ISSN 1011-7741

IICA

HUMAN CAPITAL FOR AGRICULTURAL DEVELOPMENT IN LATIN AMERICA

G. Edward Schuh
M. Ignez Angeli-Schuh

11 June, 1989
PROGRAM PAPERS SERIES

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IICA

INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE — OAS

PLAN OF JOINT ACTION FOR AGRICULTURAL REACTIVATION IN LATIN AMERICA AND THE CARIBBEAN

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Cover Design:	Mario Loaiza
Layout:	Hugo Calderón
Typesetting:	Giselle Madrigal, Olga Cascante
Editor:	Michael J. Snarskis
Production:	Marcelle Banuett
Series Editor:	Michael J. Snarskis

IICA
DP–11

Schuh, G. Edward
Human capital for agricultural development in Latin America / G. Edward Schuh and M. Ignez Angeli-Schuh. – San Jose, C.R. : Instituto Interamericano de Cooperación para la Agricultura, 1989.
39 p. ; 25 cm. – (Program Papers / IICA, ISSN 1011-7741 ; no. 11).

1. Desarrollo agrícola – América Latina. 2. Recursos humanos – América Latina. 3. Investigación Agropecuaria – América Latina. I. Angeli-Schuh, M.I. II. Título. III. Serie.

AGRIS A50

DEWEY 658.57

PROGRAM PAPERS SERIES No. 11
ISSN 1011-7741

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PREFACE

Among the usual factors used to analyze the dynamics of the agricultural economy –land, labor, capital– one may abstract a hybrid variable with far-reaching ramifications that are frequently difficult to quantify. This is **human capital**, which may be considered as synonymous with a type of human potential. Here, the authors, well-known agricultural economists (Dr. G. Edward Schuh is Dean of the Hubert H. Humphrey Institute of Public Affairs at the University of Minnesota, Minneapolis, Minnesota; M. Ignez Angeli Schuh is a Research Associate in the Department of Agricultural and Applied Economics at the University of Minnesota, St. Paul, Minnesota), first elaborate on the different kinds of human capital (population size, general health, nutritional status, and knowledge, leading to technology), and show how they are complementary among themselves and with physical capital. They then discuss the role of human capital in agricultural development in general, and for Latin American in particular; finally, specific policy recommendations are given.

As components in the Plan of Joint Action for Agricultural Reactivation in Latin America and the Caribbean, the ideas developed here are basic and important. Healthy reserves of human capital are necessary to take full advantage of the natural resource endowment, to increase rural incomes and to improve income distribution. Significantly, they also allow a fuller utilization of appropriate available technology, a goal implicit in the mandate of IICA's Program II.

IICA takes pride in presenting this concise, innovative view of a key aspect of modern agricultural development strategy.

Félix M. Cirio
Coordinator of the Plan of
Joint Action for Agricultural
Reactivation in LAC

Eduardo Trigo
Director, Program II
Technology Generation and Transfer

SUMMARY

In their Introduction, the authors show that human capital may take many forms, ranging from the purely physical (the size of a nation's population, its general health and nutritional status) to the extra-somatic, like the different forms of knowledge. The last, whether derived from scientific research or other sources, can often lead to the creation of technology, through which natural resources are transformed into production output. Emphasis here is placed on production and social (institutional) technology as it relates to agriculture.

Like physical capital, human capital can yield income over time, is reproducible (investments can be made in it), and is also subject to obsolescence, depreciation and refurbishing. Furthermore, the various kinds of human capital are complementary among themselves and to physical capital.

In Chapter 2, the role of human capital in agricultural development is discussed. First, the reciprocal relationship between new production technology (improved varieties, fertilizers, pesticides, equipment) and improved human capital (higher incomes, better foreign exchange ratio, more equity in distribution of benefits) is described. It is noted that food can be construed as a wage good and that lower income consumers spend proportionately more on food. Thus, improved supplies and lower prices of food (i.e., more effective agricultural research and development) have a pro-poor bias.

Education for rural people (improving literacy and cognitive skills) both raises the productivity of labor in agriculture and increases the demand for same, while also making rural labor better qualified for employment in the norfarm sector. A better-educated rural population can be viewed as factor-augmenting –it increases the supply of labor services without increasing the physical stock of labor *per se.* Better cognative skills also tend to lessen misallocations of resources.

As Latin American countries have tended to underinvest in the rural social sciences (most centers of power being urban-based), change is urgently needed in the institutional infrastructure (making ministries of agriculture higher-profile and more efficient) so as to capitalize on natural resource endowments. These changes can be viewed as social technology produced by social scientists, parallel to the production technology produced by biological and physical scientists.

Simple good health can be seen as more important in the rural population than the urban because the former does more physical labor. Yet rural populations are typically less well-housed and have poorer sanitary conditions than their urban counterparts; higher investments in this factor are needed.

Concommitantly, sound nutrition is key to efficient learning and its subsequent benefits. Yet, ironically, farmers often do not have sufficient income to obtain adequate and proper food, and/or they are producers of non-food monocrops (coffee, tea, fibers).

Because children are both cheaper to produce and more needed in rural areas, population growth is high there. Yet it is probably incorrect to see this from a strictly Malthusian point of view, especially in Latin America, where the man/land ratio is low compared to many other parts of the world. Rather, the key problem should be seen as providing adequate education and health care for the young, so that parents can seek "quality" rather than quantity by having fewer children.

In Chapter 3, the authors present a series of informative tables, noting that, to date, Latin America has invested proportionately more in agricultural extension than in research, as compared to the rest of the world. While generally increasing its commitment to both agricultural research and extension, Latin America still falls short of the developed world, when it should be giving the highest priority to agriculture. Comparative tables on health care and rural education are also discussed.

Finally, in Chapters 4 and 5, the authors address the formulation of agricultural policy, giving several suggestions:

(1) Agricultural research must be strengthened, through stations focused on regional ecological and economic diversity and its implications; thus, linkages with the CGIAR centers should be improved.

(2) Education for rural populations should be given high priority, at all levels; families should be subsidized with food so as to allow their children to attend school; at the same time, professionals must be trained in the new technologies.

(3) Rural health and nutrition services must be strengthened.

(4) National capacity for agricultural policy analysis and creation must be augmented.

(5) Policy reforms in countries with serious debt problems should allow access to international capital markets, making them more attractive to international investors, thus helping to alleviate financial constrictions.

(6) In sum, high priority for and investment in human capital in agriculture will produce a ripple phenomenon that should affect all these problem areas beneficially.

1

INTRODUCTION

"Human capital" is a multifaceted concept, and it may take a variety of forms, from the purely somatic to aspects of the rich variety of human cultures worldwide.

An important form of human capital is knowledge. In Western societies, knowledge is generally viewed as something generated by research, and as the product of science and the scientific procedure. Knowledge can come from a variety of sources, however, including religion and mystics, with knowledge from these other sources being useful for various purposes.

Knowledge leads to particular forms of technology, the means by which resources are transformed into output. This "production" technology is important for agricultural development, as we will see below. But there are other forms of technology, such as product technology, marketing technology, and social or institutional technology. We will tend to focus herein on production and social or institutional technology.

Knowledge is imbedded in human beings by means of education and training, as well as through a diversity of informal learning. Hence the level of literacy, the level of educational attainment, and the amount of training provided to a country's population are important measures of its investment in human capital.

Knowledge is also imbedded in the institutional arrangements in a society. Institutions have to do with the formal rules and informal arrangements by which the members of a society relate to each other. A research system and a university are particular institutional arrangements. The economic policies a country uses and such things as property rights are other examples.

The health of a nation's population is still another form of human capital. A nation with a strong health status will tend to be more productive than one with a weaker general health. Improved health raises the physical productivity of a nation's labor force. It also improves the ability of children to absorb cognitive skills from formal schooling. An epidemic, on the other hand, can erode a nation's stock of human capital quite rapidly, either by death or a seriously weakened population and labor force.

Still another form of human capital is the nutritional status of a nation's population. This is closely related to health, but can usefully be treated as a separate dimension of the stock of human capital. A more well-nourished population will tend to be more productive in a physical sense. Young people who are well-nourished also tend to absorb cognitive skills more efficiently in educational programs. And adults who are well-fed are more alert and able to do their work more effectively.

Finally, the size of a nation's population is a important dimension of its total stock of human capital. Rapid population growth relative to a nation's stock of physical resources is an increasingly important issue in many countries. Improving the "quality" of a nation's population by investments in education, health, and improved nutrition is an important means of reducing a nation's population growth rate.

Human capital has a number of distinguishing features. First, like the more familiar forms of physical capital, it too yields a stream of income over time. Second, like physical capital, it is reproducible. Societies can alter their stock of human capital by making investments in it, just as in the case of physical capital. They can also alter the ratio between quality and quantity of population. Third, human capital is also subject to obsolescence, depreciation, and refurbishing, just as is physical capital.

Physical capital and human capital tend to be highly complementary to each other. However, research has shown that investments in human capital tend to yield very high social rates of return, much higher than on ordinary commercial ventures, or on investments in physical capital. This is due in part to the fact that it raises the productivity of more conventional resources such as land, labor, and capital.

Similarly, the various forms of human capital are notably complementary. The introduction of new production technology, for example, tends to increase the demand for formal schooling and thus to raise the rate of return to investments in schooling. Similarly, higher levels of education make it possible for new production technology to be diffused more rapidly, thus raising the rate of return to investments in the production of new technology.

There is a similar complementarity between education, health and nutrition. A well-nourished society will tend to have better health, while both improved nutrition and improved health increase the payoff of investments in schooling.

The remainder of this paper is in three parts. The first part is a rather systematic analysis of the role of human capital in agricultural development. The second part will present data on the various forms of human capital for Latin America. The third part will discuss the implications of the analysis in the previous two sections for agricultural development policy, with emphasis on specific policy recommendations.

2

THE ROLE OF HUMAN CAPITAL IN AGRICULTURAL DEVELOPMENT

In this section we discuss the specific role that human capital plays in agricultural development. We focus on the particular forms that human capital can take.

Investing in Agricultural Research: New Production Technology

The production of new production technology by means of agricultural research and the diffusion of this technology among farmers by means of extension systems or other means is now accepted as the primary means to agricultural development and modernization. There are a number of reasons for the high rate of return to investments in agricultural research which leads to new production technology. We here consider three of these.

First, new production technology in the form of improved varieties, modern inputs such as fertilizers and pesticides, or in the form of tractors and equipment, increases the productivity of conventional resources such as land and labor. Improved varieties, commercial fertilizers, pesticides and herbicides tend to raise the productivity of land, while mechanization tends to raise the productivity of labor. Fertilizers and other modern inputs associated with the biological side of agriculture also raise labor productivity.

Increasing the productivity of land and labor provides the basis for raising the incomes of rural people, even though such productivity growth may require that some people leave agriculture, given the conditions of demand for agricultural output. The major share of poverty in Latin American countries is in agricultural and rural areas. The poverty-stricken in rural Latin America tend to be characterized by low productivity. Raising their productivity is an important aspect of raising their incomes.

Most Latin American countries also need to increase their foreign exchange earnings to service their foreign debt, to import the raw materials and capital goods they need to promote their economic growth, and to pay for consumer goods not produced at home or produced at lower cost abroad. Raising productivity is the means to increase competitiveness in foreign markets. Agriculture has the potential to earn additional foreign exchange for most Latin American countries, especially if there is an increase in productivity in the sector.

Finally, the production and distribution of new production technology distribute the benefits of economic growth broadly in society and in favor of the poor. Policy makers often fail to appreciate this aspect of producing new production technology for agriculture and for this reason, among others, persistently tend to underinvest in this important source of economic growth.

To understand this aspect of introducing new technology into agriculture, one needs to recognize that, under a wide range of conditions, increases in productivity in agriculture lead to

reductions in the cost of production and thus to a decline in commodity prices. Everybody in society consumes food, and in low income countries a major share of consumer income goes for food. If the new production technology is channeled to food crops or commodities, the reduction in price of these commodities is equivalent to an increase in income for consumers, other things being equal. Thus the benefits of the new production technology are widely diffused in the economy. The benefits are also large, given that everybody consumes foods, and that explains why investments in agricultural research tend to be so high.

Two other aspects of this perspective on the benefits of new agricultural technology are important. First, low income consumers spend a much larger share of their budget on food than do upper income consumers. Thus, lower income consumers benefit relatively more from new production technology than do upper income consumers. Investing in agricultural research can thus significantly improve the distribution of income in a country. Unfortunately, this aspect of developing agriculture by investing in agricultural research is all too often neglected, and the emphasis is instead put on the distribution effects within agriculture itself.

The second important aspect of viewing the benefits of new production technology in this way is to remember that food is a wage good. If food prices are lowered as a consequence of investing in new production technology, workers receive increases in real wages even though nominal wages may be unchanged. This makes it possible for the private sector to remain competitive on the international scene without squeezing the wages of workers. This aspect of using new production technology as the engine of economic development is also much neglected.

In conclusion, we see that investing in agricultural research has a pervasive effect in the economy. It raises the productivity of the substantial resources in agriculture. It is a pervasive source of new income streams in the economy since consumers tend to benefit broadly, and it distributes these income streams in favor of the poor. In addition, agricultural research makes it possible not only for agriculture to be more competitive on the international scene, but for other sectors of the economy to be more competitive as well. In fact, the increased foreign exchange earned by this means is another powerful source of new income streams as these exchange earnings are used to finance the imports of inputs needed for higher rates of economic growth.

The Education of Rural People

Literacy and cognitive skill are also important sources of economic growth since they enable a country to make more efficient use of its natural resources, provide the means for making more effective use of available technology, and provide the basis for more innovative behavior throughout society. Unfortunately, it is often believed that rural people do not need education, or don't need it at the same level as does the urban population. In this section we explain why investing in the education of rural people is so important, and especially to the modernization and development of agriculture.

First, in most Latin American countries, the disparity in per capita incomes between the rural and urban sectors, or between agriculture and the nonfarm sector, is quite large. Per capita income in the urban or nonfarm sector is often larger than those in the rural or farm sectors by a very large margin, often 100 percent or more. Education of the rural or agricultural population and labor force is critical to raising the incomes or wages of the labor force in agriculture.

Investments in the education of rural people have two significant effects in narrowing sectoral income differentials. First, it raises the productivity of labor in agriculture, thereby

increasing the demand for such labor. Second, it makes the labor better qualified for employment in the nonfarm sector, and thus makes it more mobile. This increases the rate of outmigration from the sector, and does it without dumping the migrants in urban slums as unemployable.

Education thus has positive effects on both the demand and supply of rural labor –positive in the sense that both the supply and demand forces it generates act to raise agricultural wages relative to those in the nonfarm sector. This makes it a powerful tool for narrowing the sectoral income differential and thus for improving the distribution of income in the country. The bulk of the poor in Latin American countries are in the rural sector, despite the obvious visibility of the urban slums.

Investments in formal schooling of the rural population is also highly complementary to new production technology in agriculture. Formal schooling increases the cognitive skills of the labor force. These cognitive skills are needed to decode the information required to use new production technology. The complementarity thus comes about from the interaction between the technology and the schooling. The schooling causes the technology to be adopted more rapidly and to be used more rationally. But the new technology, for its part, causes the return to schooling to be higher because it constitutes new knowledge which has to be learned. For society as a whole, it is more efficient for the potential users of this new knowledge to learn about it through the printed word than to have somebody teach them about it directly.

Two other aspects of education are important, with each of them being somewhat more subtle than those cited above. First, research on the aggregate production function for agriculture in the United States and other countries has shown that education or schooling is a perfect substitute at the aggregate level for labor as an input in the production process. In that sense it is factor-augmenting –it increases the supply of labor services without increasing the physical stock of labor *per se*. This is an important issue as labor migrates from agriculture to nonfarm employment.

Second, Professor T.W. Schultz has noted the importance of the cognitive skills that education develops as the means by which disequilibria or misallocations of resources are eliminated from the economy (Schultz 1975:827-846). By making it possible to exploit the income opportunities which such disequilibria or misallocations constitute, the cognitive skills lead to a more efficient allocation of resources. This can be a powerful source of increased output and income growth in its own right.

Investments in education are important at still another level. Here we have reference to the undergraduate and graduate programs which train the scientific manpower needed for a modern agriculture and for designing more effective national economic policies. Highly qualified manpower is needed to staff agricultural research programs and extension services if new production technology is to be produced on a sustained basis and diffused to the agricultural population. Similarly, highly trained economists and sociologists are needed if policies are to be evaluated, new policies created, and new institutional arrangements designed.

Institutional Arrangements

The issue of improved policy and new institutional arrangements deserve separate treatment since Latin American countries have tended to underinvest in the rural social sciences, and because the payoffs from such capacity is potentially so great. For example, policy-making in Latin America has tended to have an urban bias, favoring the urban sector relative to the rural sector. One of the reasons for this is that the rural sector has so few people who could effec-

tively articulate the case for agricultural development, or defend the interests of agriculture in the councils of government. Ministers of Agriculture tend not to be backed by a staff of competent economists, rural sociologists, or political scientists who could help them defend themselves and agriculture against their better supported Ministers of Finance or Planning.

The discrimination against agriculture by means of economic policy has led to gross inefficiencies in Latin American economies and the sacrifice of a great deal of income. A cadre of rural social scientists which could bring about a more efficient allocation of resources would be an important source of income growth for the economy as a whole, and an improved performance for agriculture.

More generally, social scientists contribute to economic development by designing new institutional arrangements which make for more efficient use of a nation's resources and which contribute to a more desirable distribution of income, independently of how "more desirable" is defined. The range of these institutional arrangements needed in society is quite wide. Institutions which enable local groups to become empowered and take control over the resources available to them are important, as are those which help to channel more resources to disadvantaged groups. Improved agricultural policies can be an important source of economic growth; they can also lead to a more equitable distribution of income. And the design of factors like more effective agricultural research and extension services can both increase economic growth and change the distribution of income.

Professor Vernon W. Ruttan has often made the point that new institutional arrangements are the social technology produced by social scientists that is the parallel to the production technology produced by the biological and physical scientists. Although we have little empirical evidence on this, the presumption is that the social rate of return to investments which create the capacity to produce this social technology is as high as those which produce the productive technology, since almost everybody in society may ultimately be affected.

Hayami and Ruttan (1985) also make the point that institutional arrangements also have to be changed in response to the change in economic, political, and social conditions as a country experiences economic growth, and as a nation's position in the international economy changes, as conditions in that international economy change. Thus, a continuing capacity for rural social science research is needed to evaluate and design institutional arrangements as an economy develops.

These issues are particularly important in Latin America where Ministries of Agriculture tend to be weak for reasons in addition to those cited above. The services that are typically provided from a unified and comprehensive Ministry of Agriculture in other parts of the world are often separated and spread among various ministries in the government. This makes it difficult to develop unified policies, fractures any basis for general political support for agriculture, and makes it difficult to develop an agricultural perspective in policies that affect the sector.

Health

In some sense, good health may be more important for the rural population than it is for the urban population. Farming tends to be more dependent on physical labor than does most urban or nonfarm employment. Simple physical energy is thus important.

Rural populations also tend to be less well-housed, and more exposed to the elements in their work activities. They also tend to be less well-served by safe sources of water and sound

sewage systems. Thus, maintaining good health is often more difficult in rural areas than in urban areas, and the demand for health services greater.

Good health also makes it possible for young people to more efficiently develop their cognitive skills. It is also essential to mental alertness critical to improved decision-making among adults. This can lead a more efficient use of agricultural resources, and a more rapid rate of technological change.

On the above considerations, one would expect that investments in health services for the rural population would tend to have a higher payoff than for the urban population. Moreover, one would expect more ample health services to be provided to the rural population if the goal were to keep the stock of human capital in agriculture comparable to that in the nonfarm sector. Alas, that is usually not the case.

Nutrition

Sound nutrition is essential to improved labor productivity in agriculture, for the same reasons as sound health is essential. Sound nutrition is also important if cognitive and other skills are to be efficiently absorbed from formal schooling and other educational programs.

Superficially, one might expect that the rural population would be well-nourished since it might have first access to food. However, agriculture involves much more than the production of food. Often it consists of a monoculture of nonfood crops such as coffee, tea, and cotton. Moreover, even the small self-sufficient producer needs more than food and thus has to sell some portion of his food for the acquisition of clothing, housing, medical services and so on. Within the household, children often have low priority in their claim on food, since it is reserved for those doing physical labor.

Perhaps the most important point, however, is that nutrition and food security have little to do with the supply or availability of food. It is primarily an issue of having the income or means to acquire the food. Since poverty is concentrated in the rural sectors of Latin American countries, one would expect to find malnourished people concentrated in the rural sector. Thus, like the provision of health services, the nutrition of the rural population is an important policy issue if agriculture is to have an adequate stock of human capital.

The Population Problem

Most Latin American countries are experiencing high population growth rates, with much of that growth concentrated in the rural population. The reasons for this disparity are that children are cheaper to produce in rural areas, and can be a valuable resource in farm activities, especially among subsistence farmers. Thus, both supply and demand forces countribute to high population growth rates.

Those concerned about high population growth rates often view the problem from a Malthusian perspective, thus envisaging population pressing against limited physical resources, driving productivity (and, in turn, wages) down to and below subsistance levels of income. This perspective seems misguided in most cases, especially in Latin America, where the man/land ratio tends to be low compared to Asia and other parts of the world. The real issue in high population growth rate countries is the strain this puts on educating and providing health care for the young. Family dependency ratios tend to be high when population growth rates are

high. One can appreciate the problem at the aggregate level by noting that as many as 70-80 percent of the population can be less than 18 years of age when high population growth rates prevail for an extended period of time.

A policy perspective can be had on this problem by noting that what families tend to demand is a quantity of child services which can be fulfilled either by numbers of children or some combination of numbers and quality. Under the right circumstances, families will demand a smaller number of children in order to invest more in them and thus to have a higher "quality" child or children. To reduce population growth rates, incentives are needed to help induce larger investments in the quality of the children. There are several ways this can be done.

3

THE DATA FOR LATIN AMERICA

In this section, we report some of the available data on the stock of human capital in Latin American agriculture. In some cases this involves an estimate of either the absolute level of investment for it, or a surrogate for such investments. In other cases, we document the difference between the rural and urban sectors.

The Capacity for Agricultural Research and Extension

Judd, Boyce, and Evenson (JBE) (1986) have developed the most comprehensive set of published data on international agricultural research and extension, although ISNAR has invested a sizeable effort in developing a new, more refined set. We draw on the JBE data for our purposes.

Table 1 summarizes the basic data on expenditures and manpower for research and extension for Latin America as a whole and for three sub-regions. Tropical South America is mainly Brazil, and the Caribbean/Central America is mainly Mexico. SMYs refers to scientist man-years.

The data show that both expenditures and manpower for research and for extension increases very significantly from 1959 to 1980. Latin America's share of global expenditures on agricultural research rose from 3.9 percent in 1959 to 6.3 percent in 1980. The increase in SMYs follows the same pattern as the increase in expenditures, with Tropical South America and the Caribbean/Central America experiencing the greatest increases.

Compared to other regions of the world, Latin America tends to invest relatively more in extension than in research. In 1980, it accounted for 12.7 percent of the expenditures on extension, an increase from 4.3 percent in 1959. This is consistent with a general pattern that JBE find in which the industrialized regions of the world have placed more emphasis on research, while the developing countries have tended to put the emphasis on extension.

The number of extension workers in Latin America increased dramatically between 1959 and 1980 –from 3 353 to almost 23 000. Within Latin America, the countries of Tropical South America accounted for 70 percent of all extension workers. Worldwide, Latin America's share of extension workers increased from 1.9 percent to 7.2 percent (Judd, Boyce and Evenson 1986).

In a comparative sense, the critical issue is the "intensity" of these expenditures and manpower compared to the value of agricultural product. Table 2, taken from JBE, provides expenditures on research and extension as a percentage of the value of agricultural product.

These percentages increased from 1959 to 1980 for each of the subregions of Latin America, and for both research and extension. Tropical South America (mainly Brazil) in 1980 was spending the largest percentage of its agricultural output on both research and extension, more than either of the other two subregions. However, the other two subregions were spending a larger share of their output on research than on extension in 1980, making them more like the industrialized countries in this respect. The Latin American countries do not distinguish

Table 1. Agricultural Research Expenditures and Manpower in Latin America.

Subregions	Expenditures (Constant 1980 US$ Thousands			Manpower (SMY)		
	1959	1970	1980	1959	1970	1980
Temperate South America	31 088	57 119	80 247	364	1 022	1 527
Tropical South America	34 792	128 958	269 443	570	2 698	4 840
Caribbean and Central America	13 676	29 941	112 941	491	1 160	2 167
Latin America	79 556	216 018	462 631	1 425	4 880	8 534

Agricultural Extension Expenditures and Manpower in Latin America

Subregions	Expenditures (Constant 1980 US$ Thousands)			Manpower (workers)		
	1959	1970	1980	1959	1970	1980
Temperate South America	5 741	44 242	44 379	205	1 056	1 292
Tropical South America	47 296	136 943	294 654	2 369	7 591	16 038
Caribbean and Central America	8 414	24 786	57 911	779	2 135	5 505
Latin America	61 451	205 971	396 944	3 353	10 782	22 835

Source: Judd, Boyce and Evenson (1986:82-85).

themselves from other developing countries on the basis of these shares. They do tend to rank significantly below the industrialized countries, however.

Data on the number of SMYs and extension workers per US$ 10 million (constant 1980 dollars) of agricultural product by geographic subregion are given in Table 3. These ratios also increased over time for both research and extension for each of the subregions of Latin America. In both cases, the subregions each tend to have lower ratios than either the industrialized regions of the world or other less-developed regions. Hence the "intensity" of both research and extension tends to be lower in Latin America than in other subregions of the world.

In conclusion, these data show that Latin American countries have over time increased their commitment to agricultural research and extension as a source of agricultural development. However, they tend to fall short compared to the industrialized countries, and even some of the other developing regions, in the expenditures they make and the manpower they have relative to agricultural output.

These data do not show, however, whether Latin American countries are investing at an adequate level in either agricultural research or extension. Data in Table 4 suggest that Latin American countries are underinvesting in agricultural research. (Comparable data for extension are lacking.) Even though the data in Table 4 refer to earlier periods, with three exceptions

Table 2. **Research and Extension Expenditures as a Percentage of the Value of Agricultural Product: Public Sector.**

Subregion or Country Group	Agricultural Research Expenditures			Agricultural Extension Expenditures		
	1959	1970	1980	1959	1970	1980
Northern Europe	0.55	1.05	1.60	0.65	0.85	0.84
Central Europe	0.39	1.20	1.54	0.29	0.42	0.45
Southern Europe	0.24	0.61	0.74	0.11	0.35	0.28
Eastern Europe	0.50	0.81	0.78	0.32	0.36	0.40
Soviet Union	0.43	0.73	0.70	0.28	0.32	0.35
Oceania	0.99	2.24	2.83	0.42	0.76	0.98
North America	0.84	1.27	1.09	0.42	0.53	0.56
Temperate South America	0.39	0.64	0.70	0.07	0.50	0.43
Tropical South America	0.25	0.67	0.98	0.34	0.71	1.19
Caribbean and Central America	0.15	0.22	0.63	0.09	0.18	0.33
North Africa	0.31	0.62	0.59	1.27	2.21	1.71
West Africa	0.37	0.61	1.19	0.58	1.24	1.28
East Africa	0.19	0.53	0.81	0.67	0,88	1.16
Southern Africa	1.13	1.10	1.23	1.64	0.67	0.46
West Asia	0.18	0.37	0.47	0.25	0.57	0.51
South Asia	0.12	0.19	0.43	0.20	0.23	0.20
Southeast Asia	0.10	0.28	0.52	0.24	0.37	0.36
East Asia	0.69	2.01	2.44	0.19	0.67	0.85
China	0.09	0.68	0.56	n/a	n/a	n/a

Source: Judd, Boyce and Evenson (1986:86).

they show very high social rates of return. Two of these exceptions are for wheat, where PL 480 imports of wheat caused the rate of return to be lower. The other case was cotton, in which case agricultural commodity programs of the United States also influenced the measured rate of return.

These high social rates of return indicate that Latin American countries could profitably increase their expenditures on agricultural research. The fact that they have increased their expenditures in 1980 compared to earlier periods suggests that policy makers have in fact responded to these profitable sources of growth. However, given the amounts involved, it is not likely that they have driven down the rates of return by very much. In fact, what the data fail to show is the extent to which the economic crisis of the 1980s has caused governments to reduce their investments in research and extension. If data were available for a recent year, they would surely show a substantial reduction in expenditures compared to 1980.

Policy makers in developing countries tend to argue that they can't afford to spend larger sums on agricultural research. As JBE note, however, this argument is misplaced. Agricultural research is not a consumption good; it is an investment. Policy makers can't afford **not** to make investments with such high social rates of return. If they do so, they will sacrifice a low-cost source of economic growth that could have pervasive effects in their respective economies.

Table 3. Research and Extension Manpower Relative to the Value of Agricultural Product.

Subregion or Country Group	SMYs per US$ 10 Million (Constant 1980) Agricultural Product			Extension Workers per US$ 10 Million (Constant 1980) Agricultural Product		
	1959	1970	1980	1959	1970	1980
Northern Europe	1.05	2.01	3.14	2.76	2.56	2.61
Central Europe	0.80	1.21	1.56	2.19	2.77	2.73
Southern Europe	0.93	1.17	0.96	2.00	2.76	2.69
Eastern Europe	1.44	2.97	2.84	2.36	2.88	3.13
Soviet Union	1.38	2.37	2.34	2.26	2.33	2.50
Oceania	1.91	2.64	2.43	2.26	2.17	2.11
North America	0.84	0.89	0.84	1.44	1.31	1.08
Temperate South America	0.46	1.15	1.32	0.26	1.19	1.26
Tropical South America	0.41	1.41	1.77	1.71	3.95	6.46
Caribbean and Central America	0.53	0.86	1.20	0.82	1.53	3.12
North Africa	0.91	1.44	4.24	18.83	28.45	22.23
West Africa	0.33	0.61	1.42	7.61	14.01	18.08
East Africa	0.32	0.77	1.76	16.28	22.41	26.64
Southern Africa	1.90	1.96	2.47	8.73	5.94	5.62
West Asia	0.33	0.84	0.88	4.39	7.25	6.54
South Asia	0.50	0.65	1.29	20.83	19.51	19.53
Southeast Asia	0.47	1.28	2.07	9.81	13.07	19.72
East Asia	3.80	5.29	5.72	6.57	7.05	6.13
China	0.22	1.66	1.49	n/a	n/a	n/a

Source: Judd, Boyce and Evenson (1986:88).

An alternative argument is that agricultural research is an investment with a long gestation period since it generally takes from seven to 10 years between the time a new research endeavor begins and effects of the research program begin to show up on farmers' fields. However, both the Interamerican Development Bank and the World Bank have demonstrated their willingness to lend in support of agricultural research. Their lending terms make it feasible to borrow to support national agricultural research programs. Moreover, many applied research programs, which essentially involve the adaptation of technology from other countries to local conditions, can have a payoff in a shorter period of time.

Another important aspect of the agricultural research systems in Latin America is their geographic coverage. Given the location specificity of agricultural technology, vital agricultural research stations and programs are needed for each ecological zone. For Latin America as a whole, such comprehensive coverage simply is not available.

An important issue in expanding the capacity for agricultural research in Latin America is the lack of graduate training programs in the region. The number of programs that provide Master's-level training is fairly limited, and the number that provide Ph.D.-level training is even smaller. Unfortunately, given the economic crisis most Latin American countries have experienced in the 1980s, financial support for what were once fairly strong programs has declined, and with it the quality of the degree programs offered. Hence, the capacity for graduate training is even less than what it once was.

Table 4. Summary of Studies of Agricultural Research Productivity in Latin America.

Study	Country	Commodity	Time Period	Annual Internal Rate of Return (%)
Barleta 1970	Mexico	Wheat	1943–63	90
Barleta 1970	Mexico	Maize	1943–63	35
Ayer 1970	Brazil	Cotton	1924–67	77+
Ayer and Schuh 1972	Brazil	Cotton	1924–67	77–110
Hines 1972	Peru	Maize	1954–67	35–40[a] 50–55[b]
Hertford, Ardila, Rocha, and Trujillo 1977	Colombia	Rice	1957–72	60–82
		Soybeans	1960–71	79–96
		Wheat	1953–73	11–12
		Cotton	1953–72	none
Vennergreen and Whitaker 1977	Bolivia	Wheat	1966–75	–48
Scobie and Posada 1978	Bolivia	Rice	1957–64	79–96
Barleta 1970	Mexico	Crops	1943–63	45–93

Source: Hayami and Ruttan (1985:63-66).
Notes:

a Returns to maize research only.
b Returns to maize research plus cultivation "package."

In the absence of indigenous graduate training programs, potential researchers have to be sent abroad for training. This is costly, and it absorbs scarce foreign exchange. The international debt crisis in countries such as Mexico and Brazil has caused them to drastically cut the number of people they send abroad for graduate training. This bodes ill for the future capacity to conduct effective agricultural research programs.

Another component of the capacity for agricultural research in the region is the international Agricultural Research Institutes in the region, elements of the internationally financed Consultative Group for International Agricultural Research. There are three such Institutes in the region: the International Center for Improvement of Wheat and Maize (CIMMYT) in Mexico; the International Center for Tropical Agriculture (CIAT) in Colombia; and the International Potato Center in Peru.

These Institutes are designed to support National Agricultural Research Systems (the so-called NARSs) in the developing countries. Their mission is to develop new technology that can be adapted by the NARSs. This adaption requires a strong research capacity in its own right, however. The failure to have a sufficiently well-developed capacity for research in the developing countries reduces the payoffs to the investment in the international centers.

The final issue is whether the private sector can fill the gap. Private sector agricultural research is important in the region, and is likely to grow as biotechnology becomes more important. However, much of agricultural research, especially of the biological kind, has to be in the public sector since the new technology is highly transferable and the private sector cannot capture the returns from its investments. This problem is complicated by the lack of protection

for patent rights and other aspects of biological research. Hence, the onus for strengthening the capacity for agricultural research in the region ultimately resides with the public sector and government, even though the private sector has an important role to play.

The Education of Rural People

The gap in educational attainment between the urban and rural populations in Latin America is large. Data in Table 5 show the level of illiteracy among the population age 15 and over, with comparison between the rural and urban areas in most cases. Two aspects of these data are important. First, the level of illiteracy is high in all cases except for Argentina, Cuba and Uruguay. Second, the level of illiteracy is much higher among the rural population than among the urban population.

Many of these data are from the early 1970s. General education has spread significantly in the region since that period. But the discrepancy between the rural and urban sector has not likely changed very much since the period covered by the earlier studies. Moreover, the economic crisis of the 1980s has made it difficult in many cases to sustain the earlier levels of expenditure.

Data on educational attainment by urban and rural areas are summarized in Table 6. They tell the same story as Table 5, although with more detail. What is striking is the very low percentage of rural population that completes even the first year of formal schooling.

Although overall educational attainment has in most cases increased since the dates indicated, there is very little evidence that the disparity between the rural and urban areas has narrowed significantly. Moreover, real expenditures for education may even have declined.

Finally, data in Table 7 show the distribution of higher education by field of study. What stands out in these data is the fairly small percentage of students that go into agriculture at the level of higher education. The significance of these data is that agricultural output accounts for a much larger share of total output of the respective economies than does enrollment in agricultural courses as a share of the total. Also, modern agriculture is increasingly based on science and technology. Most Latin American countries fall far short of training the cadre of well-trained people needed for a modern agriculture.

There is a qualitative aspect to these data as well. Many students enroll in agriculture only after having failed to gain entrance to their field of first choice. Thus, there is a selection factor at work in terms of quality students. In addition, many, if not most *agronomos* come from urban areas rather than from agricultural zones. This influences their ability to adapt their training to the problems of the rural sector.

Health Care

Data on life expectancy and related health indicators are provided in Table 8. These data show the very significant improvements in health care between 1965 and 1984 in most countries of the region. For there to have been such progress at the aggregate level, there must have been significant progress in agriculture and the rural areas as well. We could find no data which distinguished between rural and urban groups. However, it is widely known that the provision of health services to rural areas is significantly less than to urban areas.

The data show that the percentage of married women of child-bearing age using contraceptives is also low. That suggests that most families are still not making the trade-offs between having large numbers of children with low levels of investment in them and fewer numbers of children with far greater levels of investment in their human capital.

Table 5. Illiteracy, Age 15 and Over, by Urban and Rural Areas and by Sex, 20 Latin American Countries.

Country	Year	Category	Illiterate Population			% of Total Population		
			Total (N)	Male (N)	Female (N)	Total	Male	Female
A. Argentina	1971	Total[4]	1 177 400	–	–	8.4	–	–
B. Bolivia	1976	Total	993 437	315 460	677 977	36.8	24.2	48.6
		Urban	176 748	34 393	142 355	15.2	6.2	23.2
		Rural	816 689	281 067	535 622	53.2	37.3	68.5
C. Brazil	1978	Total	16 223 404	7 308 439	8 914 965	23.9	22.0	25.7
		Urban	7 308 975	2 870 786	4 438 189	15.6	12.8	18.1
		Rural	8 914 429	4 437 653	4 476 776	42.4	40.9	43.9
D. Chile	1970	Total	594 749	262 937	331 812	11.0	10.1	11.8
		Urban	276 270	103 183	173 087	6.6	6.4	7.7
		Rural	318 479	159 754	158 725	25.6	23.6	27.9
E. Colombia	1981	Total	2 407 458	1 091 458	1 316 051	14.8	13.6	16.1
		Urban	923 430	–	–	9.0	–	–
		Rural	1 484 028	–	–	24.8	–	–
F. Costa Rica	1973	Total	121 312	59 084	62 228	11.6	11.4	11.8
		Urban	23 177	8 522	14 655	4.9	4.0	5.7
		Rural	98 135	50 562	47 573	17.0	16.6	17.5
G. Cuba	1979	Total	218 358	101 119	117 239	4.6	4.3	4.9
H. Dominican Rep.[2]	1970	Total	678 910	319 825	359 085	32.8	31.2	34.3
		Urban	165 841	–	–	19.0	–	–
		Rural	517 796	–	–	43.4	–	–
I. Ecuador	1974	Total	932 723	390 435	542 288	25.8	21.8	29.6
		Urban	153 280	50 615	102 665	9.7	6.9	12.2
		Rural	779 443	339 820	439 623	38.2	32.3	44.4
J. El Salvador	1975	Total[1]	1 064 159	462 705	601 454	38.0	34.5	41.1
		Urban	216 593	67 830	148 763	18.0	12.7	22.2
		Rural	847 566	394 875	452 691	53.0	48.9	57.2
K. Guatemala	1973	Total	1 528 732	651 915	876 817	54.0	46.4	61.5
		Urban	291 380	97 460	193 920	28.2	20.0	35.5
		Rural	1 235 220	549 980	685 240	68.6	59.9	77.6
L. Haiti	1971	Total	2 005 052	884 678	1 120 374	78.7	73.8	83.1

Table 5. (Continued)

Country	Year	Category	Illiterate Population			% of Total Population		
			Total (N)	Male (N)	Female (N)	Total	Male	Female
M. Honduras	1974	Total	594 194	274 815	319 379	43.1	41.1	44.9
		Urban	99 015	37 523	61 492	21.1	17.6	24.0
		Rural	495 179	237 292	257 887	54.4	52.1	56.8
N. Mexico	1980	Total	9 400 000	4 100 000	5 300 000	19.0	16.7	21.2
O. Nicaragua[5]	1971	Total	410 755	193 475[a]	217 277	42.5	42.0	42.9
		Urban	94 319	33 873	60 446	19.5	16.1	22.1
		Rural	316 436	159 605	156 831	65.4	63.8	67.0
P. Panama	1980	Total	166 669[a]	80 163[a]	86 506	15.4	14.7	16.0
		Urban	26 221	10 985	15 236	6.3	5.6	7.0
		Rural	149 162	75 687	93 475	38.1	35.5	41.1
Q. Paraguay	1972	Total	256 690	93 150	163 540	19.9	14.9	24.5
		Urban	61 570	18 240	43 330	11.4	7.4	14.7
		Rural	195 120	74 910	120 210	25.9	19.7	32.3
R. Peru	1972	Total	2 062 870[a]	624 018	1 438 852	27.5	16.7	38.2
		Urban	586 191	137 018	444 176	12.6	5.9	19.1
		Rural	1 454 676	487 000	994 676	50.9	32.9	69.2
S. Uruguay	1975	Total	124 664[a]	65 007[a]	59 657[a]	6.1	6.6	5.7
		Urban	87 500	40 200	47 300	5.2	5.1	5.2
		Rural	37 000	24 900	12 100	11.0	12.6	8.6
T. Venezuela	1971	Total	1 373 561	585 928	787 633	23.5	20.3	26.6
United States[3]	1969	Total	1 435 000	708 000	727 000	1.0	1.1	1.0

1 Data refer to age 10 and over.
2 Excluding 8% of the population unspecified as to literacy or illiteracy.
3 Data refer to age 14 and over.
4 Data refer to age 18 and over.
5 In 1980, after the National Literacy Campaign, the Ministry of Education estimated that of the 722 431 illiterates identified in the census of October, 1979, 130 372 were "analfabetos inaptos" and 406 056 were made literate, leaving only 186 003 "analfabetos aptos" (or 12.96% of the population of 10 years and over).

a. Urban and rural do not equal the total.

Source: UNESCO-SY, 1980-83, table 1.3; UNESCO-SY, 1984, table 1.3.

Table 6. Educational Attainment, by Urban and Rural Areas, Age, and Sex, 19 Latin American Countries.

Country and Category	Year	Sex	Age Group	Total Population	Highest Level Attained[1] (%)					
						First Level		Entered Second Level		
					No Schooling	Incompleted	Completed	First Cycle	Second Cycle	Post Secondary
A. Argentina										
Total Population	1980	MF	25+	14 913 575	6.0	32.0	34.6	20.5		6.9
		F	25+	7 711 356	6.7	32.1	35.2	20.1		5.8
B. Bolivia										
Total Population	1976	MF	25+	1 759 432	48.6	28.5		10.8	7.1	5.0
		F	25+	918 709	62.2	20.7		8.2	5.6	3.3
C. Brazil										
Total Population	1976	MF	25+	42 096 300	32.7	53.0	4.3	5.7		4.3
		F	25+	21 419 800	36.0	50.8	4.0	6.0		3.2
D. Chile										
Total Population	1970	MF	25+	3 721 125	12.4	57.2		26.6		3.8
		F	25+	1 945 921	13.3	57.7		26.5		2.5
Urban Population		MF	25+	2 712 020	8.3	34.1	26.0	27.0		4.8
Rural Population		MF	25+	792 400	29.8	54.2	10.0	5.4		8
E. Colombia										
Total Population	1973	MF	20+	8 478 100	22.4	55.9		18.4		3.3
		F	20+	4 483 086	23.7	56.0		18.5		1.8
Urban Population		MF	20+	5 593 002	14.2	54.8		26.1		4.9
		F	20+	3 108 408	16.1	56.2		26.1		2.6
Rural Population		MF	20+	2 885 098	38.4	58.0		3.6		2
		F	20+	1 374 677	40.8	55.6		3.5		1
F. Costa Rica										
Total Population	1973	MF	25+	657 543	16.1	49.1	17.8	6.3	4.9	5.8
		F	25+	331 240	16.0	49.8	17.7	6.5	4.5	5.4
Urban Population		MF	25+	297 887	7.2	37.4	24.8	10.9	9.0	10.6

Table 6. (Continued)

Country and Category	Year	Sex	Age Group	Total Population	Highest Level Attained[1] (%)					
					No Schooling	First Level		Entered Second Level		Post Secondary
						Incompleted	Completed	First Cycle	Second Cycle	
		F	25+	161 996	8.1	39.3	24.4	10.9	8.1	9.3
Rural Population		MF	25+	359 656	23.6	58.8	12.1	2.4	1.4	1.8
		F	25+	169 244	23.6	59.8	11.4	2.3	1.1	1.7
H. Dominican Republic										
Total Population	1970	MF	25+	1 145 090	40.1	41.6	4.3	9.6	2.5	1.9
		F	25+	563 150	42.8	40.9	3.9	8.7	2.4	1.3
Urban Population		MF	25+	487 675	22.9	42.1	7.4	18.3	5.2	4.1
Rural Population		MF	25+	667 415	52.8	41.2	2.0	3.2	5	3
I. Ecuador										
Total Population	1974	MF	25+	2 296 282	31.9	53.7		5.9	5.3	3.2
		F	25+	1 160 896	36.8	49.8		6.0	5.8	1.7
Urban Population		MF	25+	958 110	13.0	56.7		12.1	11.2	7.0
		F	25+	508 630	16.4	56.3		11.9	11.9	3.5
Rural Population		MF	25+	1 338 172	45.4	51.5		1.5	1.1	4
		F	25+	652 265	52.8	44.7		1.3	1.1	2
J. El Salvador										
Total Population	1971	MF	25+	1 252 939	54.7	37.9		6.0		1.9
Urban Population		MF	25+	635 435	31.8	51.1		12.9		4.2
Rural Population		MF	25+	717 504	70.9	28.1		9		2
K. Guatemala										
Total Population	1973	MF	25+	1 785 720	93.9			4.9		1.2
		F	25+	897 960	94.7			4.8		5
Urban Population		MF	25+	639 780	85.2			11.8		2.9
Rural Population		MF	25+	1 145 940	98.7			1.1		2

Table 6. (Continued)

Country and Category	Year	Sex	Age Group	Total Population	Highest Level Attained[1] (%)					
						First Level		Entered Second Level		
					No Schooling	Incompleted	Completed	First Cycle	Second Cycle	Post Secondary
L. Haiti[2]										
Total Population	1971	MF	25+	1 726 108	83.5	10.6	1.8	1.8	2.0	3
		F	25+	915 644	88.0	7.6	1.5	1.4	1.3	2
Urban Population		MF	25+	325 778	50.3	24.5	6.5	7.8	9.4	1.5
		F	25+	192 574	59.2	22.0	6.0	6.0	5.9	9
Rural Population		MF	25+	1 400 330	91.2	7.4	7	4	3	0
		F	25+	723 070	95.7	3.7	3	2	1	0
M. Honduras										
Total Population	1974	MF	25+	858 459	53.1	34.5	6.0	1.5	3.8	1.0
		F	25+	440 453	66.3	32.1	6.0	1.4	3.8	4
Urban Population		MF	25+	279 554	29.5	41.1	12.5	3.9	10.0	3.0
		F	25+	152 135	33.7	40.2	12.0	3.5	9.5	1.1
Rural Population		MF	25+	578 905	64.5	31.4	2.9	4	8	1
		F	25+	288 318	68.3	27.8	2.8	3	8	#
N. Mexico										
Total Population	1970	MF	20+	20 797 757	35.0	39.4	15.3	4.1	3.7	2.6
O. Nicaragua										
Total Population	1971	MF	25+	503 100	53.9	41.8			4.4	
P. Panama	1970	MF	25+	537 394	24.9	53.5		9.0	8.4	4.2
Q. Paraguay										
Total Population	1972	MF	25+	842 223	19.6	57.7	10.3	5.9	4.6	2.0
		F	25+	438 419	25.4	53.8	10.6	5.1	4.0	1.2

Table 6. (Continued)

Country and Category	Year	Sex	Age Group	Total Population	Highest Level Attained[1] (%)					
					No Schooling	First Level		Entered Second Level		Post Secondary
						Incompleted	Completed	First Cycle	Second Cycle	
Urban Population		MF	25+	346 870	11.3	46.8	16.5	11.0	9.8	4.6
		F	25+	192 086	15.4	47.0	17.5	9.5	8.0	2.5
Rural Population		MF	25+	495 353	25.5	65.3	5.9	2.2	9	0.2
		F	25+	246 333	33.2	59.1	5.1	1.6	8	0.1
R. Peru[3]										
Total Population	1972	MF	25+	5 008 980	35.0	31.1	16.1	6.3	7.1	4.5
		F	25+	2 539 525	47.5	25.0	13.7	4.9	6.1	3.0
Urban Population		MF	5+	7 073 800	23.7	31.1	17.6	12.8	10.1	4.8
		F	5+	3 545 100	28.4	31.2	16.8	11.0	9.0	3.6
Rural Population		MF	5+	4 689 400	57.7	32.8	6.3	2.0	0.9	0.3
		F	5+	2 334 600	70.3	24.3	3.6	1.1	0.5	0.2
S. Uruguay										
Total Population	1975	MF	25+	1 590 200	9.9	36.7	29.6	17.4		6.3
		F	25+	824 700	10.4	34.9	31.2	16.6		6.8
T. Venezuela[4]										
Total Population	1971	MF	25+	3 714 362	47.1	39.2		11.1		2.6
		F	25+	1 872 317	50.6	37.6		10.4		1.3
United States										
Total Population	1979	MF	25+	125 295 000	3.5		65.4			31.1
		F	25+	66 309 000	3.2		69.9			26.9

1 For definition of levels see original source.
2 "No Schooling" includes illiteracy data.
3 "No Schooling" includes persons who did not state their level of education.
4 The number and percentage within the total population of persons whose educational level is unknown was: MF 25+426 614 (15.3%): F 25+194 484 (14.2%).

Source: UNESCO SY, 1984, table 1.4.

Table 7. Higher Education:[1] Distribution of Students, by Sex and Field of Study, 19 Latin American Countries.

Country	School Year Beginning	Sex	Total	Humanities	Education	Fine Arts	Law	Social Sciences	Natural Sciences	Engineering	Medical Sciences	Agriculture	Not Specified
A. Argentina	1981	MF	527 596	26 178	7 681	4 194	59 165	10 075	22 969	69 323	51 112	23 466	123 618
		F	280 972	19 487	6 622	2 940	27 296	7 245	13 495	7 730	26 683	6 460	105 580
B. Bolivia[6]	1982	MF	56 632	1 543	366	77	6 239	1 107	720	12 179	11 146	3 006	No.
C. Brazil	1980	MF	1 409 243	77 696	405 949	13 849	137 373	87 696	51 374	156 726	110 123	33 162	35 014
D. Chile[3,6]	1982	MF	121 138	11 204	10 985	4 434	2 985	1 458	8 653	35 222	12 801	3 451	4 508
		F	47 590	7 089	9 080	2 413	858	760	4 314	4 383	7 362	1 286	2 083
E. Colombia[5]	1982	MF	335 833	2 731	52 163	6 975	29 253	13 133	4 439	63 643	36 586	11 266	No.
		F	153 828	1 431	33 529	4 496	11 701	12 316	1 654	13 556	19 584	2 230	No.
F. Costa Rica[6]	1982	MF	54 334	15 105	5 891	1 031	2 511	4 516	1 611	4 177	2 742	2 463	5 145
G. Cuba	1982	MF	173 403	2 535	72 843	938	2 924	8 036	2 498	21 934	20 645	15 189	7 428
H. Dominican Rep.[2,4]	1978	MF	42 412	222	6 710	388	1 356	2 645	911	7 305	10 054	1 119	498
I. Ecuador[6]	1981	MF	258 054	10 252	48 837	1 239	13 396	23 148	2 667	52 942	32 686	14 799	6 512
		F	93 623	7 414	26 495	688	4 006	9 888	607	6 379	13 993	2 695	2 614
J. El Salvador[3]	1981	MF	25 783	84	2 938	383	690	1 337	8	6 988	1 861	829	No.
		F	7 842	23	1 677	230	187	911	3	949	1 267	67	No.
K. Guatemala[7]	1979	MF	47 555	4 838	4 056	107	6 177	1 968	1 189	5 197	5 496	2 978	1 360
		F	–	–	–	–	–	–	–	–	–	–	–
L. Haiti	1979	MF	3 801	No.	328	No.	838	620	No.	548	1 022	152	No.
		F	1 086	No.	30	No.	244	241	No.	71	382	15	No.
M. Honduras	1982	MF	33 279	668	1 056	16	2 907	5 366	587	8 257	5 072	258	155
		F	–	–	–	–	–	–	–	–	1 790	–	–
N. Mexico[4]	1982	MF	879 240	9 509	11 166	7 062	92 803	78 177	23 100	219 654	138 558	44 222	3 977
		F	291 876	5 156	7 750	3 668	31 159	42 427	8 607	20 520	64 905	9 979	980
P. Panama	1982	MF	42 486	2 015	1 956	419	2 026	3 271	1 405	6 777	3 415	783	3 644
		F	24 060	1 456	1.597	234	774	1 819	662	1 874	2 644	174	2 604
Q. Paraguay[2]	1978	MF	20 812	354	404	311	3 208	633	938	1 593	1 915	1 108	5 968
		F	9 037	195	322	227	1 350	459	583	203	978	219	2 487
R. Peru[6]	1982	MF	305 390	4 367	24 034	275	20 614	46 572	10 414	57 718	27 913	20 736	16 094
		F	105 968	2 278	15 535	159	5 659	15 471	4 196	5 500	15 302	3 529	10 374
S. Uruguay	1982	MF	48 234	1 233	386	206	11 138	3 287	3 074	2 894	9 254	4 102	530
		F	26 782	856	310	106	7 702	2 379	1 625	320	5 718	1 297	483
T. Venezuela	1982	MF	349 773	3 897	51 373	516	23 395	28 095	6 401	62 074	40 585	14 740	49 448

1. Includes awards not equivalent to a first university degree, first university degrees, and post-graduate university degrees.
2. The figures shown under "Not Specified" refer mainly to students enrolled either in the first year or in the preparatory year (general studies).
3. Social Sciences include commercial and businees administration, mass communication and documentation, home economics, and service trades. Natural Sciences include mathematics and computer science. Engineering includes architecture and town planning, trade, craft and industrial programs, and transport and communications
4. Data refer to universities and equivalent institutions only.
5. Fine and applied arts and architecture are combined. Natural Sciences include mathematics and computer science. Engineering includes trade, craft and industrial programs, and transport and communications.
6. Data refer to universities only.
7. University of San Carlos only.

Source: UNESCO SY, 1984 Table3.12.

Table 8. Life Expectancy and Related Indicators.

Countries	Life Expectancy at Birth Years[a]				Infant Mortality Rate (age under 1)[b]		Child Death Rate (aged 1-4)[c]		Percent of Married Women of Child-bearing Age Using Contraception[d]	
	Male		Female							
	1965	1984	1965	1984	1965	1984	1965	1984	1970	1983
Argentina	63	67	69	74	59	34	4	1	–	–
Bolivia	42	51	46	54	161	118	37	20	–	24
Brazil	55	62	59	67	104	68	14	6	–	50
Chile	56	67	62	73	110	22	14	1	–	43
Colombia	53	63	59	67	99	48	8	3	34	55
Costa Rica	63	71	66	76	72	19	8	–	–	65
Cuba	65	73	69	77	38	16	4	–	–	79
Dom. Rep.	52	62	56	66	111	71	14	6	–	32
Ecuador	54	63	57	67	113	67	22	5	–	40
El Salvador	52	63	56	68	120	66	20	5	–	34
Guatemala	48	58	50	62	114	66	16	5	–	25
Haiti	46	53	47	57	138	124	37	22	–	7
Honduras	48	59	51	63	131	77	24	7	–	27
Mexico	58	64	61	69	84	51	9	3	–	48
Nicaragua	49	58	51	62	123	70	24	6	–	9
Panama	62	70	64	73	59	25	4	1	–	61
Paraguay	56	64	60	68	74	44	7	2	–	35
Peru	49	58	52	61	131	95	24	11	–	41
Uruguay	65	71	72	75	47	29	3	1	–	–
Venezuela	60	66	64	73	67	38	6	2	–	49

Source: World Bank (1986: 230-233).

a) Life expectancy at birth indicates the number of years a newborn infant would live if patterns of mortality prevailing for all people at the time of its birth were to stay the same throughout its life.
b) Infant mortality rate is the number of infants who die before reaching one year of age, per thousand live births in a given year.
c) The child death rate is the number of deaths of children aged 1-4 per thousand children in the same age group in a given year.

Nutrition

Data in Table 9 indicate the daily caloric supply **per capita** as a percent of requirements for 1983. These data are crude at best, but it is clear that some countries are significantly below the minimum caloric requirement.

These numbers undoubtedly underestimate the incidence of malnutrition in the region since many malnourished people are balanced out by people with consumption above normal needs. Brazil is a case in point. On the average, it is above the norm, but there are millions of malnourished people in that country.

What one concludes from these data is that nutrition is a serious problem in Latin America, and that the severity of the problem varies from country to country. There are data available at the national level which make it possible to better understand the detailed dimensions of this problem. Analyzing that data is, however, beyond the objective of this paper.

Table 9. Daily Calorie Supply, Latin America, by Country, 1983.

Countries	Daily calorie supply per capita as % of requirement	
	Total 1983	1983
Argentina	3 159	119
Bolivia	1 954	82
Brazil	2 533	106
Chile	2 574	105
Colombia	2 546	110
Costa Rica	2 556	114
Cuba	2 914	126
Dominican Republic	2 368	105
Ecuador	2 043	89
El Salvador	2 060	90
Guatemala	2 071	95
Haiti	1 887	83
Honduras	2 135	94
Mexico	2 934	126
Nicaragua	2 268	101
Panama	2 275	98
Paraguay	2 811	122
Peru	1 997	85
Uruguay	2 647	99
Venezuela	2 451	99

Source: World Bank (1986: 234-235).

4

SOME POLICY IMPLICATIONS AND SUGGESTIONS

Many of the implications for policy from the above analysis are important at both the national and regional level. In this section we address general policy issues, with particular emphasis on problems that lend themselves to a regional solution or approach.

Agricultural Research

First, it seems clear that agricultural research needs to be strengthened, and strengthened relative to agricultural extension. Sequencing is important here. The nations of the region need to have a capacity for agricultural research and actually be producing this new technology prior to having an extension or delivery system to take the new knowledge to the farms.

Unfortunately, there is a widely held view that there is a lot of new technology available for farmers in the region and that the task is one primarily of motivating the farmers to adopt it. Both empirical research and experience show that is usually not the case. Farmers readily adopt new technology if it is adapted to their conditions and profitable to use. If they are not adopting the technology, it generally means either that it does not lend itself to their systems of production, or is not profitable for them to use. In either case, the response suggests the need for research.

An important feature of agricultural technology is that it tends to be location specific and thus needs to be adapted to local ecological and economic conditions. In this sense, agricultural technology differs significantly from the more easily transferable technology used in the manufacturing and industrial sectors.

What this means for policy makers is that there needs to be an agricultural research station for each ecologically and economically distinct region. It also means that the payoff to adaptive research may be quite high.

Given that there are regions that are economically and ecologically similar in Latin America, but that are isolated geographically from each other, there is an important basis for cooperation among nations in sharing plant materials and other technological information. The IICA is playing an important role –through its cooperative programs– and can play a still more important one in facilitating such exchanges.

National governments in the region also have important reasons for collaborating with and supporting the three International Agricultural Research Centers in the region, plus those in other parts of the world, as appropriate. The mission of these Centers is to produce new technology that can be easily adapted to local conditions. Hence, they may well have material and information that can be adapted to these conditions. Equally important, they need access to local national agricultural research centers so they can learn more about the wide variety of local conditions.

Although international cooperation can have a high payoff to national agricultural research systems, the national capacity to cooperate with research centers outside a nation needs to be in place. Thus, national governments need to develop and support, on a sectoral base, their own national agricultural research systems. These systems need to have a sense of priority in what they do, they need to cover the major ecological and economic regions of the country, and they need to have sustained financial support. The payoff to investments to that end will generally be quite high.

Small countries, or countries which have contiguous regions that are ecologically and economically similar, may want to collaborate in developing the research capacity to serve such regions. Although successful ventures of this kind are not very common, present resource constraints in Latin America make it important that serious attempts at such international collaboration be made. Strengthened collaborative efforts in Central America would seem to be especially appropriate.

Given the severe resource constraints most Latin America countries face, and are likely to face in the future, it is important that more attention be given to developing efficient research systems. Careful attention should be given to identifying priority areas of research and developing focused research programs. Governments should avoid loading research systems with political appointees who have little to offer in a technical sense. And priority should be given to providing adequate operational support to researchers so that potentially important experiments are not lost due for lack of operational money.

Another important issue in the region is that many of the professional staff in research systems were trained in the 1960s and early 1970s. Many of them have received no intellectual refurbishing since that basic training. A year of post-doctoral training for such staff would have a high payoff. Individual countries should allocate resources for this purpose. In addition, IICA should seek funding from international development agencies, both bilateral and multilateral, for a program of postgraduate training for selected researchers from the region as a whole.

Another problem is that the skill mix of present researchers reflects the needs of 20 years ago when they received their training. Given the advance of science, and especially the emergence of biotechnology as the means of making important technological breakthroughs, new skills are needed. Part of such skills can be provided through retraining programs like those described above. But additional staff should be sent abroad for in-depth training in the new skills. Significantly expanded programs for this purpose are needed at the national level. In addition, IICA might well seek funding for a regional program directed to this end.

More attention also needs to be given to the institutional arrangements and linkages of agricultural research systems. We noted above the need for national agricultural research systems (NARSs) to link up with the International Research Centers (IARCs). Within a country, institutional linkages are needed between public research systems and university research programs, and between these two systems and the growing private research programs in the region. Institutional linkages are also needed between the research programs and the extension systems.

A sense of priority is needed in each of these programs. Establishing priorities requires analysis and empirical research. Ministries of Agriculture need a secretariat to identify research priorities and to foster the institutional linkages described above. A regional secretariat in IICA dedicated to these same ends could have a very high payoff. Such a secretariat should focus on comparative studies across countries, should diffuse knowledge from one country to another on useful institutional innovations, and should provide technical assistance to the national secretariats, and coordinate their efforts.

It is popular today to argue that agricultural research programs should be focused on improving the lot of the disadvantaged in rural areas. In general, although there are important exceptions, it is not a good use of resources to direct biological and physical research programs to this end. New production technology is simply not an efficient way of changing the distribution of income within agriculture. Addressing the problems of these disadvantaged groups should have the highest priority of policy makers. But the solution in most cases involves providing them with schooling and training for employment in the non-farm sector, and the development of alternative employments, not biasing the research program in their favor. Agricultural research expenditures should be allocated to those uses which have the highest payoff at the margin. In general, this will not involve a concentration on marginal groups.

Finally, it should be recalled that the new technology that agricultural research creates is a low-cost source of income streams for all members of society, and hence a low-cost source of economic growth. Arguments that governments cannot afford such investments are not persuasive. The point is that governments cannot afford **not** to make investments which yield rates of return on the order of 80-100 percent, and whose benefits are distributed so significantly in favor of the poor.

Education

High priority should also be given to strengthening the educational systems in Latin America, especially those serving rural areas. The educational systems in the developed countries are, in general, a means of upward mobility. In most Latin American countries, they are just the opposite. They tend to have a rigid structure which makes it difficult for low-income people to move upward. The lack of educational services in rural areas makes it difficult for rural people to move on to more remunerative employment —employment which would contribute to a more rapid rate of growth for the economy. Perhaps most important of all, present educational systems often provide large subsidies for the children of well-to-do families to go on to higher education, while children of poor families cannot even attain basic literacy skills.

High priority should be given to making the educational system more open, and a means for upward mobility. A useful place to start is with mass literacy programs. The ability to read and write is critical for participation in a modern society. It is also essential for citizens to vote intelligently and in an informed way in democratic societies.

In strengthening educational programs, it is important to give careful attention to the economics of education. The most important cost of gaining an education is not the direct tuition cost, but rather the income sacrificed in going to school. This is very important for poor families in rural areas, where the first child, and often the second, is held out of school to help produce a subsistence living for the family. In many parts of rural Latin America, there is an adequate number of schools, and even an adequate number of school teachers. But still students do not go to school.

One way of addressing this problem is to pay families to send their children to school. A useful way to do this is to pay the families with food provided from international food aid programs. This is more than a school lunch program. Rather, an estimate would be made of the income or production on the farm sacrificed by sending the child to school and an amount of food in that amount would be provided the family, conditional on the child attending school. This quantity could be broken down into weekly allotments, and given to the family at the end of the week if the child had actually been in school.

Such a program has many advantages. In the first place, it induces a higher rate of school attendance and thus increases the investment in this important form of human capital. Second,

it should contribute to an improved nutritional status for the family as a whole, thus improving the health of the family, making the adults more productive, and improving the ability of the children to learn. Hence, it has a multiple effect.

Equally as important, this use of food aid does not have the usual disincentives associated with such aid, since it is provided as an income transfer to the family. As long as agricultural surpluses exist in the developed countries, Latin American countries should capture as much of it as possible for this purpose.

An important aspect of opening the educational systems in Latin America should be special provisions for women and for indigenous groups. To the extent these groups have been ignored in the past, special programs may be needed to help them recover their lost ground.

The efficiency of educational systems is also an important issue, for the resources needed to provide an adequate education for all citizens are considerable. An important means of having more resources to open the educational opportunities for the disadvantaged is to reduce the subsidies to upper income groups. Secondary education, like primary education, should be provided free to all citizens. At higher levels of education, tuition should be charged and students should live on their own income. Subsidies in the form of scholarships should be provided only to the disadvantaged.

High priority should also be given to strengthening the educational systems of Latin America at the graduate level. There is obviously a payoff from sending selected people abroad for graduate training on a sustained basis, since this will help keep national research systems apprised of what is going on in other countries. But a sufficient number of high-quality graduate programs in the agricultural disciplines should be developed in the region so that a major share of those needing graduate training can receive it near home. Training within the region can be less expensive than training abroad. In addition, there is a chance that such training will be better tailored to local conditions and thus more effective. Finally, providing the training locally will tend to reduce the brain drain.

Ultimately, every country in the region will want to have one or more graduate training programs. In moving towards that goal, every effort should be made to strengthen existing graduate programs, and to establish new ones in strategically important regions. International cooperation to those ends can be key.

IICA proposes to link existing graduate programs together in a network which will enable individual countries to capitalize on existing strengths in the region. That is a sound proposal, and should be pursued. At the same time, however, resources will be needed to increase the capacity of these existing programs. Attention still needs to be focused on developing national capacities for such programs. The complementarity between research and graduate training should give national programs a special advantage.

Nevertheless, there is much to be gained from a region-wide approach to developing the capacity for graduate training. The exchange of both professors and students can contribute to the exchange of knowledge, and to developing a more comprehensive and well-integrated system.

Professional unemployment is a recurring problem in Latin America, especially among *ingenieros agronomos.* There are two important dimensions to this problem. The first is the tendency to create college-level schools of agriculture without an adequate, technically qualified staff. The result is poorly trained graduates. The second is the failure to develop institu-

tions to employ these graduates. The point is that supply-side initiatives are not sufficient. The demand side of the market needs to be developed as well, in the form of extension and research systems. In addition, the private market for *agronomos* needs to be developed, such as employments in banks and in the modern input supply sector.

The Capacity for Policy Analysis

A socio-economic research capacity is needed to serve national government on policy issues. Building such capacity in each nation should have high priority. Establishing such capacity close to Ministry of Agriculture policy makers should also have high priority, so that the political leaders for agriculture can more effectively articulate and defend their sectoral goals.

In the absence of strong national research capacities of the kind described, a strong case can be made for developing a regional capacity for economic and social research. This center should focus on policy issues relevant to the countries in the region, and on understanding the international economic forces at work in those countries. Most of the research and analysis of such a center should be common to those countries. Hence, there is a strong case for regional cooperation. Moreover, much of the knowledge generated would be of value to national centers, and thus make them more productive.

An important function of this socio-economic capacity should be to design and create more effective institutional arrangements at the national level. Ministries of Agriculture are traditionally weak because important functions have been broken off and distributed to other ministries. This creates a segmentation of policy making and implementation, while at the same time breaking up the political support for the agricultural sector. These functions need to be unified and brought back together under the Ministry of Agriculture. Particular attention, then, needs to be given to staffing the new organs with well-trained and high-quality people.

Health and Nutrition Services

The payoff for strengthening the health services in the rural sectors of Latin American countries should also be high, as should investments to improve the nutritional status of rural people. There is ample room for international cooperation on both of these points. In particular, cooperation toward eliminating malnutrition from the region would be highly desirable, if for no other reason than that it would focus attention on a common goal, that all nations should cooperate in eliminating poverty from their midst.

Financing: The Resource Problem

The challenge policymakers face is to find the resources to make these high-payoff investments. Currently, many countries in the region face international debt problems of a significant order, severely limiting their options.

Several courses of action are appropriate. First, nations facing serious debt problems need to undertake the policy reforms needed to get their economic house in order. These include devaluations of their currencies so that they become more competitive in foreign markets, and the elimination of protectionist measures, which implicitly tax their export sectors and preclude their taking advantage of the international trading system. Painful as these measures may be, there is really no alternative.

Second, rather than to use adjustment loans from international and multilateral development agencies for short-term balance of payments relief, these funds should be dedicated to longer-

term investments that build the capacity of the economy. Chief among these investments should be those in human capital, since they tend to have the highest social rates of return.

Many countries with serious debt problems are not able, at the present time, to access international capital markets for additional resource flows. But policy reforms would make these countries more attractive to international investors, and such reforms will hasten the arrival of the time when the debt problem is put behind them. At that juncture, they can draw on international capital markets to finance investments in the physical infrastructure, using the longer-term lending of bilateral and multilateral lending agencies to finance investment in human capital.

Finally, there is an important role to be played by domestic fiscal reform in many Latin American countries. The present system of taxing implicitly by means of distortions in the exchange rate and by means of trade policy needs to be changed to a system with more transparency. At the local level, property taxes, which provide the resources to support primary and secondary education, can play an important role, and also provide the means to support health care systems. Such locally imposed and managed property taxes will not pose the same threat to land owners as do nationally imposed taxes.

More generally, some system of value-added or income taxes is needed to provide the resources for national programs. These systems need to be equitable and efficient so that unnecessary burdens are not imposed on particular groups and so that marginal tax rates can be kept relatively low.

5

CONCLUDING COMMENTS

Investing in human capital is a particular way of promoting agricultural development. It is not the only kind of investment needed. Rural infrastructure also needs to be strengthened in most Latin American countries, as does the infrastructure for linking urban areas with other urban areas and for promoting international trade.

Investing in human capital should have high priority, however, for it is the key to capitalizing on the natural resource endowment a nation has. It is also the key to increasing the incomes of rural people, and to making the country more competitive in foreign markets across the board.

Investing in human capital is also the key to improving income distribution in Latin American countries. The bulk of the benefits of such investments are channeled to the poor, even the poor outside the agricultural sector. There are few investments a society can make that both promote economic development and improve the distribution of income. Investing in the human capital for agriculture and in rural people is one of them.

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This document was edited and published by the Editorial Service, Directorate of Coordination of Institutional Affairs of the Inter-American Institute for Cooperation on Agriculture. Members of the Editorial Service and of IICA's Print Shop participated in preparing it. Printing was completed in June 1989, with a press run of 1 200 copies.

PROGRAM II: Technology Generation and Transfer

The Technology Generation and Transfer Program was created in response to two basic issues: acknowledgement by the countries and the international technical and financial community of the importance of technology for productive development of the agricultural sector; the widespread belief that the potential of science and technology can fully be tapped only in the presence of institutional infrastructures capable of developing technical responses to the specific conditions of each country, and a framework of policies which will encourage and facilitate the incorporation of new technology into production processes.

In this context, Program II will promote and support actions in the member countries to improve technological policy design, strengthen the organization and management of their technology generation and transfer systems, and facilitate international technology transfer. This should lead the way to better use of available resources and a more effective contribution to solving technological problems in agricultural production, within a framework of equitable distribution of benefits and conservation of natural resources.

According to the 1987-1991 Medium Term Plan, the Technology Generation and Transfer Program will concentrate its activities to tackle these problems through actions in five basic areas:

- Technological policy design.
- Organization and management of national technology generation and transfer systems and institutions.
- Development and/or strengthening of human resource training programs.
- Reciprocal cooperation and international coordination of research and technology transfer.
- Formulation and implementation of investment projects.

Program II pursues its primary objective by confronting several factors which hinder and limit agricultural development and rural well-being in the countries of the region. First, technological policy must be linked to other aspects of agrarian policy. Moreover, it is imperative to strengthen the organization and budgets of technological institutions, consolidate duly trained human resources, and integrate research, teaching and technology transfer. Special focus is placed on a problem faced by small countries, where there is a serious gap between the need for technological development and the amount of resources which can be invested therein.

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