphate-fixing capacity.²⁰ Such characteristics render these soils quite unsuitable for agricultural production, except perhaps a few tree crops. The use of certain soil conditioners and heavy applications of lime and fertilizer under good soil management practices can make these soils quite productive; however, present costs of these practices make them unfeasible.²¹

In contrast to the Latosols, Chernozem, Chestnut, and Brown soils are quite extensive in the temperate grasslands of Argentina.²² These soils are quite fertile and correspond to the soils of the Great Plains in the United States. The Chernozems developed under tall-grass vegetation in a sub-humid climate. Although these are highly fertile soils, erratic and low rainfall limit their productivity. The Chestnuts and Browns, which developed under shorter grass vegetation and drier warm and cool climates, respectively, have even more limited productivity because of low rainfall.

²⁰Agricultural Geography of Latin America, Op. Cit., pp. 22-24.

²¹Journal of Soil and Water Conservation, (Vol. IX, No. 4) Loc. Cit.

²²Agricultural Geography of Latin America, Op. Cit., p. 24.

The important soils of the mountains are the Lithosols and the Andos.²³ The Lithosols, which also occur on plains and hills, are relatively young soils. Although they are fairly fertile, these soils are usually shallow and strong. Their occurrence on rather rugged terrain often imposes a further restriction upon their productivity. The Ando soils, which also occur on rugged terrain, are black to brown in color, contain high organic matter, have developed on volcanic ash, and are moderately fertile.

While the quantitative supply of renewable natural resources in South America is still relatively high as compared to many populous areas of the world, it is clear that the qualitative supply has inherent limitations on the basis of present technology. On the other hand, a shift in the present land uses and the application of conservation and fertility practices would greatly extend the utility of the renewable natural resources. When the physical supply of these resources is still large with respect to population, the economic supply can be extended to meet the demand of a growing population. But, where the economic supply is approaching the physical supply or where the economic supply is being diminished by resource destruction, intensification of land use is the only alternative. Thus a paramount need for improved land use inevitably accompanies increasing population pressure and the demand for higher standards of living.

²³ Ibid.

II. CONSERVATION PROGRAMS

Successful conservation programs involve the careful integration of social and natural sciences for the purpose of providing the optimum use of land resources over time. Such programs in South America have been impeded by the existence of certain economic, social, and political institutions. Nevertheless, the conservation of renewable natural resources is being implemented to some extent throughout the continent.

Inter-American Development Programs

Perhaps no conservation movements have provided greater stimuli than those sponsored under the Inter-American development programs. As early as 1906, a natural resource conference was held for the American states.²⁴ A resolution issued at Rio de Janeiro authorized the Bureau of American Republics to:

.... establish a special service charged with facilitating the development of natural resources and means of communication, and with gathering information on the conditions under which concessions of lands, mines, and forests may be obtained.²⁵

Other important resolutions concerning the development of natural resources were: a resolution issued in Habana, 1928, recommending the publication of geodetic, geologic, and agricultural

²⁴Pan American Union, Department of International Law, Division of Conferences and Organizations, Manual of Inter-American Relations (Revised Edition; Washington, D. C., 1956), p. 156.

²⁵Ibid.

maps by the American countries; a resolution in Rio de Janeiro, 1942, calling for a permanent body of technical experts under the auspices of the Inter-American Development Commission to study the natural resources of each country; and Articles 52, 10, and 63 in the Charter of the Organization of American States, Bogotá, 1948.²⁶ Also at the Bogotá conference in 1948, a resolution was issued concerning the Inter-American Conference on the Conservation of Renewable Natural Resources, held in Denver, Colorado, September 7-20, of that same year.²⁷ The resolution called the attention of the American states to the fact that:

.... the continuing destruction of American renewable natural resources is incompatible with the objective of a higher standard of living; and recommended the fullest possible preparation for participation in the Inter-American Conference on the Conservation of Renewable Natural Resources.²⁸

Since that time, other conferences on the conservation of renewable natural resources have been held on an inter-American basis. But perhaps more importantly, individual countries have begun to initiate conservation programs. Certain regions of Argentina and Southern Brazil have made great strides in soil and water conservation programs. United States technical aid programs have included conservation planning. Centers for the training of conservation personnel have been established in various locations throughout Latin

²⁶ Ibid., pp. 156, 157.

²⁷ Ibid., p. 157.

²⁸ Ibid.

America, and many scholarships have been given to Latin American students to study conservation in the United States.

Faulty Land Use Practices

The widespread occurrence of faulty land use practices create a further awareness of the intense need for conservation methods. As the population approaches the physical limits of the renewable natural resource base, the rationale for improved land use is strengthened. But as long as the physical supply of land resources remains high in relation to the economic supply and as long as resource exploitation is guided by the free enterprise system, little incentive exists for public action to adopt and enforce good land-use practices.²⁹ Moreover, even less incentive for the adoption of conservation practices exists where occupants are only loosely tied to the land resources. Government initiative to establish rational land-use patterns seems logical, but such a public program must include the basis for individual property rights and private exploitation in order to be socially and economically successful.

²⁹Raleigh Barlowe, Land Resource Economics (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1958), pp. 464, 465.

III. CONSERVATION IN EACH OF THE REPUBLICS

Each of the South American republics represents an individual case in regard to land-use and conservation programs because of the great physical and cultural diversity among the countries. It seems appropriate that only a brief synopsis of the situation in each of the countries should be described in this presentation.

Argentina

Argentina is unique among the other South American republics in having such a large concentration of fertile, arable soil--the Argentine Pampa, an area of at least 250,000 square miles situated within the temperate zone.³⁰

The Pampa. This vast area, opened to settlement in 1857, was originally settled in large pastoral estates of 100,000 acres or more.³¹ Today these soils, formed by the deep accumulation of unconsolidated alluvial and loess materials from the drier regions of the West, are largely devoted to the commercial production of livestock and wheat and represent about 80 per cent of Argentina's cultivated land.³²

³⁰United Nations, Food and Agricultural Organization, "Soil Erosion Survey of Latin America," Journal of Soil and Water Conservation, (Vol. IX, No. 5, 1954), p. 224.

³¹James, Op. Cit., p. 314

³²Journal of Soil and Water Conservation, IX, No. 5, Loc. cit.

The Pampa is not as homogenous as many writers have claimed because it varies from a humid area around Buenos Aires to subhumid and semiarid areas in the West. Erosion control has been of primary concern for a long time in this area. The major conservation problem has been wind erosion in the wheat growing areas of the semiarid Pampa.³³

Oases and Mountains of the West. The oases and mountainous areas of Western Argentina do not represent a productive area of great size, however the productivity within many of the oases is quite high. Sugar cane, *vineyards*, alfalfa and the grazing of sheep and goats on the sparsely vegetated lands around the irrigated oases are the chief agricultural activities. Population pressures and overgrazing have caused some serious erosion hazards on the dry margins around these irrigated areas.³⁴

Patagonia. Except in the western fringes where melting snows provide moisture and along some of the rivers in Patagonia, this vast 300,000 square mile area supports little agricultural activity.³⁵ Some very extensive sheep grazing is conducted outside of the irrigated areas. Within the irrigated oases, alfalfa, cattle raising, and fruit growing are the main activities.³⁶ The arid nature of the region

³³Ibid.

³⁴Ibid.

³⁵Ibid., p. 225.

³⁶James, Op. Cit., pp. 318-324.

coupled with strong winds make wind erosion a serious problem. In some areas, overgrazing has caused accelerated erosion, however most erosion in the region is geological.³⁷

Mesopotamia. This region in the northeastern part of Argentina is characterized by forested alluvial tracts along the streams and nearly level to rolling interstream divides of open grassland.³⁸ The region is used chiefly for cattle grazing on large estates, however the southeastern portion is an important sheep producing area as well as flax and maize. In the Araucaria forest area where vast acreages of this tree have been exploited, yerba maté, rye, manioc, cotton, and corn are the principle crops. Erosion in the Mesopotamian region is not a serious problem except in the vicinity of population centers where overgrazing and the cultivation of steep slopes are practiced.³⁹

Chaco. The Argentine Chaco, an area of 150,000 square miles of deciduous scrub woodland interspersed with grassy savannas, has much subsistence farming outside of quebracho tree (quebrachia lorentzii) and cotton crops and a small amount of cattle raising.⁴⁰ Erosion is

³⁷ Journal of Soil and Water Conservation, IX, No. 5, Op. Cit., p. 225.

³⁸ Ibid.

³⁹ Ibid.

⁴⁰ Ibid.

of little concern to this area since most of the region is a great low-land plain of alluvial soils carried by the rivers from the Andes during the summer rainy season. However, one of the problems of developing this region is the seasonal inundation during which time the river channels shift radically.⁴¹ Another conservation problem is the widespread destruction of the quebracho tree in this region.⁴²

Conservation Programs. Argentina has a rather small population in relation to its natural resource base. With the exception of the drier regions, soil erosion has not been a serious problem. Nevertheless, the country is already possessed with certain deficiencies of renewable natural resources. Little work in the conservation of forests and wildlife has been reported. Water deficiency places a severe limitation upon the exploitation of soil resources in a major portion of the country.

The soil conservation movement in Argentina has been rather spectacular. This program is linked to the National Institute for Better Land Use Technology, the federal agency which also has the Institute of Soils and Crops subordinated to it. The former agency,

⁴¹James, Op. Cit., pp. 313-318.

⁴²Pan American Union, Department of Economic and Social Affairs, Division of Agriculture and Conservation, The Role of Conservation in the Education Program of Latin America, by Annette L. Flugger (Washington, D. C., 1953), p. 7.

officially created in 1958, has seven regional centers and 43 experiment stations in the country.⁴³ Although most of the work is still preliminary in nature, a soil survey and the application of a few simple conservation practices have been initiated.

Bolivia

Although more than one-half of Bolivia's area lies in the alluvial lowlands of the Amazon Basin and the Chaco Plain, about 60 per cent of the Bolivian population is concentrated in the Altiplano region, a vast, nearly barren, high plateau dotted with half-dry beds of old salt lakes.⁴⁴ The population is quite dense in the Titicaca Basin where potatoes, quinoa, maize, wheat and sheep are produced on the Indian communal farms.⁴⁵ Wind erosion is a serious local problem in this area.

The southeastern portion of the country, the Bolivian Chaco, consists of dry scrub woodland and patches of dry savanna vegetation. This area has opened up to some extent since World War I. Rice, sugar cane, and livestock raising are becoming increasingly important in the area.⁴⁶

⁴³Antonio Cavalcanti, "Conservation Program in Latin America," Journal of Soil and Water Conservation, XVII, No. 6 (November-December, 1962), p. 263.

⁴⁴Journal of Soil and Water Conservation, IX, No. 5, Op. Cit., p. 219.

⁴⁵James, Op. Cit., pp. 211-213.

⁴⁶Ibid., pp. 225-227.

The Eastern Cordillera, another densely populated area of the country, differs considerably in physical features and culture from the Altiplano. The original colonial grants have now been mostly subdivided into a great number of small private properties on which maize, barley, alfalfa, and fruit are produced. The Cochabamba Basin, an area of only about 90 square miles supports more than 325 people per square mile.⁴⁷ Accessibility is a great problem to the exploitation of the Eastern Cordillera. The overgrazing of sheep on the steeper slopes of this region has resulted in some severe erosion problems.

The major area of colonization in Bolivia is the eastern plains, a region of selva and wet savanna vegetation. This region, which suffers from extreme isolation, is dominated by lateritic soils with heavy, poorly-drained subsoils. Shifting cultivation and extensive livestock grazing are the main forms of agriculture in the region.⁴⁸

Despite the intense need for conservation programs in Bolivia, little positive action has taken place. Few soil conservation practices have been successfully introduced into the country. The introduction of conservation practices has been severely impeded by the lack of educational institutions, a high rate of illiteracy, social isolation, and the instability of land tenure.

⁴⁷ Ibid., pp. 220, 221.

⁴⁸ Ibid., pp. 223-225.

Brazil

Although certain areas of Brazil have advanced significantly in conservation programs, the major portion of the country's 3,282,000 square miles has received little attention.⁴⁹ Brazil is like a huge continent, itself, because of its diversity and vastness. No analysis of its renewable natural resources could be complete, for little is known about a large portion of the country.

Northeast. The northeastern part of Brazil was the first settled part of the country. The original forest cover was wrecklessly exploited for dyewood by the earlier settlers. Later sugar cane was produced on large plantations in the area followed by an era of smaller sugar cane farms, pastoral estates, and specialized crops of tobacco, cacao, and cotton.⁵⁰

The coastal belt, a humid area with deep sandy soils, is primarily devoted to pastureland. Local erosion has produced very deep gullies in much of the area. Further inland, in the hilly, sugar cane-producing region, moderate erosion has occurred. Rainfall decreases inland from the coast, thus the soils become shallower and less productive.⁵¹

⁴⁹Journal of Soil and Water Conservation, XVII, No. 6, Loc. Cit.

⁵⁰James, Op. Cit., pp. 430, 431.

⁵¹Journal of Soil and Water Conservation, IX, No. 5, p. 229.

The transition zone, further inland from the hilly region, receives 20 to 40 inches of rainfall per year.⁵² The main crops are corn, manioc, and cotton. Although the soils are quite fertile, their productivity is limited by their shallowness, stoniness, impermeability, and a topography unsuitable for irrigation.

The interior zone of the Northeast receives fewer than 20 inches of erratic rainfall per year. Repeated droughts cause mass migrations of the population from the marginal livestock producing areas. The torrential rains cause intense geological erosion which has been accelerated by overgrazing.⁵³

East. The decadence of the gold prosperity in the eastern part of Brazil brought about a shift to a pastoral economy and the subsequent destruction of forests in the region. Sugar cane, coffee, rice, and oranges have been important in limited areas of the East. In general, the gold rush created a greater pressure on the land with the result of shorter forest fallow periods and in turn, the depletion and erosion of the soils. The large demand for charcoal in the cities has stimulated a rapid, widespread destruction of forests around the population centers. Much of the land in the eastern region has been so depleted that natural reforestation no longer occurs.⁵⁴

⁵²Ibid.

⁵³Ibid.

⁵⁴James, Op. Cit., pp. 445-459.

São Paulo. After having much of its soils depleted by coffee and cotton production, São Paulo is making a spectacular transition to a stable agricultural economy. The famous "terra roxa" (red lateritic clays) and the "terra arenosa" (pink sands) soils provided good physical characteristics for coffee and cotton; however, they are both highly erodible. The former soils are fairly fertile, but the latter soils, being chemically poor, are the more predominate in the state.

The slopes of the escarpment in the eastern part of the state are quite heavily forested although some destruction of these forests has occurred. Another important forest area of the state is the Araucaria pine forests in the southern part. Despite the importance of this soft-wood forest region, much wasteful exploitation has taken place.

Another interesting thing that happened in the São Paulo state is the breaking up of large estates by the government for the purpose of settling European immigrants as early as 1882.⁵⁵ Small general livestock and crop farms have been able to prosper quite favorably on these soils with a good market for their products in the city of São Paulo.

South. The climate of Southern Brazil prohibits coffee and cotton production. The ethnic origin of its inhabitants is reflected in the farming systems of the region. The farms of those basically

⁵⁵Ibid., pp. 490, 491.

European people are small parcels which have been carved out of the forests since the early Brazilian settlers had occupied the grasslands by establishing large cattle ranches upon them. On these smaller farms, maize, wheat, rye, potatoes, grapes, and hogs are produced. Although crop rotation and other conservation practices have been used to some extent on these farms, intense cultivation has caused fertility depletion and soil erosion.

The Paraná region and Santa Catarina are the major colonization areas in Brazil today. Maté production is being developed to some degree; however, most of the settlers are clearing the forests and producing maize, rice, and beans with a limited amount of hog production. Shifting cultivation is still quite prevalent in the Western Paraná region.⁵⁶

Central-West. Agriculture in the Central-West region of Brazil is mostly concentrated along the rivers except for extensive cattle grazing in the southern parts of Mato Grosso and Goiás. A limited amount of coffee production is now taking place in the southeastern portion of this region. The pioneer zone around Anápolis and Brasília is the scene of rapid and widespread destruction of forests. The planting of maize, rice, beans, sugar cane, and coffee on these lateritic soils has resulted in the rapid depletion of the soils.⁵⁷

⁵⁶Ibid., pp. 503-525.

⁵⁷Ibid., pp. 527-536.

North. Most of Northern Brazil is characterized by lateritic soils under selva vegetation. Although this area represents about 42 per cent of the national territory, only about four per cent of the Brazilian population lives in this region.⁵⁸ Fertile soils occur only on floodplains where continual alluviation takes place. On the basis of present technology governing land use and human inhabitation, the uses to which this area may be employed seem quite limited. Perhaps certain tree crops such as wood products, rubber, cacao, and some fruits and nuts may offer possibilities.

Conservation Programs. Significant conservation movements have taken place in many areas of Brazil. São Paulo state established a soil conservation service in 1939, which later added an extension division and was placed under the state's Department of Agricultural Engineering and Mechanics.⁵⁹ The Agronomic Institute at Campinas, São Paulo, has conducted experiments in soil conservation since 1943, and the information is diffused through the 10 conservation districts of the state to the farmers.⁶⁰ A network of 400 demonstration farms is maintained by the Ministry of Agriculture for the purpose of promoting soil conservation, but the lack of trained personnel and inadequate

⁵⁸Ibid., p. 539.

⁵⁹Journal of Soil and Water Conservation, IX, No. 5, Op. Cit., pp. 229, 237.

⁶⁰Ibid.

finances limit the effectiveness of this program.⁶¹

Conservation projects were initiated in Rio Grande do Sul in 1937 with the creation of the Sand Dune Control Program; however, another agency now supervises the control and stabilization of sand along the 500 mile coastal area of the state.⁶² Rio Grande do Sul created the Soil and Forest Conservation Service in 1946 under the direction of the Secretary of Agriculture. In 1956, the Renewable Resources Section was formed. This includes the Soil Conservation Service, which operates in seven regions in a total of 30 conservation units, the Forestry Service, and the Water Management and Irrigation Service.⁶³

A rather broad forest code exists in the country, but apparently the enforcement of such legislation has been somewhat lax. In spite of regional interests in conservation, economic speculation, high interest rates on capital, and faulty land tenure patterns have impeded conservation movements in the country.

Chile

The extreme diversity of climate and topography in Chile render a major portion of its 286,393 square miles unsuitable for agriculture.⁶⁴ The rich Central Valley is the major agricultural

⁶¹Journal of Soil and Water Conservation, XVII, No. 6, Loc. Cit.

⁶²Ibid., p. 264.

⁶³Ibid.

⁶⁴Journal of Soil and Water Conservation, IX, No. 5, Op. Cit., p. 223.

producing region as well as the most populous region of the country.

Middle Chile. Very large farms devoted to the production of feed crops, livestock, wheat, and fruits have dominated the fertile alluvial fans of the Central Valley in the past. The subdivision of these large estates by the government has taken place quite slowly up until the present time. The northern part of this region contains deep, fertile soils on level to gently undulating terrain, but the lack of sufficient rainfall makes summer fallowing for wheat necessary. This practice coupled with the fact that the soils are quite erodible has resulted in some severe erosion problems.

The area in the northern part of the Central Valley consists of younger soils formed on alluvial fans or blown from areas of volcanic ash. The principle crops grown on the irrigated alluvial soils are alfalfa, red clover, small grains, fruits, and vegetables. Little or no erosion occurs on these soils, however slight erosion has occurred in the Andean piedmont zone, particularly on the steeper slopes under cultivation.⁶⁵

In the middle and southern portions of the Central Valley, irrigation is not so important because of a higher rainfall. A natural vegetation cover reduces erosion hazards in much of the region; however, slight to moderate erosion has occurred in the Andean piedmont and the coastal ranges. Cultivation on many of the steep slopes has resulted in severe erosion.⁶⁶

⁶⁵Ibid.

⁶⁶Ibid.

Northern Chile. Most of the northern region of Chile is a coastal desert of little agricultural importance. Only limited areas in the higher mountains and a few oases provide a basis for agricultural production. Most of the erosion in the area is geological.⁶⁷

Southern Chile. There are only minor areas of agricultural importance south of the Río Bío-Bío. Soft wheat, potatoes, oats, hay, and apples are produced in an area immediately south of the river where the forest has been destroyed.⁶⁸ Heavy rainfall, steep slopes, and very dense forests restrict agricultural activities in most other parts of this region. The development of the forest resources in this area has been very limited, although there are apparently many good commercial species present.

Conservation Programs. Soil conservation work in Chile officially began in 1942 when the government formed a section on soil conservation as a part of the Ministry of Agriculture.⁶⁹ This organization evolved into the Department of Conservation and Administration of Agricultural and Forest Resources, which is further

⁶⁷Ibid.

⁶⁸James, Op. Cit., pp. 262-265.

⁶⁹Journal of Soil and Water Conservation, XVII, No. 6, Loc. cit.

subdivided into working units throughout the country.⁷⁰ The country has exhibited considerable efforts in wildlife conservation through the National Committee for the Protection of Wildlife.⁷¹

Colombia

The country of Colombia is quite compartmentalized by alternating mountain ranges, or cordilleras, and deep, somewhat parallel river valleys. Somewhere between 50 and 70 per cent of the country is forested while only about two per cent of the country is in cropland, mostly coffee, sugar cane, maize, potatoes, rice, wheat, yuca, and bananas.⁷² The northward flowing Cauca and Magdalena River valleys are important agricultural areas as well as the intermountain basins in the Central Cordillera. After the Spaniards had effectively occupied the highlands and parts of the river valleys, many of the poorer class of Spaniards and mestizos migrated into the steeply sloping valleys of the temperate regions in the Cordillera Oriental. The major areas of such settlement were Santander, Santander del Norte, western facing slopes of the Cordillera Oriental in Cundinamarca, and Huila.⁷³

⁷⁰Ibid.

⁷¹Role of Conservation in the Education Program of Latin America, Op. Cit., p. 8.

⁷²Bases de un Programa de Fomento para Colombia, Op. Cit., pp. 70-74.

⁷³James, Op. Cit., p. 116.

Santander and Santander del Norte. Although a rather large migration of Europeans accompanied the movement of mestizos into this area, agricultural production on these somewhat poor, highly erodible soils was never very successful. The exploitation of the bark of the Cinchona tree in the area around Bucaramanga was somewhat successful during the middle part of the 19th century, but competition later folded this industry.⁷⁴ Soils of the Santanderes proved to be too dry for good coffee production, although a considerable amount of coffee is still produced on small farms in the region. Specialty crops such as tobacco, cacao, and cotton are also important in the area around Bucaramanga. Santander del Norte suffers extreme isolation as well as poor soils. The destruction of forests and the cultivation and pasturing of steep slopes has resulted in severe erosion in many areas of the Santanderes. More recently, sugar cane and cattle raising have become important in many parts of the region.

Antioquia. Much of the renewable natural resource base in Antioquia suffered wasteful exploitation during the gold rush in the colonial era.⁷⁵ Land rights in the form of small farms (50-60 acres) were administered to those not employed in the mines as early as the latter part of the 18th century.⁷⁶ The maize, hogs, and poultry

⁷⁴Ibid.

⁷⁵Ibid., pp. 118-123.

⁷⁶Ibid.

produced on these farms were successfully marketed in Medellín and other mining centers. The introduction of coffee later helped to stabilize the agriculture in the area. Whereas the more intensive cultivation was conducted on level to gently sloping land, coffee was planted on the steeper slopes under shade. There is ample rainfall for good coffee production in Antioquia. Perhaps this fact coupled with the land tenure patterns and good markets contributed to the economic success of the region.

Cauca Valley. The fertile alluvial soils, derived mostly from volcanic ash, and ample rainfall have facilitated the great agricultural productivity in the Cauca Valley. Although most of the commercial agricultural production of sugar cane and cattle is conducted on large estates, the growing of vegetables, cacao, and tobacco is increasing on smaller farms. Erosion has not been serious in this area except on the marginal slopes.

Southwest. In the departamento of Nariño, the population is mostly Indian and mestizo. Wheat, barley, and potatoes are grown on small, subsistence farms located on valley flats and on the steep slopes of the Cordillera. Cattle and sheep are grazed in the Páramo regions. In general, erosion is not too severe in Nariño because of the gentle rains on highly permeable, volcanic soils.

Caribbean Coastal Lowlands. The large delta area of the Magdalena River provides vast acreages of fertile, but frequently

inundated soils. On the higher terraces, cotton, rice, cattle raising, and banana production are quite important. Fruits and vegetables are grown near the larger population centers. The Sierra Nevada mountain range in the departamento of Magdalena has become a rather important coffee growing region of the country. Erosion is severe in many parts of these mountains. La Guajira peninsula is of little agricultural importance because of its extreme aridity. Extensive grazing of goats and a few cattle are the chief agricultural activities. Mostly geological erosion occurs in La Guajira peninsula, however overgrazing has resulted in some accelerated erosion.

Llanos and Selvas. The chief area of colonization in Colombia is the llanos and the selvas in the eastern and southeastern parts of the country. The soils of this extensive region are old and thoroughly leached, thus intensive types of agriculture are presently unfeasible for this region. Rice production and cattle raising have been moderately successful in the region.

Conservation Programs. Erosion has been severe in many areas of Colombia. Such devastation in Cundinamarca, Boyacá, the Santanderes, Huila, and Tolima has resulted in extreme depopulation. In many cases, the renewable natural resource base has been essentially destroyed. The National Federation of Coffee Growers established their own soil conservation service in 1946 with both a field and an experimental division. Many conservation practices have been adopted in the coffee

regions. Other groups such as the Tobacco Federation and the Ministry of Agriculture have initiated similar programs. The University of the Andes in Bogotá is the headquarters for the Institute of Conservation and the Utilization of Natural Resources, a study and training center in conservation problems.

Ecuador

Although Ecuador is relatively small, it is a country of great physical diversity. The three major land form regions are the gently sloping coastal belt, the highland region, and the Oriental lowlands.⁷⁷ Most parts of Ecuador receive ample rainfall, concentrated in one rainy season. The soils of the country are mostly of volcanic origin.

Highlands. A major portion of the Andean region is covered by poor, grassy páramo vegetation. The demand for charcoal and firewood has resulted in the widespread destruction of forests in the densely populated sections of the Highlands. This region, having a very high percentage of Indian and mestizos, is devoted largely to potatoes and cereal crops and cattle and sheep raising. Erosion is severe, especially around the more densely populated areas.⁷⁸

⁷⁷ Ibid., pp. 146-151.

⁷⁸ Journal of Soil and Water Conservation, IX, No. 5, Op. Cit., p. 217

Coastal Region. The commercial agriculture of Ecuador is mostly concentrated in the coastal region of the country. Cacao, cotton, rice, tobacco, bananas, citrus fruits, and cattle grazing are the main agricultural activities in this region although a limited amount of shifting cultivation is still practiced in the region. Although many of the forests in this region have been wrecklessly exploited, soil erosion is very slight.⁷⁹

Amazon Region. The lateritic soils of the Amazon region impose severe limitations upon its agricultural capabilities. Erosion is not so much a problem on these soils as is the severe depletion of fertility.

Conservation Programs. Little has been done in the way of conservation programs in Ecuador. A small conservation section is under the Department of Agriculture and a Bureau of Forestry was organized in 1949.⁸⁰ Technical assistance programs have attempted to introduce conservation programs to some degree.

⁷⁹ Ibid.

⁸⁰ Role of Conservation in the Education Program of Latin America, Op. Cit., p. 9.

Paraguay

The fact that Paraguay is more or less self sufficient in food production and boasts some of the most fertile unoccupied soils in the world does not give the country a strong impetus to improve land use patterns. The chief food crops, produced mostly on a subsistence basis, are maize, manioc, sweet potatoes, beans, rice, and sugar cane. Cotton, tobacco, tannin, timber, hides, and petitgrain oil are the chief export commodities.⁸¹ Most of the population is concentrated on the undulating to gently rolling lands around Asunción. To the west of the Paraguay-Paraná-Plata River system is the Chaco region, a vast level alluvial plain subjected to extensive annual flooding. A few spots of palm savanna in this region provide the basis for some extensive cattle grazing. Along the river zone in this region the quebracho tree is exploited as a source of tannin.

Population pressures in Paraguay have not been so great that the renewable natural resources are threatened. Serious erosion problems are restricted to the central part of the country where the clean cultivation of sloping land during the season of heavy showers is practiced. Little attention has been directed to the establishment of conservation programs in the country.⁸²

⁸¹ James, Op. Cit., pp. 290, 291.

⁸² Journal of Soil and Water Conservation, IX, No. 5, Op. Cit., pp. 226, 227.

Peru

Despite the extensive use of conservation practices by the Inca Indian civilization, contemporary Peru lags seriously in conservation programs. The Pre-Columbian use of crop rotations, terracing, irrigation, and fertilization has not been greatly restored since the Spanish disruption of these activities.⁸³

The Highlands of Peru are characterized by individual ranges separated by longitudinal troughs which serve to isolate the population clusters. Subsistence agriculture, producing potatoes, cereal crops, and sheep, prevails in this region. Moderate erosion has occurred throughout the region and intense gully erosion has resulted in certain local areas from the overgrazing of animals.⁸⁴

Although much of the coastal region of Peru is quite dry, the land is quite conducive to irrigation. Only in recent Peruvian history has the commercial production of cotton, sugar cane, rice, and fruits become quite extensive in this region. About 40 distinct oases along the coast provide fertile soils and ample water supplies for commercial agriculture.⁸⁵

As is the case with all of the Andean countries, the Amazon Basin of Peru affords limited opportunities for agricultural

⁸³Luis de Amero García and Renato Rossi, "Irrigating and Reclaiming Desert Land in Peru," Journal of Soil and Water Conservation, IX, No. 6, (November-December, 1954), pp. 266-274.

⁸⁴Journal of Soil and Water Conservation, IX, No. 5, Op. Cit., p. 218.

⁸⁵James, Op. Cit., pp. 189-198.

exploitation. The extreme isolation, heavy rainfall, dense forests, and lateritic soils render intensive agriculture unfeasible for this region.⁸⁶

Conservation programs in Peru have been impeded by poor systems of land tenure, limited educational facilities, and the general misunderstanding of conservation problems. Only a few agricultural schools and experiment stations have done much to promote conservation. Some progress in establishing conservation movements has been made by technical assistance programs. The extensive programs of reforestation and the protection of the guano birds by the Compañía Administradora del Guano are a couple of outstanding examples of conservation in the country.⁸⁷

Uruguay

The smallest and least diversified of the South American republics is Uruguay. The extensive, native tall-grass prairies which cover most of the country and the favorable climate and soils provide a solid basis for a pastoral economy. Most of the slopes of any degree in the country are stony and need not be cultivated because of the abundance of good arable land in the North and in the Southwest.

⁸⁶ Ibid.

⁸⁷ Role of Conservation in the Education Program of Latin America, Op. Cit., p. 10.

However, many of the soils presently under cultivation in Uruguay are of poor fertility.⁸⁸ Nearly eight per cent of the country's arable land is under cultivation, most of which is wheat, sunflower, flax, maize, rice, and sugar cane.⁸⁹

Overgrazing and the tilling of the soil at the period of maximum rainfall are the two chief causes of soil erosion in the country. Sheep and cattle trails have caused serious gullies in some areas. Very few forests remain in the country because of their earlier widespread destruction. A very high rate of private ownership may have contributed to this situation.

The Soil Classification and Conservation Service was established in 1944 as a division of the Ministry of Agriculture and Livestock, but the lack of funds and the lack of trained personnel has impeded its progress.⁹⁰ Uruguay has been a leader in South America in research programs dealing with mineral fertilizers.⁹¹

Venezuela

Venezuela has made significant strides toward the formulation and execution of sound conservation programs. However, many conservation problems in the country have received inadequate attention-- parts of the country have been severely deforested and eroded through faulty land-use practices.

⁸⁸United Nations, Food and Agricultural Organization and the International Bank for Reconstruction and Development, The Agricultural Development of Uruguay (Rome, 1961), pp. 5-7.

⁸⁹Journal of Soil and Water Conservation, IX, No. 5, pp. 225,226.

⁹⁰Ibid.

⁹¹Role of Conservation in the Education Program of Latin America, Op. Cit., pp. 10, 11.

Venezuelan Highlands. It has been estimated that about 75 per cent of the land in the Central Highlands has slopes greater than 25 per cent.⁹² The continual removal of forests and the cultivation of such land has resulted in some very serious local soil erosion problems. Depopulation has occurred in several of these areas. Erosion has been moderate to severe on many lands of gentler gradients where deforestation, intense cultivation, and overgrazing have taken place. Shifting cultivation is widely practiced in much of the Highland region. Only in a few bottomlands, intermountain basins, and other fertile areas with gentle slopes have sedentary agricultural systems become important.⁹³ Sugar cane, cotton, maize, beans, rice, fruits, cacao, coffee, tobacco, and dairy production are important activities in the sedentary agricultural areas.⁹⁴

Maracaibo Lowlands. The Maracaibo coastal plain is characterized by a uniformly tropical temperature and a wide variation of rainfall causing a xerophytic scrub-forest along the Caribbean coast and a rain forest in the South. While only slight erosion has occurred south and west of Lake Maracaibo, severe erosion has occurred in the region between the northern shores of the lake and the coast. Geological

⁹² Journal of Soil and Water Conservation, IX, No. 5, Op. Cit., p. 215.

⁹³ Ibid.

⁹⁴ James, Op. Cit., pp. 72, 73.

erosion has been greatly accelerated by overgrazing.⁹⁵

Orinoco Llanos. The region of the Orinoco Llanos is a vast grassy plain which slopes gradually eastward. Alternating wet and dry periods, poor soils, and the presence of insects and diseases place limitations upon the agricultural productivity of this region. The Llanos have been basically a pastoral region although recent colonization has increased cultivation.

Guiana Highlands. The Guiana Highlands, which consist of extensive tablelands, mesas, and scarps, are geologically very old.⁹⁶ The hilly nature of the terrain and the extreme isolation of the region are negative factors of development. Shifting cultivation and extensive grazing are the prevalent economic activities in the region today.⁹⁷

Conservation Programs. Venezuela possesses a rather good forest service which has been responsible for quite a number of forestry activities in the country. A soil conservation service under the Ministry of Agriculture and Animal Industry has initiated a number of programs in erosion control and land-use improvement. Watershed

⁹⁵Journal of Soil and Water Conservation, IX, No. 5, Loc. Cit.

⁹⁶Ibid.

⁹⁷James, Op. Cit., p. 90.

districts have been established in several states for the purpose of improving land-use practices.⁹⁸ In spite of the initiative taken by these organizations, many adjustments in the present land-use patterns must be made if the country is to meet the needs of an expanding population and a rapidly rising standard of living.

IV. THE ADJUSTMENT OF LAND USE PATTERNS

The wasteful exploitation of the renewable natural resource base in the South American republics is undoubtedly a very grave problem. Such destruction is highly incompatible with the demands of an explosive population determined to ameliorate its standard of living. While it is true that many societies have automatically learned conservation and fertility practices as they have approached the physical limits of their renewable natural resource bases, it seems irrational to extend this proposition to all developing societies. In as much as none of the South American republics have fully approached these physical limits, any prediction in this regard would be purely speculative. However, on a regional basis, there is evidence that these physical limits have been surpassed. The northwestern part of Brazil, the Bolivian altiplano, the Santanderes of Colombia, and other regions are characterized by advanced stages of destruction of the

⁹⁸
Role of Conservation in the Education Program of Latin America, Op. Cit., p. 11.

renewable natural resource bases and subsequent depopulation. Moreover, the greatest strides toward the establishment of sound conservation practices apparently have been made by those countries or those regions of countries whose renewable natural resources are relatively abundant in comparison to the population. Of course this latter observation is complexed by the diversity of physical and institutional factors.

Rational Exploitation of Resources

At any rate, it cannot be denied that the wasteful exploitation of a society's renewable natural resource base represents a loss of economic opportunities for that society, or in other words, a social cost which must be borne by the entire society. Mining renewable natural resources for immediate economic returns is unlike the exploitation of non-renewable natural resources. Conservation practices applied to the former class of resources usually results in an absolute increase in economic returns, whereas conservation practices applied to the latter class of resources are generally for the purpose of increasing the efficiency of exploitation and preserving a certain portion of the resources for later use. The cultivation of the soil or the harvest of timber resources should not be a consumptive use as is the mining of coal or the extraction of petroleum. For example, Venezuela may accelerate its economic development by drawing heavily upon its petroleum reserves now and foregoing their later

use; but, mining its soil would not have a positive influence upon economic development. Rather, the whole society would probably have to bear the expense of a gradual decline in agricultural output or else they would have to support extensive land reclamation programs. In either case, this social cost would tend to impede economic development.

Conservation and Economic Development

From this standpoint, the incorporation of sound conservation practices into the economic development scheme of a country seems highly advantageous. Good land-use practices facilitate economic and *social stability*. *Conversely, faulty land-use practices usually contribute to economic and social instability* as is exemplified in areas where the renewable natural resources are wastefully exploited. In the departamento of Antioquia in Colombia, the relatively small, diversified farms with sedentary agricultural practices have apparently influenced the economic and social stability of that region to some degree. In contrast, the departamento of Santander has a considerable degree of instability due in part, at least, to faulty land-use practices. Furthermore, it seems quite unlikely that economic and social development will proceed very far in any society as long as inferior land-use patterns are prevalent.

The Adoption of Conservation Practices

The conservation of renewable natural resources is certainly not a new concept for a large number of South American leaders. However, a major problem exists in the dissemination of conservation

knowledge and its adoption. The conservation problem involves much more than the physical aspects of natural resources. More correctly, man's use of the renewable natural resources is deeply seated in the economic, political, and social institutions of his environment; that is, land-use patterns are usually folkways in a society. Shifting cultivation and other traditional land-use practices are not easily changeable, for their alteration usually disrupts cultural patterns.

For example, the Agricultural Extension Service has exerted considerable efforts to eliminate shifting cultivation in certain areas of Colombia. They have established demonstration plots where they have used good conservation and fertility practices; they have held community meetings to explain the devastating effects of continued shifting cultivation; and, they have spent much time working with individual farmers. Many farmers have adopted sedentary agricultural practices as a result of their efforts, but in many cases, the consequences of adoption have been quite severe. Merely farming the same piece of land year after year is not in itself good land usage even though terracing and contouring practices are used. Many of the farmers adopted the conservation practices, but they failed to adopt fertility practices. The gradual depletion of the soils has caused a corresponding decrease in agricultural production. Moreover, insects and diseases have tended to become worse where the same crops have been planted year after year on the same land. This factor has further reduced the agricultural productivity since pesticides are expensive and have not been widely accepted either.

Apparently, some farmers have returned to shifting cultivation, where it is possible. This traditional practice increases their agricultural productivity because the fallow period rehabilitates the soil.

A similar situation resulted in areas of Colombia where the annual burning of pastureland was discouraged by the Agricultural Extension Service. The burning of pastureland during the dry season is widely practiced in Colombia because this practice helps to maintain certain grass species and it serves to control weeds and brush in the pastureland. Erosion is often a problem during the wet season as a result of this practice; therefore, the Agricultural Extension Service suggested that the pastureland not be burned during the dry season. They told the farmers that the weeds and brush should be grubbed out and that the dry vegetation should be left to control erosion during the wet season until the new vegetation became established. Farmers who adopted this practice soon found that their pastureland was degenerating. Natural vegetal succession was causing the reduction of the carrying capacity of the pastureland. This economic loss was accompanied by increased labor costs required to grub the weeds from the pastureland. Furthermore, the pastureland tended to start more slowly at the beginning of the wet season because the practice of burning had resulted in a temporary fertility increase. That is, ashes from the burning of the dry vegetation had provided a source of plant nutrients in a readily available form. Such cultural disturbances caused most of the farmers to return to their traditional practice of burning the pastureland.

These examples demonstrate the difficulty of fitting conservation practices into any given society. Before the adoption of a practice is solicited, its consequences should be carefully considered in order to avoid drastic cultural disruptions. This situation does not, however, defeat the argument for conservation programs in the early stages of economic development. Once a practice is deemed worthwhile, its adoption should be secured for the sake of adding economic and social stability to the society.

The obstacles to the adoption of conservation practices are, in themselves, an extremely difficult problem. Overcoming the traditional element of a society is a long and tedious process. A strong emphasis may justly be placed upon education for this reason. The economic implications of the adoption of conservation practices have been mentioned in foregoing discussions. Private ownership rights in soils and to a certain degree in the other renewable natural resources seems highly desirable for securing the adoption of sound land-use practices. Farmers must be rewarded for adopting such practices. Otherwise, economic speculation and short-run planning horizons are likely to prevent the adoption of conservation practices. This factor seems to have been important in the early acceptance of sedentary agricultural practices in Antioquia of Colombia.⁹⁹ However, many other factors such as the physical

⁹⁹ James, Op. Cit., pp. 118-123.

qualities of the resources, transportation costs, markets, and cultural patterns tend to complicate this assumption.

Many conservation practices require capital expenditures thus the availability of special credit facilities for financing these practices is quite important.¹⁰⁰ The Caja Agraria and the Federación de Cafeteros in Colombia are providing such loans to farmers. Other South American countries have similar agencies which provide credit for conservation practices, but such credit facilities are severely lacking in most countries. Above all, stability in the economic, political, and social institutions of a country are important for securing the adoption of conservation practices.

Conservation and the Agrarian Reform

It seems very logical that a strong emphasis upon conservation programs should be made in connection with agrarian reform programs. The quality of renewable natural resources is often overlooked by the planners of the agrarian reform programs. Administering ownership rights to individuals on any type of land and providing for a few services is not in itself adequate. For example, the government of Colombia has strongly encouraged colonization in the intendencia of Caquetá. Settlers receive free land if they clear it and farm it.

¹⁰⁰ Batlowe, Op. Cit., p. 313.

Aside from the fact that very few provisions for schools, roads, markets, credit, and technical services have been made, the soils in this region are mostly lateritic. When the selva vegetation is removed for cultivation, rapid chemical and physical changes occur in the soils. The changes render the soil unproductive for cultivation purposes within a few years. Where native grasses are permitted to succeed upon the land, a fairly substantial basis for a pastoral economy results. But, many of the colonists brought their traditional land-use practices with them. When the soils become depleted and form an erosion pavement, the colonists clear additional land or else they move to a new frontier of settlement. In contrast to this form of settlement, the recent projects sponsored by the Colombian agrarian reform agency have included information on the soils, topography, forests, climate, and hydrology in the development schemes. The careful integration of such information into agrarian reform projects seems to be of foremost importance to the success of the projects.

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