REORIENTATION OF THE AGRICULTURAL SECTOR

A STRATEGY TO ACCELERATE
APPLICATION OF SCIENCE TO INCREASE
AGRICULTURAL PRODUCTIVITY
IN ECUADOR

Submitted by:

A Joint Ecuadorean/N.C. State University Subcommittee
to support the
Agricultural Science and Technology Committee
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Advisor to the Minister of Agriculture and Livestock of Ecuador

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A Strategy for Accelerating the Application of Science to Increase Agricultural Productivity in Ecuador

Executive Summary

For the last 10 years, the agricultural sector has been a declining contributor to the gross domestic product of Ecuador. The annual increases in the demand for food, 3.0 to 3.5% per year) exceeds the annual increases in the domestic supply of foods (2.0 to 2.5% per year).

It seems apparent that the Ecuadorean food strategy for the last ten years has relied primarily on increasing land and irrigated areas plus increasing food imports to meet food demands. Changes in productivity to meet these demands appears not to have been a priority component of the strategy.

Given the oil crisis and most importantly, the need to meet long-term food requirements, the agricultural sector must be a prime engine of growth. The primary choice for vitalizing the agricultural sector is to retrieve productivity increases. This productivity thrust is imposible without developing a science-dependent system. There must be a more nearly equal distribution of agricultural investments among the options of new land areas, expanded irrigation areas and a science-based system that focuses on productivity.

Increase in total agricultural production resulting from increases in agricultural productivity requires a strategy involving research, extension, and education (an REE strategy). It is clear that the research, extension and educational institutions in Ecuador are so highly dispersed and uncoordinated that they cannot sharply focus their financial and human capital resources on an effective system.

Clearly, the pre-university and agricultural university systems are not producing a flow of high quality human capital grounded in science and knowledgeable of its application to agriculture. The agricultural educational system is not providing students with the background essential to future graduate work, a career in extension, an academic careeer, or entrance into the agribusiness community.

In large part the agricultural educational system has focused on vocational agricultural issues and not on acquiring basic science skills as applicable to agricultural productivity problems.

The extension component of such at system faces problems of poorly trained personnel, low morale, low operating budgets, and poor linkages with research. Further, the extension functions are widely dispersed, poorly focused on the main task of technology transfer (as compared to a disperse set of actions on rural development), not prepared to deal with on-farm water management as a mechanism for increasing yield, and lack a vigorous well trained set of extension-education leaders.

The research component of the system has fared better than the other two but has also experienced the lack of human talent, operating budget deficiencies, poor linkages with technology transfer agencies and a dependency on external training institutions to meet the need for adequately trained research personnel.

In addition, frequent changes in INIAP's leadership have caused instability in essen-

tial long-term research objectives and has brought about a lack of creditability among the agricultural sector clientele groups, and has caused loss of prestige with the general public.

If productivity gains are to be realized, these difficult problems need to be abdressed. It is our convention that the proposed integrated REE system will provide a vehicle whereby solutions can be formulated on a logical framework. Technology cannot continue to feed on technology and real agricultural progress cannot be based solely on acreage expansion or larger dams. The synthesis of new technologies, based on scientific principles and applied to the agricultural sector, offers more secure advances and higher potential than can be realized through expansionist strategies.

The agricultural reorientation strategy proposed in this report focuses on requirements for a science-dependent productivity thrust. There are short- and intermediate-term recommendations that focus on the critical elements required to integrate and fortify the research, extension and educational components.

Recommendations

1. Give priority to the application of the sciences to the resolution of the agricultural production problems, rather than depending solely on being able to increase the tillable area.
2. Create an Agricultural Research Foundation, making use of the infra-structure of INIAP, in order to upgrade the generation of agricultural technology and assure its efficient application by means of tight linkages with both extension and education.
3. Convert the scattered technical assistance (extension) programs into an integrated outreach system, involving both the public and private sectors, modifying the approach in accordance with clientele groups; i.e.
   a. For the large export-oriented farms — consolidate the current credit system and encourage a system of contract (private) extension (consulting).
   b. Other commercial farms — develop a national extension program and encourage contracts with private (production) associations and with the agribusiness sector.
   c. The peasant farmer (minifundista) — develop a plan of training and information among the national service, the private voluntary organizations, and other programs for rural development (military, etc.)
4. Strengthen the three levels of agricultural education in terms of agricultural science:
   a. Restructure two technical schools (one on the coast, one in the sierra) using a scientifically-based system, focused on agricultural production, agribusiness, and public service.
   b. Strengthen the professionalism of two universities (coast and sierra) in order to improve both the quality of their faculties and their linkages with research and extension.
   c. Develop a postgraduate program in conjuntion with the Foundation and one of the selected universities.

CHAPTER I

INTRODUCTION

A. BACKGROUND INFORMATION

It is estimated that the total agricultural sector, including inputs, product marketing, and agricultural services represents a major part of the GNP in Ecuador. However, the contributions from the agricultural sector to Ecuador's GNP have declined during the last 10 years; in 1975 agriculture comprised 18% of the county's Gross National Product (GNP); in 1985 it was 13% 1/. Given a growing population, increase in income, and the oil crisis, the agricultural sector as a whole can be regarded as a potential growth generador for Ecuador. This report focuses on the way in which agricultural science could become an important component toward reorienting the agricultural sector.

For the last 25 years, the main source of agricultural growth, which has been approximately 2.0 to 2.5% per year, has resulted from an increase in the number of hectares devoted to farmland and on an increase of irrigated land. There is little evidence that the low rate of change of agricultural productivity has been modified by technological change. An emphasis on a scientific agriculture that produces and delivers technology that will impact productivity has not been an important component of the agricultural strategy. No doubt the amount of farmland and irrigated land will continue to increase, but these changes do not represent a long-term solution. Further emphasis on or a transition toward greater dedication in increasing productivity should not bedelayed.

Application of sciences must be strongly encouraged to increase the productivity of agriculture in Ecuador, particularly for resources in key agricultural products. To achieve these goals, a common strategy will be needed which would guide allocation of resources provided by the government and those supplied by external sources. An overall strategy for agricultural science includes both short- and mid-term elements. Such a strategy focuses strongly on technology; defines and establishes priorities among groups of end-users; develops and effectively uses limited human resources; and identifies and implements linkages among the three essential components (research, extension and education).

An essential step is to revise the agricultural sector's policies to help establish goals for the subsector of agricultural science.

B. THE AGRICULTURAL SECTOR AND RESEARCH, EXTENSION AND EDUCATION POLICIES

The general objective of Ecuador's agricultural sector is to increase its contribution to the country's overall economic growth. The sector must reduce its increasing dependancy on imports to meet the demand for food, which is growing at a rate of 3.0 to 3.5% per year. The agricultural sector's specific objectives are:

1. To meet domestic demand for basic commodities at incentive prices for producers and at decreasing real prices for consumers;

1/ In terms of 1975 US $.

2. To achieve self-sufficiency in food production or to create the capacity to substitute for basic foods (family commodity basket or **canasta familiar**) and to provide raw materials required for food processing (agroindustrial sector), consistent with the competitive requirements of the world market.
3. To increase agricultural exports as a source of foreign exchange, thus obtaining the necessary capital to promote growth of the agricultural and other sectors (particularly the industrial and services sectors).
4. To increase real income of all the components that make up Ecuador's agricultural sector, including agricultural production, input markets, product markets, and the public/private subsector (that provides regulatory, technical/financial knowledge plus its transfer and a foresight capability).
5. To increase the economic and social well-being of the many small farmers and rural disadvantaged of Ecuador.

In order for the system of agricultural science — or research, extensión, and education (REE) to aid in achieving these objectives the goals of REE must be well defined.

The general goal is to assure that changes in technology or in productivity become a major contributor to the annual increase of overall agricultural perfomance. More specific objectives are to achieve a much greater impact on productivity of producers who supply the needs for a growing urban population, and of those producers who participate in generating foreign exchange. Although it is expected that all agricultural clients will benefit from a realistic perspective, it is necesary to bear in mind that the impact of science per se on subsistence agriculture will be limited.

C. STUDY OBJECTIVES

This report reviews the current situation of the essential components that comprise agricultural science (research, extension and education), discusses the major problems that constrain those components, and suggests a strategy that includes recomendations which would begin changing the role that productivity/technology could play within the country's economy. The steps include the following:

1. Description of the general situation of Ecuador's agricultural sector;
2. Description of the present situation of the REE system's institutional components,
3. Outlining the main problems that limit the role of science in the agricultural sector;
4. Development of a strategy that can effectively stimulate the application of science and technology to Ecuadorean agriculture.

D. CHARACTERISTICS OF A SCIENCE BASED AGRICULTURAL SYSTEM

Few countries have been successful in agriculture without substantially relying on science. The basic components of a science-based agricultural system are the following:

1. A political component that provides a rational set of price, trade, and tax policies, offering incentives both to people investing in agriculture and to the consumers through the potential for steadily decreasing real food prices.
2. A research component that can supply a steady flow of relevant information and technology that will have its impact on agricultural productivity, input and com-

TABLE 4. STORAGE AT PUBLIC, MIXED, AND PRIVATE INSTITUTIONS ON A NATIONAL LEVEL (metric tons).

	SIERRA				COAST					
	SILOS	GRANARIES	MILLS	STOCK PILES	SILOS	GRANARIES	MILLS	STOCK PILES	TOTAL	% OF TOTAL
ENAC	17,159	69,643			61,309	40,815			188,926	37.3
ENPROVIT		5,707				2,364			8,071	1.6
INIAP	180	750			190	220			1,340	0.3
ENSEMILLAS	73	2,114				1,064			3,251	0.6
MAG		3,486				345			3,831	0.8
IERAC		127				26			153	0.0
CEOEGE					32,052				32,052	6.3
FENACOPAR						3,180			3,180	0.6
Port Authorities					50,000				50,000	9.9
Private Companies	17,000		29,000		33,200		67,808	50,736	197,744	39.0
ECUATORIANA DE GRANOS					18,000				18,000	3.6
TOTAL	34,412	81,827	29,000	0	194,751	48,014	67,808	50,736	506,548	
%	6.8	16.2	5.7	0.0	38.4	9.5	13.4	10.0	100.0	100.0
		116,239		29,000		242,765		118,544		
%		22.9		5.7		47.9		23.4		

SOURCE: MAG (MINISTRY OF AGRICULTURE AND LIVESTOCK), Division of Stable Development, Ecuador

TABLE 5: AREA AND NUMBER OF AGRICULTURAL PRODUCTION UNITS (APUS) ACCORDING TO TYPES OF TENURE BASED ON NUMBER OF HECTARES, ECUADOR, 1974

TYPE OF TENURE / FARM SIZE	TOTAL				OWNERSHIP				LEASING				SINGLE TENURE					
	Number		Area		Number	%	Area	%	Number	%	Area	%	Number	%	Area	%	Number	%	Area	%
-- ha --																				
0 – 5	344,764	100	535,158	100	242,367	70.3	359,291	67.1	34,077	9.9	48,654	9.1	24,097	7.0	43,295	8.1	44,223	12.8	84,001	15.7
5 – 20	96,347	100	931,094	100	68,028	70.6	661,759	71.1	4,225	4.4	37,377	4.0	11,742	12.2	115,757	12.4	12,352	12.8	116,201	12.5
20– 50	42,617	100	1,315,559	100	30,755	72.2	951,435	72.3	1,151	2.7	33,713	2.6	7,580	17.8	233,669	17.8	3,125	7.3	96,742	7.4
50 – 100	22,216	100	1,348,927	100	14,042	63.2	874,006	64.8	355	1.6	22,460	1.7	6,233	28.1	345,610	25.6	1,586	7.0	106,651	7.9
100 – mo.	10,972	100	3,824,519	100	8,250	75.2	3,133,767	81.9	204	1.9	51,449	1.3	1,516	13.8	354,196	9.3	1,002	9.1	283,107	7.4
National Total	516,916	100	7,955,257	100	363,452	70.3	5,980,175	75.2	40,012	7.7	193,653	2.4	51,168	9.9	1,092,727	13.7	62,248	12.0	686,702	8.6
SIZES	PERCENTAGE																			
0 – 5	66.7		6.7		66.7		6.0		85.2		25.1		47.1		4.0		71.0		12.2	
5 – 20	18.6		11.7		18.7		11.1		10.6		19.3		22.9		10.6		19.8		16.9	
20 – 50	8.2		16.5		8.5		15.9		2.9		17.4		14.8		21.4		5.0		14.1	
50 – 100	4.3		17.0		3.9		14.6		0.9		11.6		12.2		31.6		2.5		15.5	
100 – mo.	2.1		48.1		2.3		52.4		0.5		26.6		3.0		32.4		1.6		41.2	
Total	100.0		100.0		100.0		100.0		100.0		100.0		100.0		100.0		100.0		100.0	

SOURCE: INEC, Agricultural Census, 1974.

modity markets, and in establishing agricultural policies.

3. A transfer system that will make biological, physical, and economic technologies available to farmers and agribusinesses.
4. An education component that will provide human resources versed in the complexities of biological, physical, and social sciences to all the system's sectors, including producers, input suppliers, product processors, researchers, technology transfer agents, and other educators.
5. A functional group of public and/or private companies that can manufacture, import, and distribute essential inputs for the entire agricultural sector. Likewise, there must also be a functional group of public and/or private companies that can collect, store, transport, process, and distribute farm produce.

E. METHODOLOGY

A team of professionals from Ecuador and N.C. State Univesity were identified (see Appendix 1). The Ecuadorean members of the team have ample knowledge in research, extension, and education, vast experience, and access to a large array of secondary data. The team evaluated the present situation, the limitations, and the options to produce a vigorous scientific action. The Ecuadorean and N.C. State University members of the team jointly (1) visited several REE system institutions; (2) held conversations with many other Ecuadorean scientists, educators, and technology transfer experts, leaders within the private sector, including input dealers, agricultural industry managers, producer associations, and private farmers; (3) held a series of meetings with program directors regarding improvement of rural welfare; and (4) held special meetings with the Minister of Agriculture and members of his staff as well as program directors of selected international agencies for research and development (see Appendix 2 for a visit list).

Team members held a series of meetings to identify the various policy options, factors, and linkages of a science-oriented REE strategy; to establish the criteria for setting priorities among strategy elements; and to discuss options for training the necessary personnel needed. These joint meetings also focused on the role of science to solve extreme rural proverty and the means to increase the role of the private sector in research and development. The teams critically evaluated the relationships among expansion of farm land, expansion of irrigation, and increase in agricultural technology. Further, the basic document was drafted by the Ecuador team members and reviewed, edited and collated by the joint sub-comission.

Chapter II contains a brief diagnosis of the agricultural sector. Chapter III reports on the current state of research, extension, and education. Chapter IV provides a broad strategy, our proposed strategies, and specific recommendations for reorienting the agricultural sector.

CHAPTER II

BRIEF DIAGNOSIS OF THE AGRICULTURAL AND RURAL SECTOR 1/

A. DESCRIPTION OF THE COUNTRY

1. Geography

The continental portion of the Republic of Ecuador is located in northwestersn South America. The equator crosses the country, and most of its territory lies to the south; its area totals 272,258 square km. Ecuador borders Colombia to the north, Peru to the south and east, and the Pacific Ocean to the west. The insular province of Galapagos, made up of 17 large islands, several barren isles, and rocks, lies 1,000 km off the coast in the Pacific.

The Andes lie northeast to southwest and divide Ecuador into three semi-parallel branches -- the Western, Eastern and Central cordilleras -- which split the country into three natural regions known as the Coast, the Sierra, and the Amazon. Differences among these regions are clearly marked and include orographic, climatic, ecological, and socioeconomic nomic characteristics.

The Coastal region has an area of approximately 6,770,200 ha. It extends from the foothills of the Andes in the westersn Cordillera to the Pacific Ocean. Its topography is generally flat, but is interrupted by a few low mountain ranges. Four different types of climate occur: rainy tropical, Amazonic tropical, savanna tropical, and dry tropical. Together with the different types of soils, these climatic divisions provide diverse natural vegetation and epable cultivation, both for export and domestic consumption, of many crops, such as banana, cocoa, coffee, sugarcane, and African palm, among others.

The Sierra, or Inter-Andean region, runs between the slopes of the Western and Central Cordilleras of the Andes. Width of this region does not exceed 70 to 90 km, although its area is 5,600,000 ha. Average altitude is 2,500 m above sea level, As the altitude increases, temperature decreases; thus there are at least five different types of climates, which permit the growth of a wide range of crops, including wheat, barley, potatoes, sugarcane, cassava, and tomatoes, among others.

The Ecuadorean **Oriente** or Amazon region lies east of the Central Cordillera, with an area of approximately 13,023,000 ha. Most of the region is covered by forests, while farming and cattle raising take place in certain areas suitable for them. During the last few years, several African palm plantations have been developing in the Amazon region.

2. Political Division

Since its beginnings as a Republic in 1835, Ecuador has been politically divided into provinces, cantons, and parishes. Currently the country is made up of 20 provinces, 136 cantons, and 965 parishes. There are five provinces in the Coastal region, ten in the Sierra, four in the Amazon region, and one in the insular province of Galapagos. There are 248 urban and 717 rural parishes.

1/ Unfortunately, time allotted for the subcommittee to prepare this report did not permit verification of quoted figures.

3. Demography

The present population of the country is estimated at 9.4 million. Between 1974 and 1984, the increase in population was 2.9% per year. Of the total population, 48.9% is in the Coastal region, 47.1% in the Sierra, 3.3% in the Amazon region, and 0.7% in Galapagos. In 1974 the urban population represented 41.4% of the total population, whereas in 1985 it was 51.3%. This increase is due to the significant migration of people from the rural to the urban areas. It is estimated that in 1990 the total population of Ecuador will be 10.8 million, and, if the same trend continues, the urban population will comprise 55% of the total.

4. Economy

During the 1970s Ecuador had an economic growth never before enjoyed, with annual rates nearing 10% mainly due to rapid development of the oil subsector and later to availability of external credit. The world economic crisis beaween 1981 and 1983, irregular weather conditions, and certain structural and political factors decreased the economic growth rate, resulting in a 3.1% decline in the 1983 GNP as compared with with 1982 (Table 1). The agricultural sector also declined during this time: agricultural growth was 5.3% in 1980 and 6.8% in 1981, whereas it barely reached 2.0% in 1982 and then decreased 14.6% in 1983. This decline was primarily due to substantial losses of agricultural produce because of drought, excessive rainfall, and floods that affected the Coastal region during the latter part of 1982. In 1984 the economy began to recover as the world economy improved climatic conditions normalized, and corrective measures were implemented by the government; these factors enabled a 4.1% growth in the country's total GNP and a 6.7% growth in agricultural GNP.

Economic policy measures adopted by the present government, which produced the above-mentioned results, were brought about by applying a real price policy for the agricultural producer, by rationalizing industrial development, by allowing the entrance of foreign capital to key economic sectors, by implementing an oil policy focused on increasing production, and by executing a realistic exchange rate policy along with fiscal and monetary policies more consistent with available resources.

Overall growth in the amount mentioned, plus an import expansion at a rate of 9% per year, allowed overall supply to grow by 4.9% in 1984. Regarding overall demand, it is important to note that gross formation of fixed capital grew 6.8% during that year, compared with a 28.3% decline in 1983. Family consumption also improved -- from a 3.5% growth in 1984 after a 2.9% decrease in 1983. Nevertheless, this improvement was less than the growth recorded for 1980 and 1981 (7.2% and 4.8%, respectively). On the other hand, exports increased 11.1% that year, and only the public administration's final consumptien decreased, which was due to a strict expenditure control aimed at controlling inflation.

TABLE 1. GNP OF ECUADOR (millions of constant 1975 sucres).

ITEMS	YEAR				
	1970	1975	1983	1984	1985
GNP	62,912	107,740	150,529	156,630	160,520
Agricultural Livestock GNP	15,710	19,333	19,721	21,048	21,400
Total agricultural GNP Share (%)	25.0	17.9	13.1	13.4	13.3
Growth rates of total GNP		5.6	(3.1)	4.1	2.5
Growth rates of agricultural GNP		2.3	(14.6)	6.7	1.7
Total GNP without oil	65,339	95,590	130,818	134,567	137,660
Agricultural GNP share of Total GNP without oil	24.0	20.2	15.1	15.6	15.5
Growth rate of total GNP without oil		10.2	(6.4)	2.9	2.3
GNP in millions of sucres (current)	35,019	107,740	555,722	784,891	1,040,700

SOURCE: CONADE Socioeconomic Indicators, National Statements Nos. 6 and 7, Central Bank.

( ): Negative

B. SUMMARY OF THE AGRICULTURAL AND RURAL SECTOR

1. Population

Rural population decreased from 58.7% of the total population in 1974 to 48.6% in 1985 (Table 2), indicating abandonment of the rural areas primarily because of the relatively low profitability of agricultural activities, lack of remunerative employment sources, and, in general, the low standard of living normally found in rural areas.

Participation of the rural working population in the national labor force decreased sustantially during the last decade (Table 3); nevertheless it is estimated that in 1984 the rural working population was higher than 1.6 million people.

2. Education

According to the 1982 Census, the rural population employed in activities related to agriculture, forestry, fishing, and hunting totaled approximately 722,000 people. Of these, 31% had no schooling whatsoever, 1.4% were educated at alphabetization centers, 22.9% had 3 years of elementary schooling, 35.3% completed elementary school, and only 1.5% finished 9th grade. People with a high school degree totaled 0.5%.

Deficiencies in official instructional programs, as well as in the teaching methods used, are problems which, to a lesser or greater degree, affect the country's overall education. Generally speaking, the problem is far greater in the rural areas.

3. Transportation System

Currently Ecuador has a network of roads and rural access ways that link urban consumption centers with rural production areas. In the Coastal region, there is an extensive system of dirt roads that can only be used during the summer months. In 1982, the primary network was 9,983 km long, of which approximately 52% was paved, 44% were gravel, and 4% were dirt. The secondary network was 25,725 km long, of which only 1.2% was paved, 36.7% were gravel and 62.1% were dirt roads.

The importance of other transportation systems such as railroads and river ways is relatively minor. Together they make up less than 10% of transportation in the Coastal and Sierra regions. In the Amazon region, river are the main source of transportation; roads are second in importance although none of them are paved.

4. Storage Facilities

Present storage capacity for grains is estimated at 506,548 metric tons, of which 45.2% is in silos and the rest in granaries, mills, and stockpiles (Table 4). ENAC (Empresa Nacional de Almacenamiento y Comercialización) owns 37.3% of the total indicated amount; the private sector holds 42.8%.

TABLE 2. TOTAL POPULATION: URBAN AND RURAL POPULATION STRUCTURE OF ECUADOR. Period 1974—2000 (Number of Inhabitants).

YEAR	URBAN POPULATION	RURAL POPULATION	TOTAL POPULATION
1974	2,821,199	4,008,268	6,829,467
%	41.3	58.7	100.0
1985	4,819,620	4,558,360	9,377,980
%	51.4	48.6	100.0
2000 (est.)	8,516,033	5,423,367	13,939,400
%	61.1	38.9	100.0

SOURCE: Latin American Center for Population Statistics (CELADE), Estimations and Projections for the Population, 1950—2000. CONADE — INEC.

TABLE 3. ECUADOREAN WORKING POPULATION (EWP): NATIONAL TOTAL URBAN AND RURAL. Period 1974—1984 (Number of Inhaditants).

YEAR	URBAN EWP	RURAL EWP	TOTAL EWP
1974	845,513	1,463,929	2,309,442
%	36.6	63.4	100.0
1982	1,287,168	1,697,808	2,984,976
%	43.1	56.9	100.0
1984 1/	1,378,452	1,684,775	3,063,227
%	45.0	55.0	100.0

SOURCE: Latin American Center for Population Statistics (CELADE), Estimations and Projections for the Population, 1950—2000. CONADE — INEC.

1/ Estimated according to the 1982 structure.

C. RESOURCE AVAILABILITY, DISTRIBUTION AND UTILIZATION

1. Land

The country's total area is 27,258,000 ha, of which 24.8% is in the Coastal region, 21.6% in the Sierra, 46.2% in the Amazon region, and 2.9% in Galapagos.

In 1974 there were 516,916 agricultural production units (APUs), which covered an area of 7,955,257 ha (Table 5). Permanent pasturelands occurred in 32%; woodland and forests in 29%; farmlands in 22%; permanent crops in 11%; and other uses in 6%. In real terms this meant that approximately 350,200 ha were potentially productive and unused land.

Between 1974 and 1984, the area covered by pasture had increased from 2,558,874 to 4,377,330 ha, so that these figures have changed somewhat. Possibilities for expanding the agricultural boundaries in the Sierra region, mainly through irrigation, are relatively low, although they are greater in the Coastal region. The Amazon region depends on a colonization program subject to the restrictions imposed by handling the Amazon ecological system, which in general does not provide the opportunities that are attributed to it in terms of agriculture and livestock raising. On the other hand, it is estimated that 48% of the country's area is made up of zones that are either presently affected, or in the process of being affected, by erosión.

In 1974, 62% of the total agricultural production units (APUs) (516,916) were located in the Sierra, covering an area of 3,074,200 ha. and 33% were in the Coast, taking up an area of 3,716,160 ha.; the remaining 5% were located in the Amazon and insular regions (INEC, Agricultural Census 1974).

In the Sierra, 78% of the APUs covered an area of less than 5 ha, which amounts to 12% of the total area, whereas only 3% of the APUs were larger than 50 ha, accounting for more than 60% of the total area. In the Coast, 50% of the APUs covered an area of less than 5 ha, representing 4.4% of the total area, and 8% of the total APUs were larger than 50 ha, covering 66% of the total area. In the Amazon region, 25% of the total area corresponded to APUs between 5 and 50 ha; the remaining land area was covered by APUs which extend for more than 50 ha.

Thus it can be inferred that, on a national basis in 1974, more than 80% of the APU were smaller than 20 ha, covering ony 18% of the total land area, while the number of APU of more than 50 ha amounted to 7% of the total, accounting for 65% of the total land area.

The land tenure structure of the country included 70.3% as land owners (363,450 APU), 7.7% as lessees (40,012 APUs), 9.9% were on a single-tenure basis (51,198 APUs), and 12% were under mixed forms of tenure (62,248 APUs) (see Table 5).

2. Water and Irrigation

As Ecuador is a tropical country, there are two distinct seasons based on climate: rainy and dry. In the Coast the rainy season runs from December through May, with an annual average rainfall fluctuating between 250 and more than 3,800 mm depending on the location. In the Sierra the rainy season lasts from October through May; rainfall ranges

from 380 to 1,270 mm, which is lower than in Coastal region but normally better distributed throughout the season. In the Amazon, annual rainfall exceeds 2,500 mm, and is well-distributed throughout the year.

It is estimated that in 1984 there were 413,560 irrigated hectares on a national level (Table 6), of which 78% corresponded to private irrigation systems and 22% to the government's irrigation system. The private system had greater volume and coverage than the goverment's.

The government's irrigation system is under the direct control of INERHI (Ecuadorean Institute for Hydraulic Resources) and regional organizations, legally responsible for the development of irrigation projects. Some provincial boards are also included within the State system, but their influence is limited.

The total amount of land irrigated by the private and public systems accounts for 87% of the total irrigable area, which indicates an under-utilization of water resources, due to various factors: incomplete infra-structure, lack of service promotion to potential users, and, more significantly, inadequate use of water resources. All the country's irrigation projects have not generated the changes and the production and productivity increases that the studies justifying such investments projected for most of the areas covered by these projects. Indeed, the same rain-fed production methods and technologies are still being used. It is imperative to improve the efficiency rate of irrigation usage on a farm level.

In sum, during the next 4 years, INERHI alone would bring irrigation to approximately 34,000 ha. Studies indicate that by the year 2000, 415,700 ha could be irrigated on a national level, of which 209,600 ha are located in the Sierra and 206,100 ha are in the Coast.

3. Credit

The main source of financing for the agricultural sector is the Central Bank of Ecuador, which provides credit directly, or through the so-called financial funds mechanism, which is channeled through private banks and the National Development Bank that jointly make up the National Banking System.

Between 1980 and 1984, total agricultural credit supplied by the National Banking System, in circulating medium, grew at an annual rate of 30%, which is greater than the amount granted to the commercial sector during the same time period (27% annually), and lower than the credit growth rate alloted to the industrial sector (53% a year). Credit granted to the sector multiplied fivefold during the above-mentioned time period, increasing from S/ 11,556 million to S/ 60,175 million.

To the agricultural sector total credit alloted by the National Banking System averaged 13% per year from 1980 to 1984, a figure much lower than those for the industrial sector (28%) and the commercial sector (40%).

Approximately 60% of agricultural credit was channeled through private banks and financial institutions; around 33% went through the National Development Bank, and 7% was granted directly by the Central Bank of Ecuador, which shows the involvement of private banking in the sector's financing.

TABLE 6. AREA PLANTED, RAINFED AND IRRIGATED FOR TWO REGIONS OF ECUADOR, 1983 1/

Location and Ownership	Total Planted		Non-irrigated		Irrigated		Harvested	Pasture and Cropland
	Hectares	%	Hectares	%	Hectares	%	Hectares	Hectares
SIERRA								
INERHI	67,764	10.6	41,581	8.8	31,427	7.6		
Regional agencies 2/	19,000	3.0	14,500	3.1	10,000	2.4		
Private	321,366	50.4	240,822	50.8	218,723	52.9		
SUBTOTAL	408,130 4/	64.0	296,903	62.6	260,150	62.9	467,532	2,368,941
COAST								
INERHI	38,668	6.1	36,090	7.6	29,720	7.2		
Regional agencies 3/	34,000	5.3	27,450	5.8	20,000	4.8		
Private	157,039	24.6	114,001	24.0	103,690	25.1		
SUBTOTAL	229,707 4/	36.0	177,541	37.4	153,410	37.1	914,688	2,971,771
TOTAL	637,837	100.0	474,444	100.0	413,560	100.0	1,382,220	5,3240,71[illegible]

1/ The farmed area of the Sierra, Coast, Amazon, and Galapagos regions totals 1,436,895 ha.; pastures are 4,375,353, providing a grand total of 5,812,248 ha.
2/ Includes Zamora and El Oro.
3/ Includes Provincial Board or El Oro.
4/ These data were developed from multiple sources and differences were unresolved resulting in selected sub-totals being incorrect.

The National Development Bank is an institution that fosters growth. It has branches and agencies throughout the country, and most of its clients are small and medium-sized producers. The main crops financed by credit from the National Development Bank are rice, hard maize (for poultry feed), potatoes, cotton, soybeans, coffee, cocoa, and bananas, listed according to their importance. Approximately 86% of total agricultural credit was destined to these crops annually in 1980 - 1984, which explains why 68% of total agricultural credit granted by the National Developmepnment Bank was channeled to the Coast where most of these crops grow, and only 27% to the Sierra.

D. CHANGES IN PRODUCTION

During the last 15 years, Ecuador has experienced profund social and economic changes, mainly because of an unprecedent development of the national oil sector. These changes were associated with the population growth: in 1970 the Ecuadorean population was 6.0 millions; it is estimated that in 1985 it will surpass 9.5 million people. Between 1970 and 1985, urban population jumped from 39.5% to more than 51%. Income and its distribution also drastically increased: in 1970, per capita income was US $. 270, and in 1984, US $. 1.300. A growing middle class in the cities demanded foodstuffs with specific nutritional value and with a higher degree of preparation, which progressively influenced the level and structure of agricultural demand.

As a result, since 1970 production of certain domestic crops has substantially increased: African palm, hard maize, soybeans, and rice triggered by an increasing demand for vegetable oils and lards, which have slowly been substituted for animal fat. The demand for produce rich in proteins has also expanded. In contrast, during the same period, domestic production of a number of traditional products has been decreasing (Table 7). Such crops include potatoes, barley, flowers, maize, peas, broad beans, lentils, and quinoa, the consumption of wich has evidently decreased in the country due to changes in eating habits. The production of wheat has undergone the most drastic reduction.

1. Export Products

Banana, cocoa, and coffee are Ecuador's chief export crops; together they comprise more than 65% of the country's total agricultural exports. The total area of cultivated banana fields has decreased dramatically (Table 7), due to a national policy that is attempting to diversify crops in marginal banana plantations, as well as to adjust domestic banana production to the actual placement possibilities in international markets.

Cocoa production has more than doubled in the last 15 years, mostly due to an increase in cultivated fields (Table 7); however, because of this, profits are becoming a serious problem. Furthemore, because most cocoa plantations are quite old, and due to disease and pest problems, the yield per hectare is still relatively low, notwithstanding the afore-mentioned results. Due to the ease with which the so-called **aroma cocoa** or "Ecuadorean cocoa" is marketed abroad, this item which is internationally renowned, has great possibilities for increasing its present export volume.

TABLE 7. TREND SUMMARY OF SELECTEC CROPS.

CROP	AREA	1970 — 74 (AVERAGE) PRODUCTION	YIELD	1980 — 84 (AVERACE) AREA	PRODUCTION	YIELD
	(ha)	(metric ton)	(kg/ha)	(ha)	(metric tons)	(kg/ha)
Wheat	62,122	60,062	967	29,469	31,616	1,073
Flower maize	187,232	131,122	700	75,793	62,978	831
Dent maize (poultri feed)	119,052	132,355	1,112	166,992	230,467	1,380
Cassava	32,894	313,899	9,543	26,235	237,020	9,035
Cotton	19,965	18,154	914	16,020	20,008	1,249
African palm (oil)	4,484	44,116	9,840	25,085	138,240	5,511
Soybeans	1,313	1,690	1,287	16,169	21,157	1,308
Potatoes	44,223	547,684	12,385	32,217	377,726	11,725
Rice	82,033	265,678	3,239	122,983	378,471	3,077
Barley	105,374	71,339	677	35,578	26,939	757
Bananas	144,674	2,681,653	18,536	60,560	1,873,216	30,931
Coffee	222,213	70,062	315	311,155	83,054	267
Cocoa	220,018	69,437	316	271,376	75,725	279
Sugarcane	43,941	3,235,426	73,632	38,965	2,757,612	70,772
Abaca (manila hemp)	4,229	3,864	914	13,609	11,077	814

SOURCE: World Bank Annual Report and Agricultural Advisor of the U.S. Embassy.

Coffee production also increased by approximately 50% between 1970 and 1985, primarily because of an increase in farm land (Table 7). According to figures of the 1982 Coffee Census that have not yet been published, coffee plantations presently exceed 400,000 ha, as compared to 214,800 ha reported in 1970. Average coffee yield decreased by about 18% during this period, and it is one of the lowest in the area and in the world.

Although coffee and cocoa are produced under low levels of technology in Ecuador, they have been traditional export crops. Approximately 30% of the banana production, on the other hand, is produced with modern technologies.

Ecuador also exports abaca fiber, flowers, fruits, and other crops in much lower quantities, which overall do not even make up 5% of total agricultural exports. Flowers and certain fruits have undergone an unexpected development in the last 5 years, however.

One of the major objectives of the present government's policy and strategy for development is strengthening the country's economy by increasing and diversifying exports in general and particularly agricultural exports, because it is considered that the country has certain comparative advantages. To this end, the government is striving to stimulate the sector's exports by granting them an adequate profit margin; supporting the private sector in acquiring new markets and consolidating traditional ones; providing sufficient and adequate credit, technical assistance, inputs, etc.; and simplifying administrative procedures inherent to this activity. Overall, these methods willl improve the quantity and quality of exports.

2. Domestic Consumption Products

This group includes farm produce that makes up basic commodities of the Ecuadorean population and which are consumed without being subject to a transformation process, some of which are rice, soft corn, wheat, barley, grain legumes, potatoes, cassava, fruits, vegetables, meats, milk, and eggs. Following is an extremely brief analysis of the changes that have taken place in areas farmed with these crops, their production and yield, based on the averages obtained during the 5-year periods between 1970-1974 and 1980-1984 (Tables 8, 9, 10).

Rice production has increased by 43% due solely to an expansion of cultivated fields. Rice yield has decreased, however, apparently because of a standstill in technologies used. Under normal weather conditions, domestic rice production is sufficient to meet the country's present needs.

The area of land planted to maize has decreased by 68%, and maize production has decreased 52%; however, yield has increased by around 50% because of improved seeds and the introduction of new farming methods. Although production has drastically declined, the country produces enough maize to meet present demand, as domestic consuption has also proportionally decreased.

Wheat production has been progressively decreasing (45.5% for the period) because of a decrease in farmed land (54.25%); conversely, the crop's yield has improved by 18%. Consumption of wheat more than doubled between 1970 and 1985 as a result of a subsidy policy on imported wheat which was effective between 1973 and 1982, providing the country with a better quality product than the domestic one and, generally, with a cheaper one as well. This situation slowly anihilated domestic production and consequently boosted imports, which went from 78,000 to 250,000 metric tons during the 10 years.

TABLE 8. AREA PLANTED TO MAJOR ECUADOREAN CROPS, 1980, - 1984 (ha).

PRODUCT	1980	1981	1982	1983	1984	Average 1980—84
I. DOMESTIC CONSUMPTION CROPS						
Grains and Cereals						
Rice	126,608	131,275	131,720	94,851	139,080	124,707
Flower maize	59,203	59,762	61,087	60,553	62,282	60,577
Wheat	32,100	37,187	33,058	25,754	24,499	30,520
Barley	26,244	28,847	33,921	29,756	30,702	29,894
Peas	13,967	14,000	12,476	8,558	8,597	11,520
Common beans	48,156	53,525	50,976	36,844	44,312	46,763
Broad beans	7,872	7,077	6,869	7,543	6,436	7,159
Lentils	671	922	836	715	428	714
Tubers and Roots						
Potatoes	30,380	31,602	35,101	26,743	33,489	31,463
Cassava	25,174	26,000	19,926	20,103	23,993	23,039
Vegetables						
Garlic	339	408	543	536	526	470
Onions	3,333	4,742	4,731	4,594	5,794	3,972
Cabbage	1,271	1,360	1,457	1,523	1,739	1,470
Lettuce	420	558	602	791	987	672
Beets	230	341	701	653	826	550
Carrots	1,209	1,295	1,374	1,393	942	1,243
Tomatoes	2,564	2,868	2,314	2,422	3,501	2,934
Fruits						
Peaches	514	513	515	536	506	517
Lemons	1,379	1,453	1,478	1,538	1,785	1,527
Apples	3,201	3,204	3,230	3,122	2,848	3,121
Oranges	25,193	25,182	25,158	24,619	21,662	24,363
Naranjilla (green orange)	2,200	2,515	2,484	2,921	2,859	2,596
Pears	661	666	656	660	627	654
Bananas (cooking)	69,749	66,910	66,166	63,087	64,607	66,104

—— Continued

TABLE 8. (Continued).

PRODUCT	1980	1981	1982	1983	1984	Average 1980--84
			II. INDUSTRIAL AGRICULTURE			
Oil Seeds						
Castor oil plant	6,716	4,341	3,117	2,629	2,103	3,781
Peanuts	11,611	10,946	7,479	6,141	7,109	8,657
African palm	18,025	26,000	26,799	28,538	29,195	25,711
Soybeans	24,943	21,100	21,325	10,053	28,364	21,157
Grain						
Dent maize (poultry feed)	166,708	184,729	155,418	145,275	182,830	166,992
Fibers						
Raw cotton	19,416	24,086	17,400	10,370	9,940	16,242
			III. EXPORTS			
Bananas	70,494	63,999	65,009	59,306	60,646	63,891
Cocoa beans	269,878	270,000	277,000	270,000	265,051	270,386
Coffee beans	288,060	320,900	321,877	339,971	344,980	325,146

SOURCE: Division Ministry of Agriculture and Livestock, Data and Statistics.

TABLE 9. PRODUCTION OF MAJOR ECUADOREAN CROPS, 1980 — 1984
(metric tons.)

PRODUCT	1980	1981	1982	1983	1984	Average 1980 -84
I. DOMESTIC CONSUMPTION CROPS						
Grains and Cereals						
Rice	380,614	434,395	384,356	273,502	437,166	382,007
Flower maize	45,266	48,625	54,692	44,421	56,820	49,965
Wheat	31,113	41,431	38,538	26,914	25,172	32,633
Barley	24,350	26,090	35,435	29 589	24,952	28,083
Peas	7,452	7,440	7,261	4,714	5,007	6,375
Common beans	26,275	29,699	28,539	20,282	26,055	26,170
Broads beans	4,566	5,153	5,298	5,277	4,708	4,986
Lentils	437	578	519	345	232	422
Tubers and Roots						
Potatoes	323,222	391,579	416,417	314,011	389,565	366,966
Cassava	229,313	236,789	183,936	194,794	239,221	216,811
Vegetables						
Garlic	1,909	2,059	2,808	2,842	2,714	2,466
Onions	30,108	42,132	41,669	40,670	50,705	41,057
Cabbage	24,760	25,365	22,839	26,397	31,631	26,198
Lettuce	5,740	7,911	7,662	10,475	13,075	8,973
Beets	1,361	2,106	3,388	5,182	6,831	4,174
Carrots	9,147	11,118	11,645	11,624	8,127	10,332
Tomatoes	38,147	42,309	36,783	35,999	70,619	44,771
Fruits						
Peaches	5,796	6,145	5,905	3,200	3,047	4,819
Lemons	17,788	16,262	15,822	14,144	16,858	16,175
Apples	30,899	33,944	34,644	35,123	29,437	32,809
Oranges	533.493	525,236	500,507	355,154	271,961	437,270
Naranjilla (green orange)	7,786	11,489	12,763	15,548	11,673	11,852
Pears	8,808	9,351	8,831	7,608	6,935	8,317
Bananas (cooking)	550,983	761,389	753,528	687,212	744,007	699,424

—— Continued

TABLE 9. (Continued).

PRODUCTS	1980	1981	1982	1983	1984	Average 1980—84
		II. INDUSTRIAL AGRICULTURE				
Oil Seeds						
Castor oil plant	6,081	3 916	2,527	2,788	2,288	3,520
Peanuts	13,642	12,671	5,510	5,104	5,942	8,574
African palm	198,300	300,000	309,288	354,225	372,443	306,851
Soybeans	33,549	33,184	37,419	14,074	47,479	33,141
Grain						
Dent maize (poultry feed)	196,414	232,620	269,287	184,996	269,020	230,467
Fibers						
Raw cotton	39,806	41,971	25,196	4,151	7,826	23,790
		III. EXPORTS				
Bananas	2,269,479	2,009,850	1,998,749	1,642,073	1,677,571	1,919,544
Cocoa beans	91,215	80,460	96,941	45,000		78,404
Coffee beans	69,445	86,085	83,938	81,075	97,062	83,521

SOURCE: Ministry of Agriculture and Livestock, Data and Statistics Division.

TABLE 10. PRODUCTIVITY OF MAJOR ECUADOREAN CROPS, 1980 — 1984, (kg/ha).

PRODUCTS	1980	1981	1982	1983	1984	1980—84	Percentage Increase from 1980
			I. DOMESTIC CONSUMPTION CROPS				
Grains and Cereals							
Rice	3,066	3,309	2,918	2,883	3,143	3,064	
Flower maize	765	814	895	734	912	824	10
Wheat	969	1,114	1,116	1,045	1,027	1,069	
Barley	928	939	1,047	994	813	944	
Peas	534	521	582	551	582	556	
Common beans	546	555	560	550	588	560	
Broad beans	580	728	761	700	731	696	26
Lentils	651	627	621	483	542	591	
Tubers and Roots							
Potatoes	10,639	12,391	11,863	11,742	11,633	11,633	12
Cassava	9,109	9,107	9,231	9,690	9,970	9,411	
Vegetables							
Garlic	4,784	5,047	5,171	5,302	5,169	5,116	
Onions	9,033	8,885	8,808	8,853	8,751	10,337	
Cabbage	19,481	18,651	15,675	17,332	18,189	17,822	
Lettuce	13,669	14,177	12,728	13 243	13,247	13,351	
Beets	5,917	6,176	7,686	7,936	8,270	7,589	27
Carrots	7,566	8,585	8,457	9,345	8,627	7,460	16
Tomatoes	14,878	14,752	15,895	14,863	15,566	15,228	
Fruits							
Peaches	11,276	11,981	11,466	5,970	6,022	9,321	
Lemons	12,899	11,192	10,698	9,196	9,444	10,591	
Apples	9,653	10,594	10,726	11,250	10,336	10,512	
Oranges	25,176	20,858	19,895	14,426	12,555	17,948	
Naranjilla (green orange)	3,539	4,578	5,138	5,323	4,083	4,565	35
Pears	13,325	14,041	13,462	11,527	11,140	12,717	
Bananas (cooking)	10,767	11,739	11,388	10,893	11,516	11,186	

TABLE 10. (Continued).

PRODUCTOS	1980	1981	1982	1983	1984	1980—84	Percentage Increase from 1980
			II. INDUSTRIAL AGRICULTURE				
Oil Seeds							
Castor oil plant	905	902	811	870	904	884	
Peanuts	1,175	1,158	737	831	836	990	
African palm	11,901	11,538	11,541	12,412	12,757	11,935	10
Soybeans	1,345	1,573	1,755	1,400	1,674	1,566	19
Grain							
Dent maize (poultry feed)	1,178	1,259	1,733	1,273	1,471	1,380	22
Fibers							
Raw cotton	2,050	1,743	1,448	400	787	1,465	
			III. EXPORTS				
Bananas	32,194	31,404	30,607	27,688	27,662	30,002	
Cocoa beans	333	298	350	167		290	
Coffee beans	241	268	261	239	282	259	

SOURCE: Ministry of Agriculture and Livestock, Data and Statistics Division.

The availability of relatively low-priced wheat flour byproducts (bread, cookies, spaghetti, pastries, etc.) slowly replaced consumption of barley, broad beans, peas, common beans and soft maize. This compounded with a series of agricultural and marketing difficulties faced by producers of these crops, determined a substantial decrease in their production. Areas planted with barley have decreased by 72% and production by 60%, whereas yields have expanded by more than 40%. Ecuador is a deficit producer of barley, and approximately 50% of domestic consumption is supplied by imports.

Production and the amount of land planted to peas, common beans, broad beans, and lentils have decreased; however, yields have increased in all cases. The country practically supplies itself with legumes. Up until last year, small quantities of lentil were imported, but there has never been an evident shortage of this crop. In the agricultural year 1984-1985, there was a slight surplus of common beans (1000 metric tons), which has not yet been absorved by the domestic market or exported.

Potatoes have decreased on all counts: planted area (28.7%), production (32.7%), and yield (5.6%). Apparently, the country is self-sufficient, although domestic markets are greatly influenced by harvets from neighboring countries, namely Colombia and Peru. There are no official exports and imports of potatoes, but an intensive commercial traffic occurs among neighboring countries.

Similar to potatoes, cassava has decreased in planted area production, and yield, primarily because until recently the market was very limited and because farmers lack information about improved varieties and technologies.

Production and yield have increased in fruits such as peaches, apples, oranges, pears, and bananas, undoubtedly because of technological improvements. The opposite holds true for naranjilla (green oranges) and lemons, among the most important.

Production and yield of beets, carrots, and onions have also increased. There is a higher production rate of tomatoes as planted areas have expanded, but yield is decreasing. Production, total planted area, and yields of lettuce, cabbage, and garlic have declined.

The country is apparently self-sufficient in a variety of fruits and vegetables, and it is even able to generate exportable quantities of crops such as tobacco, strawberries, melons and green peppers, among others. There are great expectations regarding the possibility of substantially increasing these nonconventional exports.

Important increases have taken place in the national production of milk, meat, and eggs. Production of milk has increased by close to 200,000 liters per year; meats have practically doubled, and eggs have more than tripled in the last 15 years. Nevertheless, the country does not supply enough milk to meet its present needs and must therefore import to cover domestic demand. Ecuador is practically self-sufficient in meat for current needs; however, meat consumption is below recommended nutritional levels. The country has obtained an exportable surplus in eggs, but in 1983, the poultry population was greatly affected by climatic conditions, which, in turn, affected this industry. Presently, the situation is becomming more stable.

3. Raw Materials

The primary agricultural products used as raw material for agro-industry are soybean, red palm oil, hard maize, sugarcane, and cotton. Production of all of them, except sugarcane is increasing progressively and considerably. Soybean and African palm crops are relatively new to the country. From a gross production of 600 metric tons per year in 1970, it is estimated that in 1985 soybean production will be over 80,000 metric tons as cultivated areas are expanded. Production of about 490,000 metric tons of African Palm fruit are expected for 1986 against 21,000 obtained in 1970. Again due to growth in cultivated area.

Hard maize crops have also expanded, due to an increase in cultivated areas, not to improved yields. Behavior in this area has a direct relation with growth of the domestic poultry industry obtained in the last 10 years.

Although cultivated areas have decreased, cotton production has increased notably; in some years, excess supplies have been obtained that have not been absorbed by national markets nor exported. The country has the capacity for covering textile requirements for short— and medium-fiber cotton. Long-fiber cotton has to be imported.

Certain circumstances have decreased national production of sugarcane since 1978, and production has stabilized at about 3 million metric tons. Irregular climatic conditions and the ever-decreasing volume of sugarcane exports under the quota system along with low national prices for extended periods of time have produced very low profits.

It is evident that the behavior of raw material products for agro-industry has been favorable and that these, as well as cattle products, are mainly generated by organized producers who were able to negotiate with the government for the best prices and public services more effectively than producers of the basic agriculture products.

4. Gross Value of the Agricultural Production Composition and Changes

Gross value of agricultural production reached 13,000 million sucres in 1984, at 1975 prices, against 12,990 million sucres obtained in 1980 (Table 11), which means that from 1970 to 1984, national agricultural production has decreased and its structure has changed.

The grain and cereal group has been losing its relative importance as its participation declined from 20.3% to 13.4% of the total gross value composition from 1970 to 1980. In 1984, however, it rose to 17.9%. Similarly, the tuber and root group decreased from 13% in 1970 to 6.3% in 1980 and 5.7% in 1984. The fruit group declined even further, from 33% of the total gross value in 1970 to 18.5% in 1980 and 13.4% in 1984. Beverages also declined from 20% in 1970 to 15.4% in 1980 and 8.8% in 1982. The vegetable group decreased from 4.6% in 1970 to 1.5% in 1980 but then rose to 3.6% in 1984.

The only cultivated crops that have improved their contribution to total gross value are oil crops and fibers. The first ones were 2.2% in 1970, 5.7% in 1980, and 4.8% in 1984. Fibers fluctuated from 0.47% in 1970 to 1.9% in 1980 and 1% in 1984.

Livestock's contribution to the total gross value of agriculture and cattle production went from 46.7% in 1970 to 29.7% in 1980 and 41.5% in 1984.

From 1980 to 1984, the gross value of export products decreased from 32.5% to 23.5 % and that of agroindustrial products declined from 45.2% to 19.6%. On the other hand, domestic consumption products increased from 22.3% to 56.9% in the same period of time (Table 12)

TABLE 11. GROSS VALUE OF AGRICULTURE AND LIVESTOCK PRODUCTION AT 1975 PRICES IN ECUADOR, 1980—1984 (MILLIONS OF CONSTANT SUCRES).

	1980	%	1982	%	1984	%
Agricultural Products	12,989	70.3	11,883	55.4	13,023	58.5
Grains and cereals	2,479	13.4	2,697	12.6	3,976	17.9
Tubers and roots	1,164	6.3	1,413	6.6	1,266	5.7
Vegetables	275	1.5	602	2.8	813	3.6
Fruits	3,414	18.5	3,235	15.1	2,984	13.4
Oil seeds	1,049	5.7	992	4.6	1,073	4.8
Fibers	356	1.9	199	0.9	212	1.0
Beverages	2,840	15.4	1,803	8.4	1,952	35.7
Other crops				4.4	747	3.4
Livestock Products	5,472	29.7	9,480	44.6	9,242	41.5
TOTAL AGRICULTURE AND LIVESTOCK	18,461	100.0	21,363	100.0	22,265	100.0

SOURCE: Ministry of Agriculture an Livestock, Data and Statistics Division.

5. Agriculture and Commercial Balance of Trade

With the development of the Ecuadorean oil sector since 1973, deep changes have been produced in the national economy, and consequently in the level and structure of foreign trade. Basically, agricultural and cattle exports have been losing their relative importance as total exports: 85% of exports in 1970 were from agriculture and cattle sector, but only 24.5% in 1980 and 20.2% in 1984.

The primary agricultural and cattle imports include foods, raw materials and intermediate products for agriculture; raw materials and intermediate products for agroindustry; and agricultural production inputs. Agricultural and cattle imports went from 48% of total imports in 1970 to 15.5% in 1980 to 23.5% in 1984. During 1970–1980, food imports for direct consumption increased more than eightfold, and imports of foods for industrial use increased twelvefold. On the other hand, imports of raw materials and intermediate products for agriculture increased ninefold, and fargible assets for agriculture did not even double. This illustrates the low investment in this sector.

Food imports for direct consumption and for industry represented 12% of the total value of agricultural and cattle imports in 1970. This proportion increased to 26% in 1980 and 29% in 1984, while raw material imports, intermediate products and agricultural inputs (chemicals, fertilizers, etc.) decreased from 17% in 1970 to 11% in 1980. Total value of agriculture and cattle imports was US $ 121 million in 1970, US $ 348 million in 1984, which means that between 1970 and 1980, this value did not increase fourfold.

Agriculture and commercial balance of payments has shown a surplus in the last 15 years, although it decreased from 1980 from US $ 259.45 million to US $ 162.3 million in 1982 and US $ 109.9 million in 1984.

E. STRUCTURE AND FUNCTIONS OF AGRICULTURE AND LIVESTOCK PUBLIC SECTOR

1. Conformation of the Sector

The agriculture and livestock public sector is constitued by the Ministry of Agriculture and Livestock MAG), as well as other related public agencies. MAG is charged with formulating, directing, and implementing (a) investigation policies; (b) production and trade of agricultural and livestock products; (c) agrarian reform and colonization, (d) irrigation; (e) rural development, and (f) rational use of renewable natural resources. Its goals are to increase production and productivity of agriculture, livestock, and forestry; generate employment opportunities, and contribute to the income redistribution policy for the Ecuadorean population.

The agricultural and livestock institutions in the public sector of Ecuador, according to the nature of their objectives, could be classified as follows:

a. **Management of Renewable Natural Resources**

- Division of Agrarian Regionalization: Branch of the General Board for Planning, MAG, responsible for inventory and evaluation of renewable natural resources and agrarian regionalization of the country.
- National Department of Soil Conservation: Branch of the National Agricultu-

TABLE 12. GROSS VALUE OF EXPORT, DOMESTIC CONSUMPTION, AND AGRO-INDUSTRIAL PRODUCTS IN ECUADOR, 1980—1984 (IN CURRENT SUCRES).

	1980	%	1982	%	1984	%
Export Products 1/	4,230	32.5	2,872	24.2	3,057	23.5
Domestic Consumption						
Products 2/	2,892	22.3	2,408	20.3	7,408	56.9
Agroindustrial Products	5,868	45.2	6,602	55.6	2,557	19.6
TOTAL	12,990	100.0	11,882	100.0	13,022	100.0

1/ Banana, coffee, cocoa, abaca.
2/ Dent maize, royal palm, African palm, soybean, sugarcane, other use cane, tobacco.

ral Board of MAG, responsible for encouraging the rational use of fertilizers and soil conservation practices.

- Ecuadorean Institute of Hydraulic Resources (INERHI): Department within the MAG, responsible for the administration of irrigation resource use in the country.
- Ecuadorean Institute of Colonization and Agrarian Reform (IERAC): Office within the MAG, responsible for the organization and execution of the colonization and agrarian reford processes.
- National Institute of Colonization of the Ecuadorean Amazon Region (INCRAE): Department within the MAG, responsible for planning, coordinating, and executing colonization programs in the Amazon region.
- Other offices include: Rehabilitation Center of Manabi (CRM); the Economic Development Commission for Guayas River Basin (CEDEGE); The Center for Economic Reconversion for Azuay, Cañar, and Morona Santiago (CREA); and Regional Program for the development of the Southern part of Ecuador (PREDESUR) The offices develop and manage irrigation and drainage projects, which in some cases have multiple porpuses.

b. **Agricultural and Livestock Research**

- National Institute of Agricultural and Livestock Research (INIAP): Office within the MAG, responsible for determining and executing agricultural and livestock research policy in the country.
- Schools of Agriculture and Livestock of universities and national polytechnic institutes: These schools also perform research, although according to the organization of public administration in Ecuador, they are not part of the public sector for agriculture and livestock, whose ruling organism is MAG, but are administered by the Ministries of Education, Culture, and Sports.

c. **Agriculture and Livestock Extension, Plant Health, and Veterinarians**

- Ministry of Agriculture and Livestock: MAG has (1) national programs for this purpose, organized by crop or by specialized areas (rice, banana, coffee, cocoa, cotton, plant health, agricultural engineering); (2) central specialized offices (National Boards of Agriculture, Livestock, Rural Development, Institute of Farmer Training); and (3) technical delegations in each one of the provinces.
- Other offices include CREA, PREDESUR, CRM, IERAC, INERHI, CEDEGE. These offices are geared toward technology diffusion.

d. **Production, Distribution, and Trade of Inputs**

- Ecuadorean Fertilizers (FERTISA): Quasi public company, with actions defined by the public sector. It produces and formulates simple compound and complete fertilizers.

— State Fertilizer Office (EMADE). Branch of MAG, produces some types of organic fertilizers.
— Certified Seed Enterprise (EMSEMILLAS): Quasi public company, with actions defined by the public sector. It multiplies and trades certified seed of some basic products, including rice, maize, wheat, and potatoes.
— National Department of Seeds: Branch of MAG responsible for seed multiplication and certification. It inspects seeds produced by EMSEMILLAS and private farmers.
— INIAP: Produces basic and registered seeds delivered specially to EMSEMILLAS and organized farmers as well as individuals.
— National Enterprise of Semen (ENDES): Produces and trades improved semen for bovine cattle.
— MAG, INIAP, CREA: Provide improved breeding stock of bovines, ovines, porcines, guinea pigs, and rabbits, at promotion prices.

e. **Agriculture and Livestock Product Trade**

— The Subsecretary Office of Trade: Branch of MAG responsible for trade policy definition of agriculture and live-stock products nationwide.
— National Office of Storage and Trade for Agriculture and Livestock, and Agroindustrial Products (ENAC): Office within the MAG, responsible for market regulation for basic agriculture produtes through buying and selling, in order to stabilize prices.
— National Programs of MAG: Offices responsible for regulation of trade processes of some agricultural products, including rice, maize, soybean, cotton, wheat, barley, coffee, cocoa, and banana.

f. **Agricultural and Livestock Insurance and Credit**

— National Development Bank (BNF): Institution within the MAG, responsible for agricultural credit loans.
— National Company of Agricultural and Livestock Insurance (CONASA): Quasi public company with actions defined by the public sector. It provides agricultural insurance for a group of basic crops, livestock and forestry.

g. **Other Nonspecified Areas**

There are other quasi public companies dedicated to certain activities, including milk processing (PROLACEN, PROLAHUAN, COMPROLACSA), livestock slaughter (CAFRILOSA), meat product elaboration (PROCARMOS), tea processing (TE ZULAY), wood processing (Cayapas Forestry Industry), and citrus processing (CITRICOS BOLIVAR).

2. General Organization of the Ministry of Agriculture and Livestock

Since its inception on August 10, 1984 MAG was determined to be an essential institution in the reorganization of the country. As a leading institution, it is totally responsible for the development and growth of the county's agriculture and livestock sector. A recent move toward decentralized administration will in time provide efficient services and performance of new actions which are to be its role.

CHAPTER III

ANALYSIS OF THE PRESENT STATUS OF REE

A. RESEARCH

1. History and Current State of the Public Sector

Agricultural and livestock research officially began in 1942 with an agreement between the Governments of Ecuador and the United States, which created the Agricultural Station of Ecuador In 1943 the first experimental center was founded with the help of the Development Corporation of Ecuador on the Pichilingue farm in Los Rios Province.

The National Institute of Agricultural and Livestock Research (INIAP) was created in July, 1959 and began operations in October, 1961 in what is now the Santa Catalina experiment station south of Quito. In 1963 INIAP established a new experiment station in the Rio Portoviejo valley in Manabi. In the same year, the Pichilingue experiment center, the wheat research program (part of the National Wheat Commission) and the African palm program (in the Ministry of Development) were transferred to INIAP.

Thus were established the first four INIAP experiment stations covering the highlands, the dry and wet areas, and the coast.

The Boliche experiment station were founded in 1972, and INIAP created the Austral experiment center in 1974 at Chuquipata, Cañar Province. In 1978, the Napo experiment station in Oriental Province was founded and in 1981 the Payamino Projet was annexed, giving it the current name Napo—Payamino experiment station.

Once the national system of agricultural and livestock reseach was consolidated through INIAP, the system was expanded to include the model farms of MAG such as Tumbaco, Pillaro, Nagsiche, La Margarita, La Molestina, and Laguacoto, as well as other farms such as Misahualli, Palora, and El Almendral. All of this complex forms part of the system that INIAP uses to carry out research and seed activities. All the stations and farms are located to cover a wide range of existing ecological conditions (Figure 1) which facilitates transfer of results of research through a broad geographical area.

Other public and private institutions have been developing research activities in agriculture and livestock matters for some time. For the last 30 years, several national and international private agencies have developed certain specific research activities, and such activities have been increased lately since some companies now working in the country need such research to reach their goals.

2. Description of Major Programs

INIAP maintains several research programs distributed in seven stations and six experimental model farms throughout the country. The most important criteria used by the institute for determining the level of work within each area include:

Domestic staples
Traditional exports
Import substitutions
Non-traditional exports
Agroindustry

INIAP has prioritized its research activities, considering first those products essential as domestic food staples (wheat, rice, maize, potatoes, milk, barley, etc.) and those for traditional exports (cocoa, coffee). Other products are being incorporated according to needs and as a result of INIAP's growth; these include soybeans, African palm, vetetables, legumes, and fruits.

3. Work Strategies

INIAP's main objective is to develop and adapt the necessary technology for increasing production and productivity on agriculture and livestock, considering farmers' agronomic and socioeconomic conditions with the goal of increasing their income and well-being. Three levels of research activities were considered by INIAP for reaching this objective: experimental station, regional, and production.

a. Experiment Station Research

Genetic improvement: Development of new cultivars with wide adaptation, improved yields and early maturity and with higher resistance or tolerance to pests and diseases, as well as a high degree of quality demanded by customers.
Cultural improvement: Research on improved methods of seeding, tillage, fertilization, crop rotations, harvesting and producing, product benefit, and others.
Integrated pest management: Research on more efficient methods of fighting pests and diseases in the principal crops.
Livestock research: Development of management practices, breeding and nutrition for various species.

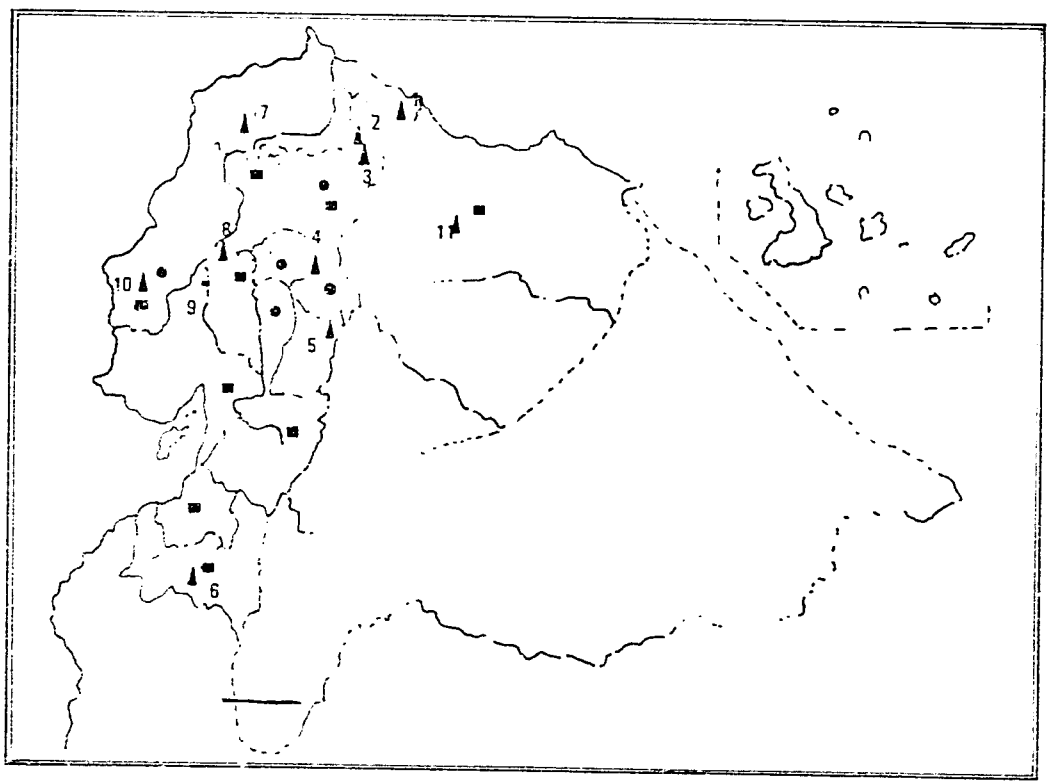
b. Regional Research

Regional research is performed in different agroclimatic regions in each experiment station. Various aspects of yield and stability of experimental cultivars as well as the validity of those new cultural practices and integrated pest management recommendations developed at the experiment station level. Farmers' participation at this stage is minimal, since it is very high level research and naturally very risky.

c. Production Research

Production research was initiated on areas that have a high concentration of small farmers with limited resources. INIAP creatted another level of investigation since 1977, in which validation trials, at the farm level, are made with technology developed by the Institute on experiment stations and regional test fields. This strategy is considered valid for small, mid-ssize, and large producers. It is considered a validation and feedback process that would permit adjustments or changes in the technology generated according to the experience of farmers, who in theory actively participate in the process.

Figure 1. RESEARCH FACILITY LOCATIONS BY TYPE AND SPECIAL PRODUCTION PROGRAM LOCATIONS OF INIAP



4. Work Plans

INIAP develops its activities mainly in the Sierra and Coastal regions but is also interested in integrating certain research programs in the Amazon.

Apart from the fact that research activities are assigned to program and service departments, in practice a multidisciplinary approach is used in planing, implementation, and evaluation. Each head of a program (generally a plant breeder) works with various specialists in several branches — agronomy, soils and fertilizers, crop protection, biometrics, and so on — to coordinate each proposed activity.

Each agricultural programs follows a basic work plan. Generally, work begins with plant breeding — introduction and selection and selection of materials — and continues with crossing, selecting and regional adaptation trials. This work is followed on agronomic practices — soil preparation, plant density and sowing distance, cultural work, along with crop protection practices — pathology, entomology, weed control, fertilizers and soil amendments. The principal objective is to select improved varieties or lines with superior characteristics for commercial release to the public along with technical recommendations.

For certain products, such as rice, soybean, maize, cereals, and some pastures, INIAP provides basic seed to the Quasi-public Seed Company (EMS) for multiplication. The National Seed Program (PNS) Supervises this process. Unfortunately, the volume of seed handled is quite low, which reflects serious problems in the system.

For potatoes which are perishable and perennial crops, EMS is not needed for multiplication, and distribution is handled by other entities, such as national programs (PNs) and through individual farmers. In the case of the livestock programs of INIAP (dairy cattle, dual -purpose cattle and swine), the research is confined mainly to management areas (production systems), nutrition, health, and animal breeding. Genetic improvement fer livestock is minimal, for example in the case of swine it is confined to the distribution of breeding stock. A project for dual-purpose cattle in the coast is trying to crossbreed (5/8 Holstein — 3/8 Brahman) a new race, which implies selection of parental genetic material. No animal genetic improvement program has been implemented for dairy cattle in the Sierra.

The livestock program formally provides breeding stock for reproduction or fattening in both the swine and cattle programs in the several stations involved in this activity. Delivery is made directly to swine producers or under contract to public and private institutions.

On some stations, INIAP currently provides soil, chemical and leaf samble analyses; analysis of some causes of plant disease, identification of harmful insects, analysis of feed and forage quality; and analysis of toxic residues and blood. It has some capacity for training technicians and farmers, which is offered sporadically. A Department of Communication and Public Relations publishes the results of research support departments.

5. Interinstitutional Linkages

INIAP collaborates with several International Agricultural Research Centers: CIMMYT, CIP, CIAT, ICRISAT ICARDA, IBPGR, and others. Currently, there is a very strong link with CIMMYT through its permanent mission in Quito. Significant cooperative projects habe been developed over the last decade with CIP, CIAT, and IPGR. Linkages with other

centers that are more distant are minimal. There are also 28 existing agreements with national institutions such as producer associations, universities, and private enterprises.

6. Budget and Staff

As part of the agriculture and livestock sector, in charge of scientific research, INIAP is part of the Ministry of Agriculture and Livestock. Its principal funding comes from a special budget approved by the Legislative Commission on Finance and Banking and from the National budget. Additional funds are obtained from seed sales and other services, which in 1985 represented 12% of INIAP's budget.

For the period 1981—1985, INIAP's budget averaged 8.8% of the total budget for the agriculture and livestock sector (Table 13). Because this is insufficent INIAP has obtained some loans and contributions from national and international organizations.

In 1985, 88% of the budget was used for personnel expenses and 12% for operational expenses and capital improvements (Table 14). Until 1985, a high percentage of the budget was used for wage labor and other costs from collective contracts, signed by the Institution with FENOINIAP (National Federation of Workers from INIAP) which has 677 workers. Since March, 1986, INIAP has had no permanent laborers, and field work is done by a small group of contract labor. INIAP officials made this decision because in recent years, labor demands were so high that the budget was unbalanced and dificult to maintain

INIAP has a team of technical professionals and administrators. Of the 663 employees in February, 1986, 52% were technical personnel and 48% had administrative functions (Table 14) Among the professionals working for INIAP, there are agronomists, animal scientists, veterinarians, economists, chemists, and others (Table 15); 33% of them have postgraduate degrees (Ph.D. and M.Sc) (Table 16).

The inability to retain high-quality professionals, especially those with postgraduate degrees, has produced permanent instability in INIAP. A large number of former technical personnel at INIAP are now working abroad, in national private businesses, or at universities within the country.

INIAP gives special attention to the training of its technical personnel. There is a plan for training two professionals at the Ph. D. level and 30 at the M. Sc. level for the period 1985 1990 funded by PROTECA (Table 17).

7. Impact of INIAP

INIAP has had some successes in its research program: has delivered more than 100 improved varieties of some species along with technical recommendations for cultivation. It also has available some families or lines as raw material for the development of new improved crops for future use In the livestock sector, INIAP has accumulated information on management of dairy cattle, dual purpose cattle and swine. At present, INIAP delivers breeding stock of swine, cattle, guinea pigs and rabbits.

According to INIAP data; the prospects of improving yield performance in many crops are good (Table 18). With certain exceptions, however, these results have not had the expected impact in the sector. Even with incomplete data, there are only a few crops where better performance has been obtained by unit area (See Table 18). If these data are accepted, recognizing data limitations, the impact of INIAP has been limited, especially in products for domestic use.

TABLE 14. COMPARATIVE BUDGETS FOR THE AGRICULTURE AND LIVESTOCK SECTOR, 1981—1985.

Item	★ 1985	★ 1984	1983	1982	1981
			(thousands of sucres)		
General budget	144,151,888	107'750.000	75'800.000	64,770,000	55,800,000
Agriculture and livestock sector budget	5,822,012	4,707,396	5,292,931	4,448,144	3,941,728
MAG budget	2,206,133	1,384,634	1,616,825	1,418,109	1,285,388
Special agencies	3,615,879	3,322,762	3,676,106	3,030,035	2,656,340
INIAP budget	529,891	540,137	282,964	324,059	347,328
PERCENTAGE OF THE AGRICULTURE AND LIVESTOCK SECTOR'S BUDGET					
Agriculture and livestock sector	4.0	404	7.0	6.9	7.1
MAG, agriculture and livestock sector	37.9	29.4	30.5	31.9	32.6
Special agencies	62.1	70.6	69.5	68.1	67.4
INIAP	9.1	11.5	7.2	7.3	8.8

SOURCE: Official Registry

★ Asking budget.

TABLE 14. PERSONNEL AND BUDGET OF INIAP, 1985.

Item	PERSONNEL			BUDGET		
	Administrative	Technical	Total	Current Expenses	Operational and Capital Expenses	Total
	(number)			(sucres)		
RESEARCH	318	345	663	804,144,951	110,350,019	914,494,970
INIAP (%)	48	52	100	88	12	100

NOTE: The detail of personnel does not consider workers who departed (677) or vacancies (22) that existed December 31, 1985.

The detailed budget includes S. 220,000,000 paid to 628 workers who were fired in December 1985.

TABLE 15. HUMAN RESOURCES AT INIAP, 1985. 1/

Research Station	AGRONOMY					VETERINARY			SOCIAL SCIENCES, OTHERS						ADMINISTRATION AND SUPPORT SERVICES							Total
	PhD	MSc	AE	Stat	Agr	MSc	MV	DMV	Agr	MSc	Econ	AE	Chem	Journ	Stat	MSc	AE	Law/ Econ	Gen Arch	Srv	Laborers	
	(number)																					
Central Administration	1	2								4		4		4	1	1	1	7	5	56		86
Santa Catalina	2	103	50	12	37		6	1	3	1		3	3			1	1		1	71		205
Pichilingue	1	10	15	4	15		1					1				2			1	50		123
Boliche		13	18	1	6		3		1			2	1			1	1		1	69	45	136
Portoviejo		6	21	1	5		2				1					1	1		1	38		77
Santo Domingo		5	5	1	9	1			1								2			25		49
Napo Payamino			7	2	5											1				9		24
Chuquipata			6		2											1				8		17
TOTAL	4	49	122	21	19	1	12	1	5	5	1	10	4	4	1	8	6	7	9	313	45	727

ELABORATION: CCT Dept. INIAP

SOURCE: Personnel Dept. INIAP

1/ AE = Agricultural Engineer; Stat = Statitician; Agr. = agricultural Technician; MV = Medical Veterinarian; DVM = Doctor of Veterinary Medicine; Econ. = Economist; Chem = Chemist; Journ = Journalist; Arch. = Architect; Law. = Lawyer.

TABLE 16. TRAINING LEVEL OF THE TECHNICAL PERSONNEL OF INIAP. FEBRUARY 1986. 1/

Research Station	Ph.D.	M.Sc.	AE	AS	DVM	Econ.	Chem	Other	Total
Central Administration	1	6	5			1		10	23
Santa Catalina	2	15	53	2	6		3	1	82
Boliche		15	21	3			1	1	41
Pichilingue	1	12	16		1			1	31
Portoviejo		8	21		2	1		1	33
Santo Domingo		6	7						13
Chuquipata		1	6						7
Napo Payamino		1	7						8
TOTAL	4	64	136	5	9	2	4	14	238

ELABORATION: CCT. INIAP.

SOURCE: Personnel Dept. INIAP.

1/ AE = Agricultural Engineer; AS = Animal Scientist; DVM = Doctor of Veterinary Medicine; Econ = Economist.

INIAP's effort in professional training represent a very strong investment in the agricultural and livestock potential for the country. Unfortunately, INIAP has not yet benefited from this investment due to the constant departure of trained professionals. On the other hand, since 1962 INIAP has offered a good number of courses (310) and field days (270) with the purpose of transferring technological information to different levels of interested people. Impact of all these efforts has been diluted due to various factors. INIAP has had relatively good success in the production and distribution of seeds, propogation of materials, breeding stock, etc. These activities although an important part of a development strategy, cannot be considered as research "per se".

All evaluations of INIAP's program have been internal without contributions from indigenous and external private and public entities working with agriculture and livestock activities. It is worth pointing out that any evaluation is worthwhile only when a system of rewarding productivity exists.

B. EXTENSION

1. History

Technology transfer and technical assistance in agriculture and livestock, have been and continue to be one of the main obligationss of the national government, through the agencies of the Ministry of Agriculture and Livestock. Since agriculture and livestock production is so important, the national government has offered many kinds of assistance for improving production and increasing productivity. A brief chronology of the evolution of agricultural extension or technology transfer follows:

1901: Very minimal assistance programs to farmers were carried out by technicians belonging to the Ministry of Development and later Public Instruction.

1935: The Ministry of Social Affairs, Agriculture and Commerce established agencies for agricultural services in some cities.

1938: The Ministry of Agriculture, Commerce, Industries and Mines added technical personnel, placing them in all provinces.

1944: All inherent functions of the agriculture and livestock sector became part of the Ministry of Economy through the Technical Agricultural Board.

: The Institute of Production Development was created to direct plans for increasing production by the establishment of 22 projects. One them was the use of para-professionais widely dispersed throughout the country (Servicio Ambulante Rural).

All of this period is characterized as being a set of service oriented activities without giving any attention to the education of producers.

1952: An agricultural extension division was established, through a bilateral agreement between the Government of Ecuador and the United States, with assistance from the Cooperative InterAmerican Service of Agriculture (SCIA).

195.: Agricultural extension services were established, with the Ministry of Development and the Cooperative InterAmerican Services of Agriculture sharing responsibilities. To backstop the extension agents they formed departments of specialists, techical communication and administration. The establishment of

TABLE 17. SUMMARY OF THE AGRICULTURAL PUBLIC SECTOR PERSONNEL WHO ARE RECEIVING ADVANCED TRAINING, 1985 -- 1990.

Ph.D.			M.Sc.		
NUMBER	PLACE	SUPPORT SOURCE	NUMBER	PLACE	SUPPORT SOURCE
1	USA	AID	2	USA	AID
1	USA	Swiss Gov.	2	Puerto Rico	AID
			1	Costa Rica	CIID
			12	USA	PROTECA
			8	México	PROTECA
			2	Costa Rica	PROTECA
			2	Holland	PROTECA
			1	Brazil	PROTECA
TOTAL 2			30		

SOURCE AND ELABORATION: CCP, INIAP.

TABLE 18: EXPERIMENTAL AND NATIONAL PRODUCTIVITY LEVELS AS ESTIMATED BY INIAP AND CGIAR 1/.

Crop	EXPERIMENTAL INIAP	EXPERIMENTAL CGIAR	NATIONAL AVERAGE INIAP	NATIONAL AVERAGE CGIAR
	(metric tons/ha2/)			
Wheat	4.1	2.7	0.95	0.86
Barley	4.8	5.2	0.69	0.68
Maize	4.5	4.5	0.71	0.59
Dent maize	4.9	5.9	1.10	0.91
Rice	7.3	7.3	1.30	1.00
Soybean	2.7	2.7	1.10	1.09
Sesame	1.4	1.4	0.87	0.68
Peanut	3.6	3.6	0.82	0.86
Beans	2.3		0.46	
Cocoa	1.4	1.1	0.30	0.27
Cotton	2.5	2.5	0.70	0.81
Coffee	2.7	2.3	0.40	0.23
Potatoes	27.3	3.0	9.50	
African palm	6.0	3.0	1.10	1.50

1/ Consultative Group for International Agricultural Research.
2/ Average yields of recommended varieties.

SOURCE: INIAP and International Statistics Institute Potts H.C. Dec. 1, 1975. Seed Program for Industrial Development in Ecuador. A Rep under AID/ta-C-1219. Mississippi State Univ. Mississippi.

the agricultural extension service drastically changed the transfer of agricultural technology from service activities to educational programs. This change in the technical assistance system led officials to prepare technical personnel in the use of this new philosophy and methodology.

Without forgetting the development and production of agriculture and livestock, especially for export and domestic products, agricultural extension introduced home economic and youth programs. The methodologies implemented by agricultural extension had a positive impact and led to the establishment of extension programs for banana, rice, coffee, cocoa, wheat, sheep, and others.

: The United States help ended and all agencies became part of the Ministry of Development, which later was transformed into the Ministry of Agriculture and Livestock.

1968: The Ministry of Agriculture and Livestock decided to concentrate all its programs within one office, establishing the General Board of Agriculture and Livestock Extension.

1973: The Andean Mission of Ecuador was joined to the Office of Agricultural Extension, establishing the Rural Development Office which absorbed agricultural extension.

With this new model, technology transfer was effected on a small scale, directed to small farmers organized in cooperatives, communes and other types of associations. Farmers who were not organized, especially small and mid-size farmers, were offered technical assistance and programs from the Ministry of Agriculture.

1985: The Ministry of Agriculture and Livestock issued a resolution establishing the current structure.

2. Present Status of the Public Sector

a. Institutions.

Based on current laws, all public sector agricultural and livestock activities are the responsibility of the MAG and associated public sector entities.

b. Description of Principal Programs.

1) Provincial Offices

The provincial offices along with the national programs form the basis for technology transfer since they have the technical personnel. The main objective of the provincial offices is to increase the production and productivity of agriculture and livestock through a well-programmed technical assistance program. Elaboration of work programs is made annually by establishing activities and goals according to their importance for specific crops or livestock production in specific provinces.

Because there are no short — or long — programs, it is difficult to evaluate project progress and many times activities are repetitive, year after year. In addition farmers have no participation in programming.

Farmers are the persons who benfit from all programs, whether small, medium-sized or large-scale farmers whether as individuals and as they are organized in communes, cooperatives, associations, etc.

Theoretically, the work methodology being used is based on that established by agricultural extension, which is method demonstrations and results, field days, short courses, seminars, and published materials such as newsletters. Some technicians offer assistance in one specific program or crop, and others provide general assistance.

Coordination with research and education is limited. Closer relationships exist when research is done in provinces where there is an experiment station.

2) Technical Offices

Technical offices in the Sierra, Amazon, and Coastal regions, as well as the Galapagos, execute policies, plans, programs, and projects for increasing regional production and productivity. They also collaborate with provincial offices and national boards in executing plans for agricultural and livestock development, promoting the organization of producer's associations, and training technical personnel through courses, seminars, field days, and other methods of technology transfer.

At this level, coordination between research and extension is significant, but coordination with education is limited.

3) National Programs

Five national programs are part of the Coastal Subsecretariat: National Cotton and Oil Seeds Program; National Rice and Rice Mills Program; National Banana Program; National Cocoa Program; and National Coffee Program. The Animal Healt and Agricultural Mechanization Programs, the Farmer Training Institute, and the National Forestry Office are directed by the central administration.

Beneficiaries of these programs are mainly small and mid-sized farmers, especially those organized in cooperatives, communes, and associations.

Work methodology is based on that defined by agricultural extension, primarily demonstrations, field days, and short courses.

Coordination between research and education is limited, although some programs maintain agreements with INIAP for certain research.

4) Related Agencies in MAG, Technology Transfer Responsibility

Within the functional organic structure of the Ministry, there exist appointed entities, created with the purpose of developing a region or zone of the country.

5) Other Institutions from the Public Sector, Wich Participate in Agriculture and Livestock Technology Transfer

Two institutions from the public sector have assistance programs for the rural sector without being part of the Ministry. They are the Integrated Rural Development Subsecretary and FODERUMA.

The Integrated Rural Development Subsecretary is in charge of organizing, maintaining, and directing projects of Integrated Rural Development (IRD) mainly in areas where the population has few economic resouces but do have the potential for changing their status.

This subsecretary coordinates with government and local institutions to obtain their participation from project elaboration to execution and evaluation as well as required economic and technical help. Some projects have international funding, such as from the World Bank, Interamerican Development Bank, AID, etc.

FODERUMA is part of the Central Bank of Ecuador, and its main objective is to provide loans to the rural poor. These loans are delivered by legally established rural organizations for specific development projects.

3. Present Status of the Private Sector in Agricultural Extension

Various private organizations are in the process of assistance and technology transfer for several communities, some of them work ing with agriculture and livestock. The following organizations are included:

- Ecuadorean Center or Agricultural Services (CESA).
- Andean Center of Popular Action (CAAP).
- Rural Training and Education Center of Azuay (CECCA).
- Ecuadorean Loan Fund (ECLOF).
- Regional Cooperative of Agricultural and Livestock Services (COORSA).
- Ecuadorean Fund for Popular Progress (FEPP).
- United Brethren Foundation of Ecuador (FBU).
- National 4 F Foundation.
- International Plan.
- Short-Cycle Producers' Association (APROCICO)

The private sector entities were created to accomplish specific objectives for helping the rural sector. Most of the time these services are provincial or regional in area, and in very few cases assist on the national level.

Economic support in general comes from international grants and assistance. These activities are usally focused on production improvement and coordinated through national institutions. Sometimes these activities offer credit to farmers in support of their projects.

C. AGRICULTURAL EDUCATION

1. Technical Education in Agriculture: High School Level

a) Historical Background and Review of the Current Status

The first agricultural high school was established in Ambato in 1903. Its name was the Fifth Agricultural Normal School. In 1927, Salesian priests founded a school in Cuenca for training young men from the Amazon region in collaboration with the plan for Loja, Azuay, and Canar led by the Interamerican Cooperative Service of Agriculture. These educational centers granted a diploma with the title of Agricultural Practitioner.

The Agricultural Training Center was created in Otavalo in 1954 for farmers' children. It provided 2 years of training without conferring a title. Other such centers were created later. MAG administered these training centers, practical schools and high schools. Teaching was divided into theory and practice in the field.

At the same time, the Ministry of Education, through the rural normal schools taught agriculture. By 1957, some high schools were created in El Angel, Patate, and Chimbo. In 1971, the Ministry of Agriculture transferred the administration of all schools to the Ministry of Education.

9. Institutions

There were 195 schools of agriculture and livestock in 1985 (Table 19) of which 88% were government schools, 10% mission schools and 1% private. The first group is funded by the government. The second groups is funded by the government and the church. Types of schools include:

Technical high schools in agriculture and livestock with diversified cycle (10%).

Agriculture and livestock high schools, with diversified cycle and basic cycle (63%).

High schools, with basic cycle (3 years), agriculture and livestock diversified cycle (3 years) and other fields (27%).

Some technical high schools in agriculture and livestock have been raised to the category of superior technical institutes.

c) Academic Structure

The basic cycle is general for all high school studets. Its period is 3 years (Appendix 3). The diversified cycle is professionally oriented at the technical or intermediate level. Its period is also 3 years. At the end of the diversified cycle, students receive a title of "Bachelor" in agriculture, livestock, forestry, mechanization, farm management, and agriculture industries. The title of "Bachelor in Agriculture and Livestock" would let the student begin working or continue studying at the university level.

At the high school level, there is also a technical education post high school. Its objective is to provide Bachelors in agriculture and livestock with 2 years of intensive study in specific production areas, such as fruit and farm management.

d) Students

The number of students enrolled in the agricultural schools has increased from 2,434 in 1970 to 21,905 in 1980 and to an estimated 25,000 in 1985. However, education statistics indicate that students enrolled in agricultural schools constitute only 6% of total high school students and that 2% are matriculated in technical education, which includes industry, commerce, and other fields. The annual cost of each student enrolled in agricultural technical education for 1979 was S/ 23,000 (sucres).

During the period 1975-1984, 11,205 students graduated from agricultural schools. Considering that during this period an average of 90 schools were functioning, an estimated 12 students have graduated from each school during the school year, a low figure which results in a high cost per graduate (S/ 96,000) in 1979.

TABLE 19. AGRICULTURAL TECHNICAL SCHOOLS, 1985.

Type	Schools	Students	Teachers	Relation Stud./Schools	Relation Stud./Teacher
		(number)			
Agriculture	156	7446	1800	47.7	4.1
Forestry	4	90	26	22.5	[illegible]
Agr. mechanics	7	264	65	37.7	[illegible]
Farm. management	8	310	55	38.7	5.4
Agroindustry	16	685	142	42.8	4.8
Others	4	182	32	45.5	5.7
TOTAL	195	8977	2120	46.0	4.2

SOURCE: Table 4 — DIE
MEC — DET — PROMEET

e) Faculty

Agricultural school teachers are prepared in the areas of general culture, scientific education, and professional orientation. The subjects of general culture are handled by high school graduates in humanities (38%), bachelor degrees (13%), and Doctors of Education (6%). The subjects for scientific and professional studies are taught by agriculture high school graduates (30%), Ing. Agronomos (6%), Veterinarians (2%), and other professionals in various technical fields (5%).

f) Study Plans

Study plans for the diversified agricultural cycle include such subjects as general culture, scientific and professional studies with a total of 40 hours per week each of the three courses of the diversified cycle. Study programs establish 50% for theoretical aspects and 50% for practice. Each course has an average of 16 subjects.

g) Teaching Method

Teaching is subject to the amount of classroom hours available for each subject. Lectures are the most common method for teaching. Few schools possess audiovisual equipment and libraries to help the teaching process. Laboratory or field experience is limited to observation or very small short term studies.

h) Budget

The annual budget for agricultural schools is 10% of the total budget assigned for national education at the the high school level.

It is estimated that 61% of the budget for agricultural schools is assigned for salaries, 13% for general operational expenses, 4% for scholarships, and 22% for construction and equipment.

i) Facilities

The infrastructure of agricultural schools varies. Some schools have very good infrastructure, especially those which have participated in projects to strengthen high school education. The rest of the schools, most of them, have few facilities to offer. The same is true for laboratories and workshops.

All agricultural schools possess farmland for practical training, but most of these pieces of land (60%) have less than 10 ha. About 25% of the schools have farmland of 20 — 30 ha., and of these only half have some water for irrigation.

One can reach most of the agricultural schools by car, and communication is possible by telegraph or mail, on a more or less regular basis.

2 University Agricultural Education

a) Historical Background and Review of the Current Status

University agriculture education began in 1931 when the Agronomic School was established at the Central University of Quito. Two years later, the Veterinary Medical School was created in the same university.

In 1945, the University of Loja established an Agronomic School, and in 1948 the University of Guayaquil did the same. At later dates universities were created in Manabi, Machala, Esmeraldas, and other places, all including agricultural training. In 1949 and 1950, the schools of Loja, Guayaquil, and Quito consolidated into faculties of agronomy and veterinary medicine.

The private universities such as Guayaquil, Cuenca, and Quito and the Technical University of Loja established schools of agriculture. Catholic University of Quito closed its School of Agronomy in 1973.

The Schools of agricultural engineering were created at the universities of Ambato, Babahoyo, Riobamba, and Quevedo. There are also faculties of animal science in the technical universities of Esmeraldas and Riobamba. A School of Forestry was created in the technical universities of Esmeraldas and Quevedo.

There are no university programs for postgraduate studies in agriculture which would lead to a Master or Ph.D. degree.

On April 15 1973, the National Council of Schools in Agricultural Science of Ecuador (CONFCA) was created whose main objective is to unite the faculties of agricultural science in a system of coordinating faculty relations within the public and private sector of the country and abroad.

b) Institutions

By 1986 there were 29 universities and polytechnic schools duly approved by law. Of these 20, 15 offer 30 careers in agronomy (11); veterinary medicine (7); forestry (4); animal science (6), agricultural engineering (2); livestock management (1); and aquaculture (1). Selected universities have satellite programs such as the Forestry Engineering Faculty in Ibarra, which is an extension of the University of Loja; the School of Forest Engineering in Jipijapa, an extension of the University of Portoviejo; and Milagro, an extension of the University of Guayaquil. In Santo Domingo de los Colorados there is an extension of the Technical University EQUINOC (private).

Of the 14 universities offering careers in agriculture, 11 are public and 3 are private; these last three include the Catholic University of Cuenca (agronomy); Catholic University of Guayaquil (livestock management); and the lay college Vicente Rocafuerte in Guayaquil (agronomy). In total there are eight universities in the Coast and six in the Sierra.

State universities are free, private universities require tuition paid by the students.

Career duration (Appendix 3) is from 5 to 10 semesters, in fields and 6 years in 6 faculties. Graduates must serve 1 year as a rural technician to be able to progress into their career. In 1985, 35% of the graduates complied with this requirement.

Requirements for obtaining a degree vary among faculties, but in general a thesis is required after the complete study plan has been approved.

LIST OF UNIVERSITIES, FACULTIES AND SCHOOLS

UNIVERSITIES	DEPARTAMENT	SCHOOL
CATOLICA DE CUENCA (Private)	Ag. Science	Agronomic Engineering
CATOLICA DE GUAYAQUIL (Private)	Technical Education for development	Zootechnology (3 years)
CENTRAL DEL ECUADOR Quito	Agricultural Science Veterinary Science	Agronomic Engineer Medical Veterinary
E.S.P.O.CH.	Agronomic Engineering	Agronomic Engineering
RIOBAMBA	Agronomic Engineering Zootechnology Engineering	Agronomic Engineering Zootechnology Engineering
ESTATAL DE CUENCA	Ag. Sciences	Agronomic Engineering Veterinary Medicina
ESTATAL DE GUAYAQUIL	Agrarian Sciences Veterinary Science	Agronomic Engineering Veterinary Medicine
LAICA VICENTE ROCAFUERTE Guayaquil (Private)	Agronomy	Agronomial Engineering
NACIONAL DE LOJA	Agricultural Science	Agriculture Engineering
	Veterinary Science	Forestal Engineering
TECNICA DE AMBATO	Agronomic Engineering	Agronomic Engineering
TECNICA DE BABAHOYO	Agricultural Science	Agronomic Engineering
TECNICA DE MACHALA	Agronomy and Veterinary	Agronomic Engineering Medical Veterinary Aquaculture
TECNICA DE QUEVEDO	Ag. Science	Forestal Engineering Zootechnical Engineering
TECNICA LUIS VARGAS TORRES - Esmeraldas	Ag. Science	Zootechnical Engineering Forestal Engineering
UNIV. TECNICA (QUINOC) (Quito)		Technology

c) Students

The 30 careers of superior agriculture education conferred by the 14 universities had an enrollment of more than 4,500 students in 1983 - 1984. This an average of 151 students per career. This same year 3593 students completed their education and 261 were graduated.

During 1973 - 1984 matriculation varied by an average annual percentage of 15%. In 11 years matriculation grew from 1,850 to 4,560 students. Comparing this to the growth and development of other careers, is quite modest.

The average number of graduates per year during the last 11 years is 265 for all careers, with a majority in agronomy.

The average cost per graduate (at constant 1973 values) was S. 195,000 with a range of S. 7,000 for those graduated in agronomy at the Technical University of Manabi, and S. 330,000 for those graduated at the Technical University of Esmeraldas. Average cost per student (at constant 1973 values) was S. 38,000, a very high cost, but justified for a Technical career (Table 20).

d) Faculty

In 1984 there were 707 teachers for the 30 careers in agricultural science: 20% were full time, 12% half time, and 46% part time or per class hour.

Of the teachers 47% were Ing. agronomos and 21% were veterinary DVM; the rest were civil engineers, architects, forest engineers, animal scientists, economists, administrators, and other educators. Eighteen percent of the teachers and master's degrees, but very few had Ph.Ds.

Salaries vary according to the various universities, but are generally low (Table 21).

e) Study Plans

The agricultural science faculties have inflexible and semi-flexible study plans, which are applied by the academic year studies or by semesters. Some faculties apply the subject systems and others the credith systems. (Appendix 3).

Three faculties have divided their core structure in stages: an initial stage in basic science (2 years), a second stage in aplied science (2 years), and a final stage in professional orientation, including the thesis (2 years). The faculties of agronomy in Quito, Estatal de Guayaquil and Manabi also grant specialized degrees.

The Central University of Quito, the University of Loja, the Technical University of Babahoyo, and the ESPOCH dedicate their 6th year to research (thesis) as well as practice and seminars before students obtain a professional degree.

All faculties have a 35-hour schedule per week, which varies between theory and practice from 20 to 43 hours.

f) Teaching Tethod

There is an excessive use of lectures, with almost no practical laboratory work. More attention is given to theory than practice and students very seldom work directly in the field.

TABLE 20. OPERATIONAL BUDGETS AND AVERAGE ANNUAL STUDENT COSTS FOR SELECTED UNIVERSITIES, 1973-1983 (CONSTANT PRICES 1973).

UNIVERSITY	FACULTY	YEAR											AVERAGE COST PER STUDENT
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	
		(sucres)											
Espoch.	Animal science	39,980	26,101	43,800			43,620	24,990	19,040	22,870	25,570	20,790	29,540
Cen. Quito	Ag. science					35,760	38,360			25,050		21,045	30,050
Tec. Ambato	Agronomy		49,980	69,520	80,910	50,840	45,745	43,827	22,375				53,285
Tec. Babahoyo	Ag. science					38,849	34,462	42,160	52,645	50,801	46,013	37,507	43,615
Tec. Machala	Agronomy	20,333	19,240	15,227	31,033	21,772	29,352	25,181	41,644	30,081	50,762	17,591	25,297
Tec. Manabi	Ag. engineering		30,254	25,006	20,277	18,240	22,539	37,425	50,608	27,809	72,217	54,085	41,157
Tec. Manabi	Ag. science		10,846	8,146	10,605	9,172	10,363	12,480	15,516	21,461	32,545	19,787	15,383
Tec. Manabi	Vet. science	19,064		16,670	21,047		27,405		61,266	52,202	55,100	45,221	39,845
Tec. L.V. Torres	Ag. science		32,502	47,616	59,873	59,297	44,944	109,440	56,004	64,274	116,664	40,641	60,471
											AVERAGE		37,627

SOURCE: Fundacion Jose Joaquin de Olmedo.

TABLE 21. MONTHLY SALARIES FOR SELECTED UNIVERSITIES, 1973-1984.

UNIVERSITY	DEPARTMENT	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
		(thousand sucres)											
Espoch.	Ag. Engineering	1,723											
Espoch.	Animal Science	1,513	1,723	3,296			6,591	7,294	7,593	12,570	18,864	22,376	25,185
Estatal Cuenca	Ag. Science											14,757	14,750
Estatal Guayaquil	Ag. Science									22,738	30,100	39,853	61,645
	Veterinary Science									21,242	27,385	31,216	47,556
[illegible]	Ag. Engineering												
Tec. Ambat	Agronomy	1,150	2,790	5,145	7,801	8,934	10,000	14,641	8,907	22,683			
Tec. Babahoyo	Ag. Science	1,953	2,720	3,901		13,117	10,207	12,440	10,710	15,982	19,407	22,472	23,393
Tec. Machala	Agronomy and Vet.	4,634	4,320	7,367	6,570	6,640	9,568	13,018	24,360	31,688	39,201	43,611	
Tec. Manab	Ag. Engineering		2,970	3,672	4,826	5,114	5,177	7,095	10,555	11,904	12,975	14,871	18,540
	Ag. Science	2,690	3,473	4,172	6,549	6,875	6,771	7,402	12,547	14,009	19,826	23,447	
	Veterinary Science	2,841		3,155	4,241		6,290		12,357	13,660	18,880	24,470	
Tec. L.V. Torres	Ag. Science		9,175	9,020	9,691	18,015	15,781	16,659	26,164	31,232	35,899	39,177	51,619
Tec. Quevedo	Ag. Science												

SOURCE: Fundacion Josh Joaquin de Olmedo.

The importance given to the thesis in general is very high, although the quality of the research varies from university to university.

The concept of the Año Rural is mainly to give graduates the opportunity to complement their studies and to practice under actual circumstances. During 1985, 35% of the graduates were required to perform this service. Experience during this year has been shown to be positive. This is financed by the Ministry of agriculture (MAG).

g) **Research**

Research is mainly performed through work for the thesis. Plans for research in some faculties are very limited; other faculties have agreements with CONACYT for the fullfillment of the research projects. INIAP has a scholarship system for graduates for their thesis work. University budgets for research are very low or non-existent. A large percentage of the topics researched are duplicates of INIAP work.

Several faculties have signed 72 agreements for the execution of research projects and/or services with national and international agencies. Furthermore, funds for research are available, subject to the presentation by each of the universities of their research projects.

h) **Extension**

The faculties of agricultural science do not possess an extension service (education to the farmer); however on rare ocassions they do provide such services. Faculties provide for their areas of influence through a series of services such as soil aialysis, veterinary clinics, plant health, milk analysis, food analysis, ,bacteriological analysis, mechanization, family services, analysis of the banana stock, and building plans for farm construction.

In most cases the services offered by the faculties are paid by an agreement with some institution of the area. The values charged try to cover the operational cost of the service.

i) **Physical Resources**

In most case, agriculture education institutions have their own buildings, which range from satisfactory to very satisfactory. To some degree, they also possess laboratories and greenhouses. All faculties have small farms used for practical experience in the field. There are 23 farms or experiment stations, of different sizes.

Quito University has a library with 7,000 books; Loja, with 3,500 and ESPOCH, with 3,000; the rest provide very little help in this educational support service.

j) **Budget**

Information on the budget is very difficult to analyze in terms of exact numbers, since the faculty assignments are involved at an administrative level in each university. Even though the studies are incomplete, the following can be stated.

The budget for the FCA are always limited especially because the university budgets are limited and the faculties are at a disadvantage because they are so small. The FCA has at its disposal the assigned budget and income from additional sources as farm produce, sale for services, or specific agreements for especially assigned sales. These sales are not so important, but they help in the function of FCA. By law, these additional funds should be deposited in the treasury of the respective university (common fund) and later used as required by the faculty.

CHAPTER IV

ANALYSIS OF AND RECOMMENDATIONS FOR THE REE SYSTEM

A. A SCIENCE ORIENTED SYSTEM

Technology is basically a new form of using resources for production of a product or service. The application of scientific principles to agriculture implies a search for and transfer of new technological options over and above an applied effort that is concentrated on utilization of existing technology.

The overall recommendation is to change the Ecuadorean food production strategy from a major dependence on increases in land under cultivation or in irrigated land to a much greater dependency on science and technology. Thus, the administrators of the education, extension and research components must expand their philosophy from a focus that is primarily applied in nature to one more firmly based in adapted and applied science. The success of this change in strategy for production of food requires:

1. A sustained commitment on the part of the political and scientific leaders,
2. A recognition that specialists in the different agricultural disciplines should substitute for generalists,
3. A system of promotion and compensation that attracts and retains the best professionals in the agricultural disciplines,
4. An establishment of priorities for the utilization of this professional talent with respect to:
   a) the objectives of the agricultural sector,
   b) the crops and animals where the technology will be applicable,
   c) those locations that have natural resource advantage,
   d) the absolute requirement for knowledge of scientific principles,
   e) education and training based on scientific principles in those areas where the necessary human capital is limited, and,
   f) the general establishment of priorities for an REE system that can be maintained with limited external support.
5. A recognition that technological change cannot be a major force in the solution of those problems that confront smallholders (minifundistas). On the other hand, an appropriate proportion of the resources of all the components of REE system should be directed toward all user groups.

The proposed change in emphasis designed to increase the productivity of the agricultural sector describes an evolutionary process. There are elements in the REE strategy of immediate effect which serve as catalysts for the mid - and long-term effects of the strategy. Many of the recommendations in this report are short-term (from 1 to 5 years) in nature and will form the basis for continuous growth.

The effect of a strategy oriented toward science can be measured through the gradually increasing production of food and fiber caused by an increase in productivity. Another measure will be the more balanced distribution of public funds between the options of expanded arable land, expanded irrigated land and the REE system.

In order to achieve these objectives there has to be a strategy to identify an integrated set of critical elements among the disperse research, extension and education institutions. These critical elements are:

1) a high-priority institution dedicated to research with linkages to the education entities that serve to train future technologists in research and with the components of extension that are dedicated to the effective transfer of technology.

2) a selective emphasis on education with an element that changes the emphasis toward scientific principles, an element that trains technologists as research and extension leaders, and element that involves carefully selected professors who may complement the national research system;

3) a set of extension elements, both pubnic and private, that have as their goal the improvement in the kinds of extension appropriate for identifield user groups, with strong linkages to research and to education so that future extension specialists and administrators may be trained.

B. LIMITATIONS

The identified constraints are discussed below and related to each of the components of the REE system.

1. **Research**

a) **Research Plannig and Evaluation:**

Planing of research programs functions at two levels; at the level of a national policy whose end is the prioritizing of programs directed to diverse crop and livestock enterprises and the level of resource distribution within each program (cereals, fruits, cattle, etc.).

(1) At the national level the principal factors that currently limit or impede rational planning are the following:

The absence of a defined set of priorities makes the efficient use of contributions of national or international donors extremely difficult.

The lack of a mechanism for systematically including the influence of prices, supply/demand an the external market on the various crop and livestock enterprises.

The fact that INIAP is not sufficiently isolated from changing political pressures.

The lack of a mechanism to evaluate the feasibility of actually solving a problem via research in the short or medium-term.

The lack of a definition of the clientele for which the technology is to be developed.

The lack of a clear distinction between the responsibilities of INIAP and those of other public or private organizations for development activities such as the production and distribution of certified seed or breeding stock in livestock.

(2) At the institutional level the rational planning and distribution of resources is sometimes limited by various factors:

The absence of a planing entity at the institutional level that is charged with prioritizing problems, the planing of activities, and their ultimate evaluation. This planning unit would also aid in the definition of specific research activities, separating these from those responsibilities that correspond to state or private development organizations.

The absence of a mechanism for involving the interested users in the planing of research.

The lack of sustained leadership by a professional who is both adequately trained and well experienced.

The fact that the first step in research should be the evaluation of the current state of technology at the field level is ignored.

The need to reinforce socioeconomic and anthropological studies, particularly those directed toward defining the motives and the conditions for adoption of new technology at the medium and small farm level.

The lack of an appreciation of the integrated nature of all biological systems that, at times, results in the researching of components that are not the most limiting factors and also carries the possibility of overlooking important interactions among the various components of a system, such as the rational use of various resources generated within that system.

The lack of coordination among the programs that investigate the different biological subsets or subsystems at the farm level which results in the inefficient use of resources; for example, not considering the possible complementary use of labor among different subenterprises or the tendency to not make maximum use of crop residues or industrial by-products, and the loss of grazing capacity (african sheep) that exist in some tree plantations.

The lack of a larger number of actual linkages among research, teaching, and the technology-transfer process which impedes the application of new technology.

Forgetting that research on itself is incomplete until the new technology is tried at the field level, thus blocks appropriate feedback from the field level to the researcher.

The absence of a systematic mechanism carried out by colleagues from appropriate disciplines or by external experts to evaluate the results of research programs.

The necessity to reinforce INIAP's capacity for the economic evaluation of various technological alternatives.

(3) At the program execution level there are several changes in the system of operations that should be suggested.

When it comes to planning, it is advisable to maintain the closest possible contact with international institutions toward the end that familiarity with the latest scientific and technological advances can be maintained. This will facilitate planning on a solid base with regard to the possible technologies available world-wide.

These will aid in improving the image of INIAP toward the end of increasing its support and also help to avoid duplication of forces with the consequent saving of resources.

B. Personnel:

(1) Despite the constant loss of trained personnel from INIAP to other types of employment, the institute actually has a good team of researchers who are relatively young, with good academic preparation gained either within Ecuador or internationally (Table 16). Some of these are competent leaders and have demonstrated the ability to plan, execute, supervise and evaluate not only their own work in research but also that of allied projects. Unfortunately, some weaknesses in varios aspects and situations exist that warrant discussion, the only motive being that of contributing to the improvement of the status of the national agricultural researcher and, therefore, to maximize his potential contribution in the search for solutions to the agricultural problems of the country.

The possibilities of retaining valuable and limited human capital are minimal given the actual state of things in INIAP. On one hand, the salary level is much too modest at all levels, which ultimately results in a brain drain toward other activities. It is difficult to understand the fact that the institute has dedicated a tremendous amount of resources to training personnel only to be ultimately incapable of retaining them, primarily because of the economic situation. On the other hand, the pyramidal structure of the salary schedule within INIAP makes it impossible for a researcher to pursue his productive research career without suffering economic loss.

(2) Under the current system and because of the low salary levels, researchers who demonstrate promise are "pushed" toward administrative posts because these carry with them a better salary level and superior rank.

A corollary to this problem is the fact that those researchers who have been forced into administrative jobs, and who for various reasons must give up these positions, cannot return to their former responsibilities. This is totally counterproductive and should be changed in order to preserve that class of researchers who, for various reasons, have occupied administrative posts.

(3) The need to continue aiding the postgraduate training for the research personnel for the country is obvious. However, it must be recognized that though many technicians in INIAP have been motivated via postgraduate studies of various types (short and long term) this has been the only opportunity available for their professional improvement. Moreover, some of those technicians trained overseas have seen this as a step toward increasing their employment opportunities, that is, as soon as their contract with INIAP is completed they seek employment elsewhere. In some cases, obtaining a postgraduate degree does not constitute an incentive for the technician because this effort is not recognized within the current salary schedule. For this reason, many professionals are reluctant to accept this type of training.

(4) Personnel who graduate from the faculties of agriculture in the country boast no specialization in the fields of research, extension or education.

In the absence of alternative mechanisms it would be desirable for INIAP to reactivate its Escuela de Egresados (post baccalaureate studies).

Though it is certain that the policy of employing newly graduate students as researchers has worked well for INIAP in the past, it is worthwhile to consider other alternatives that would permit, in the short term, the improvement of the level of science within its professional corps. Some of the technicians who have left INIAP, for reasons mentioned previously, have left vacancies in the professional team that have not been filled by the current personnel. On the other hand, there are Ecuadorian researchers of considerable prestige who currently are working in other national or international institutions that should be considered as potential candidates, once the future needs of the institute have been defined.

(5) The disruption caused by political intervention in the recruiting of research personnel must be mentioned. A researcher is a person with certain aptitude and scientific training. His education involves the long process of developing his professional and personal skills which implies many years of dedicated work. Therefore, it is counterproductive to permit the intervention of politics in the process of selecting and employing research personnel. This practice should be avoided at all times.

(6) In the case of field labor, two items must be mentioned. In the first place INIAP, for many years, has maintained an unnecessarily large labor force (677) that has eaten up a considerable part of any budget increase. This limits the flow of these resources to research operations. In the second place the constant demand of these workers for increases in salaries and benefits has further eroded the financial situation of the institute. The ministerial decision to change this system in favor of one which would use contract labor, with fewer people involved and for shorter defined periods of time, will permit scarce resources to be used for other important activities of INIAP.

c) **Financial Resources:**

There is no research organization in the world that has funds sufficient to satisfy all of its needs. However, the situation within INIAP is particularly dire because of limited financial resources. This limitation has been aggravated by various factors such as the change in the international economic situation (the fall in oil prices, unfavorable rates of exchange, etc.) but to a certain point there are also internal factors.

INIAP receives something less than 10 % of the total agricultural budget of the country. This is not very different from the situation in many organizations worldwide. Approximately 90 % of INIAP's budget is devoted to personnel costs (salaries, labor, etc.) which is considerably higher than that desirable. There is a possibility in the future that the operational budget will be improved, given the decision of INIAP to use contract labor rather than a permanent labor force. Despite this very positive move there are some problems remaining that appear to reduce the efficiency of operation of the insittute.

(1) Apparently there is no relationship between the budget and the established institutional priorities. In the same fashion, research programs do not have their own operational budgets, which makes it extremely difficult to calculate the cost of various activities. A cost/benefit analysis does not have much application in evaluating a research project but it is valuable to the degree that it helps in allocating what should be the investment in each program. In other words, the cost per program should correspond approximately to the priority of the institutional objectives.

(2) The matter of the salary schedule has been discussed in the personnel section. However, it is worthwhile to mention that although INIAP spends an extremely high proportion of its budget on salaries, etc. the salary scale has not been designed in such a form that it adequately serves the Institute either for recruiting for retaining trained specialists.

Although the adoption of a new salary schedule will represent a tremendous investment on the part of INIAP, the more important factor is restructuring the schedule in such a form that it can be used as a tool in recruiting and to recognize productive service to the Institute, without forcing the investigador to accept administrative responsibilities in order to earn a reasonable wage.

(3) According to our calculations it appears that INIAP spends about 30% of its operational budget in development activities; that is to say, those activities outside the area of research such as providing breeding stock to livestock producers, seed or planting stock for fruit trees, etc. There is no question but that INIAP should produce seed, perhaps to the foundation or registered level (based on the national system), in the same way as improved livestock breeds, but the large-scale production of such improved material and its distribution should be the responsiblity of other organizations.

Even more so, the sale at reduced prices of such materials is not the obligation of INIAP. If it is a matter of sectorial policy this activity should be the responsiblity of an organization created for such a purpose. In our opinion it would be even better to provide incentives to the private sector to the end that it would assume this role in the transfer of technology.

(4) Another problem is also discussed the section on Planning. In a certain sense it is a question of trying to do too much with too little. INIAP feels obligated to do everything for everybody, based on the argument that "nobody else is doing it". It is worthwhile to point out that this last rationale in no sense is justification for any program within the Institute.

(5) Across the years INIAP has received a considerable quantity of external help from both national and international institutions. However, these funds have no constituted an effective assistance to the Institute for the simple reason that they have not been coordinated. That is to say that INIAP has not established priorities and not insisted that the interests of the donors match those of the Institute in obvious and direct fashion. With disperse objectives and ill-coordinated grants, the impact of such aid has not functioned to the benefit, the prestige, or the professional progress of the Institute.

(6) There are some bookkeeping mechanisms that, instead of helping the work of the researcher, actually create barriers. If such mechanisms (paperwork) are of institutional character or if their origin is at a higher level, they appear counterproductive and inefficient as much in the sense of the use of funds as in the progress of the work. The whole administrative/bookkeeping system of INIAP should be restructured with the researcher in mind. Effective and productive research is the goal of the Institute. Anything that dilotes that objetive should be changed, not in favor of the administration or the bokkeeper, but in support of the institutional objectives.

In this way not only budgetary flexibility in the movement of necesary documentation but also the ease of use of money by those actually responsible for research should be modified so that both budget and time can be used in the most efficient from.

d) Infrastructure for Agricultural Research:

As a result of various internal and external assistance programs, agricultural research has built up infrastructure which appears to be adequate in many senses and appropriate to the current and immmediate needs of the Institute. However, it is worthwhile to point out some aspects that can be improved. Following is a discussion of the areas that are considered adequate, and some of those that are currently inadequate to the needs of the institution.

(1) Physical Facilities. In general the availability of seven experiment stations and several farms within INIAP, the availability of land, of laboratories, of storage facilities, etc. is adequate.

However, there are some problems with respect to equipment in terms of both the field (vehicles, tractors, etc.) and in the laboratory. In large part the problems are those of maintenance and are brought about by the age of the equipment, lack of spare parts, inexperience of local technicians with various instruments and pieces of equipment of foreign origin, and a budget inadequate to support timely maintenance and repairs.

(2) Library and Bibliographic Services. In order that professionals can stay current with scientific advances it is indispensible to have access to at least three types of reference material: scientific journals, books, and bibliographic search services. In INIAP the number of current subscriptions is inadequate to the needs of the research corps. By the same token, the budget assigned to buy new subscriptions or new books is minimal.

With regard to access to bibliographic services it is necessary to point out that this is extremely restricted and not used because INIAP has only a few linkages of this type (AGRINTER, AGRIS) which have been available only recently.

e) **Linkages:**

One of the most serious problems that INIAP confronts is the fact that, in a sense, it works in isolation. That is to say that there exist no mechanism, apart from the transfer of its results (technology), that to a certain degree it lacks input information and material from abroad, and that it suffers from a type of inbreeding at several levels (technical, administrative and financial) which eventually affects the feedback of information and the realistic formulation of appropriate objectives.

(1) With the exception of the PIP there are no ways to assure the constant flow of information from INIAP to the used. Not excepting the publication of folders, holding field days, and teaching short courses, the diffusion of new technology is very sporadic and depends too much on personal contact.

The effects of the current situation are that many programs operate with unrealistic objectives, that sometimes the professionals do not know the real agricultural problems of the country, and for this reason the Institute suffers from a lack of sources of both information and support on every sense.

(2) One problem that concerns INIAP considerably is that of the munifundista. With strong linkages to all means of technology transfer, including civil actions and the private voluntary organizations, INIAP can relieve itself of this heavy responsiblity.

(3) Another possability with regard to linkages is that with the educational sector. Cooperation with the vocational schools, the institutes, and the universities for research work as well as for verification trials would enormously enhance the image, the impact and the efficiency of INIAP. Institutional prestige is a precious treasure. INIAP must increase and protect it, using all the means at hand. With a little bit of imagination and care in choosing advantageous linkages, the Institute can markedly increase its image and credibility.

(4) There are, and have been, linkages with international organizations. However, it appears that these have not been used to greatest advantage. It is not just a question of such granting agencies as GTZ, IDRC, AID, etc., but also those like CIAT and overseas universities. All of these institutions can serve the Institute not only as sources of financial aid but also for genetic material, new information, new methodologies, research fellowships, and for short courses. A researcher can not work in isolation. With few exceptions he lives by means of contacts with colleagues. It is in the best interest of INIAP to develop and support all possible contacts of this type. To deny this fact is to lose professional proficiency.

(5) No program can function in isolation, unless at tremendous cost. There are always essential services that can operate in support of several programs at the same time. It is not recommended, for example, that an entomologist work with 10 different crops but he certainly could work in such related programs as maize and sorghums, with the cereals, etc. The point is that, with the rational use of linkages, the Institute can at one and the same time extend its influence and efficiently utilize professional services at lower cost. It is a question of locating experts in the appropriate agricultural disciplines, in the private or the public sector, whose interests correspond to the objective under consideration.

All professionals are proud of their knowledge. It is sensible and advisable to take advantage of this pride and capacity, in whatever institution, in order to use them in favor of INIAP.

(6) Finally, linkages of all types improve the elimination of duplication of effort and, at the same time render more efficient the use of available resources. For example, under the current system it is possible to find an experimental program, a PIP, and a National Program of MAG each of which will have a verification trial or a demonstration with the same crop in virtually the same location with almost the same treatments without anyone knowing what the other is doing. It is obvious that this possibility represents a tremendous loss of resources. Open lines of communication, that is to say linkages, will avoid in simple manner such loss, and at the same time, will make possible more work with broader impact for each of the three entities.

The scenario mentioned above is not difficult to imagine, and by the same token avoidance of such a situation is not difficult. It is only a question of the establishment of functional and efficient linkages.

2. Extension

It has been said that in reality there is no such thing as a true extension service in Ecuador. However, technology transfer based on certain extension principles and methodologies is being done. The group of professional and technical people distributed at the national level have a very positive attitude and are prepared to assist in the improvement of the technical-outreach system which is a strong factor that will aid in the incorporation of new strategies at the rural level.

MAG has the basic physical and human structure that, along with the appropriate research linkages, would permit the establishment of a joint program that, if appropriately coordinated, will satisfy the demands of the producers. The establishment and implementation of various agricultural development programs by MAG through its provincial offices, national programs and associated entities has contributed to the fact that some farmers have confidence in agricultural technology and support the work done in their best interests. Some farmers are organized into groups such as cooperatives, communes, cottage type firms, producer associations, etc. This should facilitate the implementation of technology transfer programs. However, the fact that such clientele groups may be readily identified has not been used to advantage when planning outreach programs.

In the agricultural extension sector various problems that limit the efficiency in the transfer of technology have been identified and have been discussed in general form. These problems can be grouped as administrative problems or short falls, methodological pro-

blems, technical problems, institutional-relationships, and problems of financial policy. These are discussed in greater detail as follows:

a) Administrative Problems

Perhaps the greatest single administrative problem identified is the lack of short--and long--term planning, failure to establish priorities and the complete absence of any subsequent evaluation system. As suggested earlier, the identification of specific target populations, the involvement of those groups in planning and programmaing, and the structuring of programs (and methodologies) appropriate to each clientele group appear to offer obvious advantages to the extension organization.

The demand on the part of the higher authorities for a lot of paperwork surveys, censuses, price-control regulation, plans of work, etc. dilutes the time available for an extensionist to work with the farmer.

Apart from recognition of the need to have personnel in the field, there is a relative excess of agents located in urban areas (provincial capitals), decreasing the time that they can be present in the rural communities along with the farmers. This administrative error results in increased service costs due to the need to make round trips between the cities and the appropriate work sites. On the other hand the posting of technicians in the large urban centers results in the fact that agents tend to visit farms that are close to town or work with farmers who enjoy better facilities or better education to the detriment of those farmers who may have greater needs.

The presense in the extension service of professionals who have no rural background or no knowledge of agriculture results in the impression that extension is not really dedicated to its objectives and that extension plays no important role in resolving the agricultural problems of the country.

The naming of extension directors who have neither the training or the experience necessary diminishes the dedication of the service to its true objectives and creates various problems and conflicts within the system.

The unrealistic regulations that govern the use of vehicles means that the technicians cannot maintain contact with farmers at times or on days when it is most practical to do so because they quite often are after the general eight-to-five workday. This problem is particularly worrisome when it impacts on night meetings and field days with groups of organized farmers.

b) Methodological Problems

It is true that the field professionals use some extension methods for the transfer of technology. However, because of lack of familiarity with the total range of methods available, they are not used either in the planning of field work or in the actual execution of extension activities.

The principal methods used are demonstrations of method (such as seeding systems), demonstrations of results (such as yield trials), field trips, short-courses, conferences, seminars and field days. Little use is made of audiovisual techniques, bulletins or radio programs. The use of a combination of methods in the process of transfer is very limited. Therefore, the impact in the adoption of new technologies is greatly diluted.

Without denying the importance of the so-called technology packages, at times these create methodological problems because they presuppose a homogeneity in the rural environment with regard to physical conditions, economic situation and cultural level of the farmers. This results in the agent trying to impose a point of view on the farmer without discussing reasonable alternatives. This is an error in that both the researchers and the extensionists tend to disgregard or put down the knowledge and experience of the farmers themselves.

As suggested above, the early identification of clientele groups and their unique problems and environments would aid in the tailoring of such packets so that they may be appropriate to each situation.

c) **Technical Problems**

This is really a problem of the academic bakground that the professional gains from the various teaching Institutions. The programs of study rarely are related to the reality and needs of the rural clientele. There are deficiences in such important areas of their training as to water management, soil conservation, farm management, etc.

d) **Policy and Financing Problems**

Without overt support at the highest levels in the Ministry for the establishment and development of an Agricultural Extension Service the service will not exist or if it is formed, its life expectancy will be short and ineffective. By the same token the financial support of the service must be sufficient to meet its stated objetives and avoid funding short falls. The fact that budgets for the technology-transfer entities rarely match programs and are never adequate to the needs in the field. The lack of sustainable objetives further exacerbates the situation.

e) **Organizational Problems**

Given the objective of an integrated REE system it is absolutely necessary that an Agricultural Extension Service be created. In the absence of an organized Ecuadorean extension service efforts are underway to substitute and put into place a Program of Agricultural Technical Development (PROTECA) whose objectives may complement those that the REE system sets forth. However, PROTECA does not satisfy all of the requirements of an REE system including an extension service. PROTECA does not fulfill these requirements for the following reasons:

(1) Under the PROTECA system selected areas and crops will be given priority. However, there is no mechanism in PROTECA, as currently devised, that provides for the identification of target populations. Indeed there is no explanation of how the so-called priority zones are to be identified or established.

PROTECA, as drafted, sets up 11 crop and 2 livestock programs as "fait accompli". There appears to be little relation between the commodities chosen for emphasis and the priorities established by the national planning board or those that might be set up by the board of directors of the proposed research foundation.

(2) Experience in the Ministry with other programs or similar projects, financed and administered by international institutions with the appropriate national counterpart, indicates that their life expectancy is equal to that of the financing or the assistance, and the project or program disappears as soon as the funding or aid ends. That is to say there never has been any continuity in their execution. One of the assumptions undergirding the recommendations in this report is that the system as established must be sustainable. It is doubtful that the Government of Ecuador under the best of circumstances will be able to sustain the PROTECA project in its present form.

(3) PROTECA anticipates no relationship with education which will have the effect of destroying the integrity of the REE system.

3. **Education**

Agricultural education at the high school or vocational school level is offered by about 194 institutions. Their programs are characterized by an excessive number of courses that emphasize the practical/vocational aspects of agriculture with no program of hands on practices that could serve the agricultural sector. For them there is almost no application of simple scientific principles, that would serve the production and agro-industry of Ecuador. These institutions graduate a large number of students with a general education and inadequate technical preparation. These students are of little or no use for the agricultural economy.

At the higher level of agricultural education the 15 university and polytechnic institutions enroll approximately 4,500 students and graduate an average of 400 each year. The capacity of these institutions to contribute to the establishment of an agriculture based on science is at the moment very limited owing to: inadequate instruction in basic sciences and its application in agriculture; limited experience on the part of faculty members in agricultural technology based on science, a limited number of full-time professors who can participate in integrated programs of research and extension; an academic system that is highly politicized, which creates a lack of confidence and support on the part of either the private sector or the agricultural sector; little communication and limited appreciation of the programs of research and extension in the country; a limited capacity to train and retain high quality professors; very limited coordination of programs among institutions, which results in a high degree of duplication of effort; and lack of any initiative or reward for planning, implementing alternatives, or effectively attacking the problem of limited human resources.

C. PREMISES FOR THE STRATEGY

The conditions that limit more effective action on the part of the research, extension and education entities have been decribed in the previous paragraphs. Following are set forth some premises that have been identified as fundamental to the formulation of a strategy designed to improve both the specific activities and the integration of the three components of the REE system.

1. Research

(a) Given a strong leadership in the research programs, scientist who direct such programs can begin to follow a consistent policy which will result in the insulation of the total program from daily political pressures. At the same time, it will create a capacity to anticipate technical problems that may arise in the future in such a way that, when the solution of these problems becomes urgent, the appropriate technology will be at hand so that it may readily be implemented by the extension or development entities. With regard to planning, it is essential to maintain intimate contact with international organizations with the objective of staying up-to-date on the latest scientific and technological advances. This will result in more realistic planning with regard to new technologies available in the international realm.

(b) Forming interinstitutional groups (public and private) of specialists who work on the same program, for example, short-cycle oil seed crops, would improve communication among them, the more efficient planning and execution of programs, and the more rapid validation and application of new technologies.

(c) When the crop or livestock problem under consideration is of prime importance for medium and small farmers or communes, an adequate investigation of the technology in use at the field level should be carried out. These field studies can be performed by Fellows of the Ano Rural and with the participation of the zonal offices of MAG. Such studies should have an adequate duration (normally 2 years) and should include socio-economic aspects. Many times this kind of study can lead directly to a second phase, that of the testing of new technology, on the same farms that cooperated in the baseline study.

(d) The possibility of doing research by means of contracts with professionals who currently are working in other institutions, but who would offer some comparative advantage with regard to that specific study, should be explored. There are some scientists outside of INIAP who could assume this responsibility as adjunct researchers. This would permit the amplification of some areas of research and, at the same time, serve to integrate the areas of education and research.

(e) Consideration should be given to the possibility of mounting a research program in agroforestry in view of the fact that many biological systems, in areas such as the Amazon Basin, are based on forestry.

(f) It is suggested that a unit be formed for sociological, economic and anthropological studies tied to the creation, transfer, economic assessment, and adoption of technology.

(g) In both research and extension programs, the goal should be that of creating an array of production options which can be presented to the producers with the idea of aiding them to choose and apply one or another that is most appropriate to their specific operations.

(h) The evaluation of experiments, publications, and other products of research should be conducted at two levels; internally, by colleagues in the same general area research (which would be a continuous and dynamic process); and externally, by a group of experts (a periodic evaluation).

(i) In view of the fact that water is a limiting resource in some regions or during some seasons of year, research on the rational use of water must be reinforced. It is desirable that INIAP initiate a program of research in the studies of the interactions among the factors of soil, plant, and water.

(j) The salary schedule should be structured in both senses, vertical and horizontal, resulting in appropriate salaries for each responsibility that will contribute to retaining personnel and to their permanent and full-time dedication to their specific areas of work.

(k) Establishing a training program scheduled on a short-, medium- and long-term basis, taking into consideration the true needs of the Institute. This will permit the appropriate programming of both internal resources and those of donors disposed to aid training programs.

(l) Given the fact that fellowships for advanced studies are often considered in a poor light, consider other types of incentives for the professional improvement of researchers. This would permit, on one hand, the retention of these researchers and, on the other hand, would contribute to their improved technical stature.

(m) The implementation of the Escuela de Egresados would have various objectives among which the most important would be the reinforcement of the growth of basic sciences in the areas of research and the opportunity to select potential candidates for employment by the Institute. On a mid-range basis it is worthwhile to consider the possibility of creating a postgraduate school at the level of the M.S. which will work toward fulfilling this educational need in Ecuador.

(n) Given the need for INIAP to deliver technology to an organized extension system, consider the necessity to implement the so-called Centros de Capacitacion (training centers). These center should be activated with facilities already in place (for example, Pichilingue, Santa Catalina, etc.) or using new construction.

(o) Increasing available bibliographic services and promoting their appropriate use by researchers. On a long-term basis, consider the establishment of a national agricultural library which would serve all of the organizations that work in the agricultural sector. Further, the publication of a scientific journal by INIAP is worthy of consideration.

(p) Though it is true that INIAP maintains a central biometric and computing center, that this be improved and amplified at the level of the major experiment stations to the end of aiding both experimental design and the processing of data. In like manner consider the possibility of the use of certain statistical packages in other areas of INIAP such as personnel, payroll, inventory, bookeeping, etc. in order to increase the efficiency of management of these administrative services in support of research.

(q) Services such as soils analysis, foliar analysis; insect, disease and weed identification and control, the nutritive value of forages, concentrates, etc.; and animal health services must be improved and broadened on the basis of responding to the needs of the researchers. This improvement will consist primarily in appropriate equipping of laboratories and in the identification of the best and most rapid procedures that will permit the adequate use resources in support of functional efficiency.

(r) One solution to the problem of lack of contact with user groups would be the creation of extension liaison positions for each program charged with the single responsibility of communicating and transferring the results of that program to the users. That is to say a type of extension specialist in each program. This communicator should work with both sectors, public and private, and at the same time he would serve as a channel by means of which the problems and ideas of the users may be communicated to program leaders which would aid them in formulating realistic objectives and in locating potencial sources of support and financing from the private sector.

(s) INIAP has practically no research in the so-called social sciences, with regard to their application to agriculture. Currently there is only one sociologist in the Institute. We suggest the employment of, for example, an anthropologist, an economist, etc., assuming always that their professional interests are compatible with the program objectives of INIAP.

2. **Agricultural Extension**

Although it is true that within the technical and administrative organization of MAG there is no agricultural extension as a unit for technical assistance or technology transfer, the professionals at the field level use, to a greater or lesser degree, agricultural extension methods that permit them to fulfill the fundamental agricultural policy of the country towards increasing production and productivity of export crops and products for internal consumption.

(a) Clientele. In Ecuador the structure of land tenure varies among the different regions of the country. In some the smallholders predominate and in others melium-size farms are more important. Large farms are more rare.

This variability in land tenancy brings with it problems for technical assistance following the specific type of ownership Technological packages cannot be used in all cases owing principally to the fact that the economic base of necessary inputs including credit are usually unavailable to many small farmers.

However, the actual size of the farm operation is probably not the most significant factor impacting the identification of target or clientele groups. It is our contention that the end-use of the product is the better criterion. For example, it would be relatively straighforward to separate client groups into those that are export-commodity oriented, those that are dedicated to commercial production for the urban sector, and those that are primarily subsistence (minifundia). Within the first two groups some division based on farm size or gross sales would be approriate. Such a classification would permit better identification of the technologies and methodologies appropriate to each group, would aid in identifying possible involvements of private-sector transfer agents, and would suggest potential clientele who could provide some measure of financial support for the service provided (for example, those farmers who produce crops overtly destined for export usually enjoy a cash-flow situation that would support a private-sector technology-transfer program, a consultancy arrangement). This would be particularly appropriate if the credit system were structured to include consultant fees as a legitimate operations expense, to be supported as part of a production loan.

On the other hand, with those peasants whose farming operation is totally subsistence in nature a sharp focus on technology transfer might be inappropriate. Quite often the major problems for this stratum of the population require much more than a technical agricultural solution. It is a socioeconomic complex that may involve health, home economics, nutrition, non-agricultural employment options and adult education in the broadest sense. With this clientele group the so-called PVOs may provide a much more effective means of outreach than can the formal extension activity.

The clientele group of small- and medium-size commercial farms, most significant in the production of domestic food supplies, can be supported to a significant degree by

private extension efforts, through commodity contracts with agribusiness firms, producer associations, supervised-credit programs and selected private consultants. In turn these private agencies could be supported by public commodity and communications specialists, associated with the new foundation, and by training and conventional public-extension services. Early identification of the clientele, the technology appropriate, and the transfer methodology that might be most effective will aid the Government of Ecuador to mount better programs, make more efficient use of the public-sector employees, and aid in resolving the severe economic constraint that currently limits MAG's successful technology-transfer efforts.

The existence of several public and private entities dedicated to technology transfer, with similar objectives and methodologies, often results in overlapping programs and a confused clientele. For this reason, specific target groups should be clearly identified and a tight coordination at the field level should be maintained by the Provincial Director in order that all entities operate in support of the REE system.

Linkages within REE. Agricultural extension is a process that is overtly educational and informal designed to create change for the farmer and his family using appropriate technology-transfer means in order to raise his standard of living.

Agricultural extension cannot exist in isolation. It is necessary that it maintain a close relationship with research and with education, because research constitutes the principal source of scientific information for technical diffusion and education is the basis for all professional formation (see Figure 2).

This relationship is a two-way proposition, given that extension can carry problems and observations to researchers and research, for its part, provides solutions to these problems and questions. With regard to education, extension obviously has an interest in both the quality and professional experience of its people and education, for its part, places emphasis on the formation of professionals to meet the requirements of the extension service.

The formation of an extension professional depends on the area of work and the programs in his particular zone. Sometimes extension specialists are required, at other times, generalists. Further steps in providing either in-service training for agents or for training potential agents are suggested in the sections on Research and on Education. These might involve an amplification of the present Ano Rural requirement, with concurrent coordination with an on-going public or private extension effort, a second-degree program at the undegraduate level and, eventually a postgraduate option in extension education. All of these innovations would provide the opportunity to screen, as well as train, promising candidates in advance of any formal obligation on the part of the Government of Ecuador.

Usually the university cannot train extension specialists but rather generalists. In order to train specialists a continuous program of in-service training should be created using courses, seminars, the establishment of fellowships, etc. Generalists usually will work with the small and medium farmers because of the diversity of farming systems that they use.

(c) Alternatives. Ideally an effective remodeled extension service would be tied very tightly to the commodity research programs of the recommended foundation. The remodeled extension service would be a blend of a small but efficient public extension service, a strong extension-research liaison unit within the foundation, and a group of private extensions firms and agencies.

Commodity extension specialists would be attached to each of the foundation's programs

with the stated responsibility of moving new technologies to the field via either public or private activities and of bringing problems from the field to the research program leader. This integration does not eliminate the need for generalists in the field. It does provide a conduit by means of which the private and public field agent may be kept current on technologies appropriate to the needs of his province or zone. Conversely, it provides one mechanism whereby the provincial priorities can be kept in the forefront of the programmatic ongoing planning process. Further, the commodity extension specialist will have prime responsibility for coordinating activities with the Provincial Directors in order to assure that the needs of the province are considered and that the appropriate technology is, in fact, getting to the field.

For the effective functioning of the REE system several factors warrant analysis in order that possible solutions for improvement of the system can be devised. The prioritization of programs within the components of agricultural extension are based on the national agricultural policy established in the General Development Plan taking into account the following criteria:

Ecological conditions of the province or region,

Feasibility of the production of export crops,

Specific interests of the farmers with regard to a determined activity,

Determination of existing favorable factors in the zone for a specific crop or activity on the part of the technicians of MAG,

Supply of agricultural products for general consumption,

Ease of organization of producers, and

Availability of technical information and research results.

Coordination and communication among the three components avoids duplication of effort. The Provincial Director, as the one responsible for the agricultural activities in the province, should have a major input in the programming of activities for his area of responsibility.

The role of the three components is clearly defined within the system, but not the size or the interactions among them. These may change depending on various factors such as the agricultural policy, the availability of funds, and programming within the system.

There is no effective division of labor for all three components between the public and private sectors. In both sectors research, extension and education are being done. Private research and technical assistance, in general, are usually focused on the larger enterprises or on special-use crops which supply agroindustry.

Technology transfer as carried out by private institutions and associations must be specific in its objectives, maintaining a tight relationship with research and with the respective provincial office.

In the technology-transfer component there are some personnel of sufficient ability to carry out their responsibilities. However, there also exist some technical personnel who will require upgrading in order to provide more effective services to the producer.

In the same manner, the research professionals should be involved in technology transfer, in coordination with extension personnel of the provincial office, insuring appropriate technical and scientific methods.

Factor markets and product markets constitute an important source of technology-transfer but it is necessary that they be coordinated in order to avoid possible conflict-of-interest problems.

The voluntary organizations serve a most important service in technology transfer, assuming that coordination with extension and with research that can help them be involved in a development program at the provincial level or at the national level is in place in order to avoid duplication of work. Private institutions that are involved in rural assistance have specific development objectives and work in specific areas or activities. Public extension institutions have a much more broad responsibility in extension and, therefore should have an informational and training relationship with PVO agencies.

3 Agricultural Education

Ecuador has neither the time nor the money necessary to undertake a general reorganization of the educational programs that operate in support of the agricultural sector. Therefore the strategies and recommendations set forth in this report are based on the following premises:

(a) The supply of human capital produced by the educational institutions is adequate in number but totally inadequate with regard to the needs of a sustained agricultural development program.

(b) The graduates of institutions of higher learning are deficient in the basic sciences. This is principalyy due to the fact that the professors themselves are inadequately prepared and have no contact with current research activities.

(c) There is no interaction between the universities and the research or extension programs. It is estimated that only a small number, perhaps less than 50, professors have the necessary scientific capability and interest to dedicate themselves to research or agricultural extension. These professors generally teach only part time and therefore are not able to take advantage of the opportunities to improve their scientific knowledge by participating in research or extension programs. This experience would be reflected in better teaching programs at the university level.

(d) Prioritized research and extension programs should identify a small number of potentially productive professors in carefully selected universities and develop collaborative agreements in order to:

improve the scientific and teaching potential of the professors,
provide opportunities for their students' participation,
avoid duplicating costs and effort in research in high-priority areas, and
improve the quality of graduates in a relatively short period of time.

University politics has seriously eroded public confidence and support as well as decreasing effective programs of instruction. If research/extension/education interactions are carefully managed they can be successful in isolating professors from politics. This could contribute to the restoration of confidence, support and public expectancy.

(e) There are no postgraduate opportunities in agricultural education that would permit students to gain depth in scientific knowledge and improve their technical abilities. Currently there are no institutions with adequate capacity in the basic sciences which are essential to initiating postgraduate programs. However, the agricultural research programs provide some scientific talent that could be very useful to the university in connection with a postgraduate course or in those few courses that do not lead to a degree. Expatriate technical personnel who support research and extension programs can also be useful in offer-

ing especial short courses or seminars at the university. A coordinated effort to use these possibilities would provide an intermediate and effective step toward future postgraduate programs.

D. RECOMMENDATIONS

1. Research

a. The activation of complete and functional research and technology-transfer programs, impacting all importnt components of the agricultural sector.

b. The establishment of an REE system that adequately serves all user groups (large producers, medium producers, small producers and communes).

c. The separation of fomento (development) type activities from those of research without discounting the responsibility of the researcher to promote the use and maintain the genetic quality of improved materials.

d. The establishment of a postgraduate school for agricultural science in Ecuador.

e. The assurance that the public and private sectors work together in the most effective manner in the planning, financing, and execution of research.

f. The establishment of a permanent, external mechanism of evaluation for the REE system.

Preceeding are the long-term goals for the suggested REE strategy. These can be accomplished by means of the short- and mid-term activities described below:

Short- and mid-term. The recommendations for short-term innovations have been formulated with two ideas in mind: to prepare a sound basis for the implementation of the long-term objectives and to have on-going short-term activities while progress is made toward the more difficult mid-term objectives. On this basis we recommend:

1. The inmediate creation of a Foundation whose mission will be the coordination and support of the REE system. With sufficient funds and leadership, this Foundation could provide immediate resolution to varios problems such as: the establishment of priority programs, their planning and development; prioritization among the elements of each program and its activities; rational budget-planning and a flexible budgetary administration; increasing the efficiency of use of donor contributions, coordinating them with the priorities and objectives of established programs; appropriate salary schedules for research personnel; correction of the current absence of research programs on plant/soil/water relationships, socio-anthropological studies related to technology adaptation, etc., programming on the logical study of complex biological interactions; the creation of functional linkages among all important REE institutions, public as well as private, including international organizations and programs; aiding in the elimination of duplication of effort among the institutions; and improving support services.

   The Foundation will be a legal entity, privately owned with social and public objectives, non-profit, autonomous character and owning its own facilities. This entity will establish mechanisms for identifying and channeling national and international donations in support of both ith own objectives and those of qualified researchers troughout the country.

The research foundation will act as a catalyst in the area of national agricultural science, selecting and supporting those activities related to agricultural science and linking them directly with extension and education.

Moreover the Foundation should identify and select appropriate research personnel who will serve to link new technology and knowledge with both public and private entities in the country that are responsible for the transfer of adapted or local technology (Appendix 5).

2. The implementation of a logical process of programming, planning and development will meet the following short-term objectives: to resolve the problem of vehicle needs and equipment repair, replacement and purchase; to correct infrastructural deficiencies; to program the necessary training for scientists and commodity extension specialists in the foundation; and to implement an efficient internal evaluation process for the research programs.
3. The training of new research and extension-specialist personnel based on a reinforced and expanded Ano Rural program in order to offer fellowships to new university graduates who will serve for one year as research or extension assistants. This will provide imediate aid to programs with insufficient personnel, valuable training for the participants, and the opportunity for an efficient selection of potential candidates for long-term employment immediately fund and establish an Escuela de Egresados within the Foundation in order to provide short-term, specialized training for potential research and extension personnel; provide more opportunities for Ecuadorean and foreign students to conduct thesis research within the priority programs the Foundation.
4. As a means of improving the preparation in basic sciences of future university graduates the immediate implementation of a program of small grants for promising professors in the basic sciences and mathematics.

2. Extension

Agricultural extension or technical assitance is an integral component for the improvement of the production and productivity of the country. Therefore, it deserves the maximum attention on the part of the higher administration toward resolving the problems that currently exist. The fundamental objective of agricultural extension within an REE system is the establishment of an efficient technology-transfer service, coordinated and supported by research and agricultural education and capable of raising both the production and productivity levels as well as the quality of life of the farmer and his family. In order to attain these objectives, and in more specific form, we recommend:

(a) Based on the available physical, technical and economic resources of MAG, the formation of a remodeled, integrated extension service.

(b) The identification of target populations in the sector, the establishment of program priorities and movement toward enhancing coordinated private-sector intervention where appropriate; the coordination of extension priorities with those of the research foundation and the establishment of the necessary commodity-specialist positions; consider the employment of such specialists within the research foundation but with state extension liaison responsibilities.

(c) Consider the establishment of a semiautonomous extension institute outside MAG. This step has to recommend it: the decentralization from and elimination of much of the bureaucratic paper work currently demanded of the public sector; the enhanced facility to seek and secure technical and economic assistance from external, national or international organizations; greater ease in establishing and requiring enhanced and continuing training of its personnel; complete authority to demand full-time work from its staff, thereby eliminating the current trend toward increased outside involvements; the authority to establish a new pay scale appropriate to the skills demanded of its professionals; and fewer problemas of potential conflict of interest, etc. that might be created by increased private-sector cooperation.

(d) Establish a pay scale commensurate with the capabilities and responsibilities of the professionals employed.

(e) Create mechanisms such as the Año Rural and "second title" to assure the ongoing upgrading of extension personnel at all levels and, eventually, the formation of a postgraduate program in extension education.

(f) Include the private sector in the planning, execution and evaluation of outreach programs on both the short- and long-term basis. Provide for the continuous feedback from the private sector to the research organization. Options appropriate to private-sector intervention include consultants, producer associations, contracts with purchasing firms, supervised credit, and private volunteer agencies.

(g) Encourage the formation of farm groups around appropriate mutual interests to the end that they may take part in the decision-making process at all levels.

(h) Promote the development of rural families with programs that increase the contacts with women and young people in the economic, social, and cultural improvement of the community.

(i) Include the improvement of post-harvest technology, marketing and processing of farm products as active legitimate outreach objectives within priority programs.

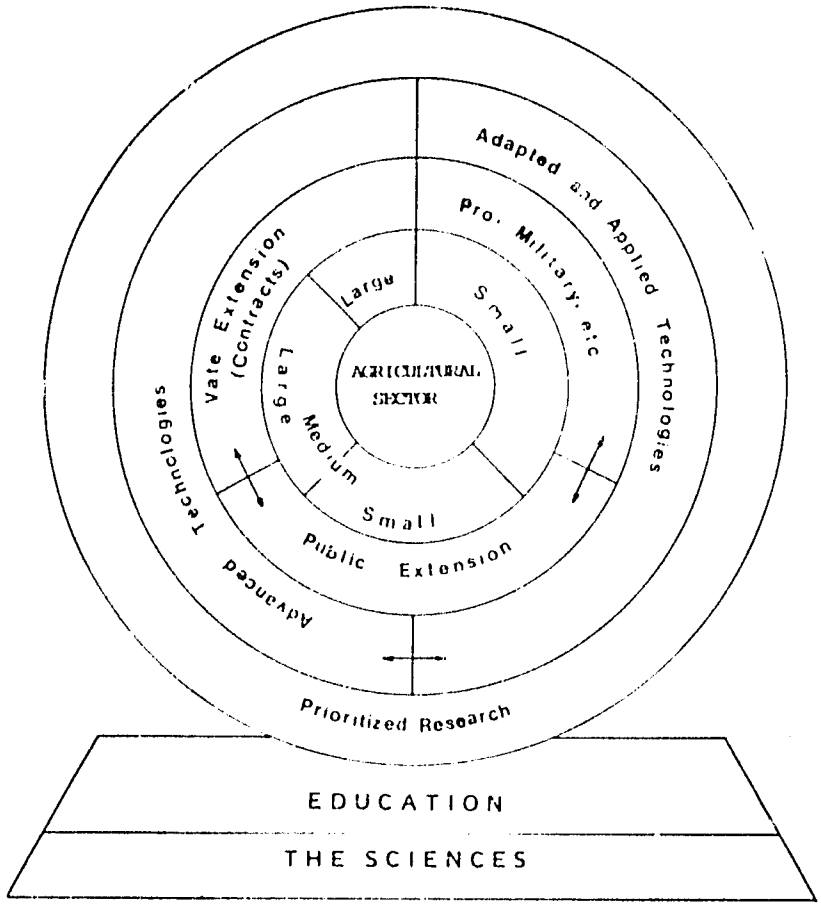
(j) Consider the integration of PROTECA into the new extension format and its coordination with the research foundation. One device might be to have the board of directors of the foundation manage the funds, not the organization of PROTECA. Another might be to consider the interim use of the foundation's board of directors as the the interim board for any new extension entity that might be considered. It seems reasonable that the foundation's board, composed of persons vitally interested in the success of agricultural research, would also be keenly interested in the appropriate application of the results of that research. Either or both of these devices would help assure linkage at the administrative level in addition to the programmatic links discussed elsewhere.

(k) Investigate the degree to which some components of the agricultural sector, such as the better export-commodity producers or the larger producer associations, could financially support the technical assistance provided them.

(l) Provide for the direct involvement of the agrarian provincial councils in the planning and prioritizing of outreach programs at all levels.

(m) Extend technologies that promise to increase productivity and/or production, reduce underemployment and conserve the natural-resource base of the country.

Figure 2. THE TECHNOLOGICAL IMPLOSION.



3. Agricultural Education

The subcommission has agreed that the enormous problems that confront education in general and particularly in agricultural education cannot be covered in this report. Instead, the subcomision decided to identify specific elements withir the the universities that can serve as initial points of useful interaction with research and extension, that might play a catalytic role in directing other university elements toward an agriculture based in science in the near future.

All of the aspects discussed address the critical problem of the shortage of the human resources necessary to support a more viable effort in increasing production and productivity.

a. Intermediate Agricultural Education.

In order to satisfy the extension and education needs technically-oriented people with practical experience at a pre-university level it will be necessary to establish a few institutions that can function toward this specific end. A minimum of one technical school at the intermediate level in the Sierra and another in the coast should be considered.

These schools should be administratively separate from the current system so that the programs of studies, its members, and the incorporation of practical agricultural experience can be designed in accordance with the specific needs of a science-based agriculture. It is desirable to use the experience of similar schools in other countries such as Zamorano in Honduras in order to develop programs of study, methods of instruction and provide practical on-hands experience.

Specific steps that should be considered include the following:

Identify a middle-level school that exists in the Sierra and another in the Coast that have land and buildings appropriate to the program and that are easily accessible but at some distance from densely populated areas.

Design and develop some type of independent foundation that will maintain, administer and operate these schools. Such an organization should be supported by public, private and international agencies.

Link the programs of these schools to both public and private extension activities in order to assure the quality of instruction and the benefit to those who will employ their graduates. This can be achieved by means of an appropriate board of directors.

Transfer the responsibilities for the management and administration to the foundation and its board of directors.

b. Higher Agricultural Education.

These recomendations are divided in short - and long-term objectives.

(1) Short-term Recommendations.

(a) Reorient the concept of the Año Rural to one of practical training in the fields of research and extension. The foundation and the institute will coordinate the location of graduates in different public and private centers of production. Carefully selected students in their sixth year will be assigned for one year to the Foundation as field technicians, assuming that they also will complete their thesis work. By the same token, those students who are interested in extension will be assigned to public or private extension activities.

(b) Develop and implement a program to reinforce the basic science courses in the universities that have been selected to interact with research and extension. The basic courses in physical and biological sciences should be reinforced with additional courses in mathematics, chemistry, physics, and statistics. Within the social sciences the courses in economics should be upgraded. The focus will be to retrain a group of professors responsible for teaching the principles of science. One option would be the inclusion of six-month courses with an emphasis on modern teaching methods, the use of laboratory equipment, the introduction of textbooks, and the use of available technical assistance in the other activities of research and extension.

(c) Develop programs of specialization in two of the selected agricultural universities (one in the coast and the other in the Sierra). These one-year programs of specialization will concentrate on training both researchers and extension specialistas.

For researchers the programs will emphasize courses in applied science, research methodology, experimental design and research planning. Similarly, for extension the focus will be on extension philosophy, methodology, communications, human relations and extension planning.

This program of specialization should be linked with short courses at international or national centers (for investigation, the foundation, and for extension, MAG or the new institute).

(d) Implement a technical unit covering the soil, plant, water relationship. This initial effort will be the first step in creating a nucleus of professional Ecuadorean agronomists prepared in the management of water at the farm level, drainage, utilization of irrigated land, farm management and technical agricultural production.

(e) Improve the preparation of a selected group of university agricultural professors. Professors should be chosen to receive training abroad in order that they may become adjunct investigators to the national programs. A program of fellowships could be linked to postgraduate programs in Brazil, Colombia, Costa Rica, Peru, United States, etc. A strong emphasis on the application of science to the priority programs of Ecuador could guide the selection of graduate candidates who will return to Ecuador in order to complete their theses.

The acute shortage of such profesionals as agricultural economists, irrigation researchers microbiologists and agricultural biochemists should be taken into account when candidates are selected.

Some leaders in the area of Ecuadorean agriculture estimate that a small percentage of professors of agriculture have the training, the motivation, and the experience required to materially contribute to the national research network. They should be supported by research grants from the Foundation. Approved research proposals from university professor should be complementary to the Foundation's programs. A list of selected professors indi-

cating their training, their current research activites and interests, and their motivation to do research should be drawn. This inventory would be compared with the priority research needs of the Foundation. A procedure would be developed to assure that the investigation of selected candidates would coincide with the national priorities. Contributions for this research training could include operational support, needed laboratory of field equipment, fellowship support for student assistants, and bonuses for the directors of university research projects.

2. Long-term Recommendations:

The implementation of the recommendded short-term activities will serve as a catalysts to foment the institutionalization of a scientific orientation. Within two or three years it should be possible to detect catalysers of short-term initiatives. This should aid in identifying institutions for additional activities. In order to achieve this catalysing effect there are two recommendations:

(a) The substantial restructuring and modernization of two centers of higher education. Even though there are diverse Ecuadorean agriclimatic areas there need to be two, one on the Coast and the other in the Sierra. These centers should develop a solid scientific base and seek the application of scientific principles in order to promote agricultural growth. The program of studies will serve all agricultural sub-sector components including production, factor markets, product markets and the public-service sub-sector.

The two centers of higher education should seek to develop integrated programs of study with specialization in several disciplines, selecting and attracting capable students and seeking to change the poor imagen that students and the public have of agricultural careers. These two centers should be leaders in attracting and retaining the best professionals in Ecuador and should prepare a base for a new program of postgraduate education in agriculture. It will be necessary to develop an the scientifically-based efforts made by the two higher-education institutions.

(b) The development of a postgraduate program in agricultural science should be part one of the two institutions chosen for revitalization at the undergraduate level along with a formal linkage with the national research program. This will serve two purposes: 1) that the directors of the national research programs schould serve as adjunct members of the postgraduate faculty and 2) to improve the flow of new knowledge obtained from the research of those professors, associated with highly qualified postgraduate students.

The new postgraduate school will be structured with at least four specialties. These will include programs in animal science, agronomy, farm and business management, and extension education. One example of a higher specialization would be a department of agronomy that incorporates the sciences of crops, soils, water and pest management.

APPENDIX N° 1

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APPENDIX N° 2

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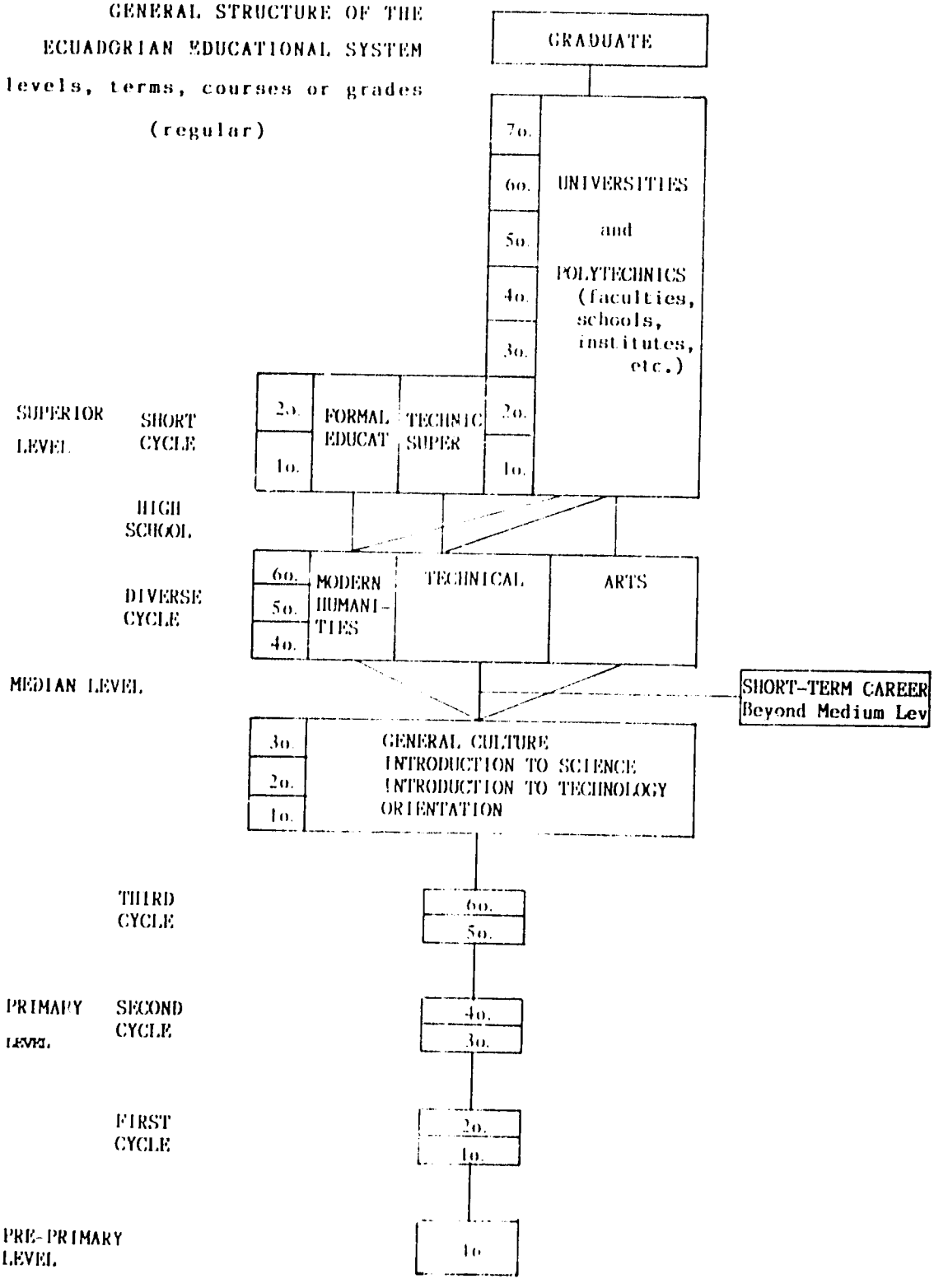
APPENDIX No.3

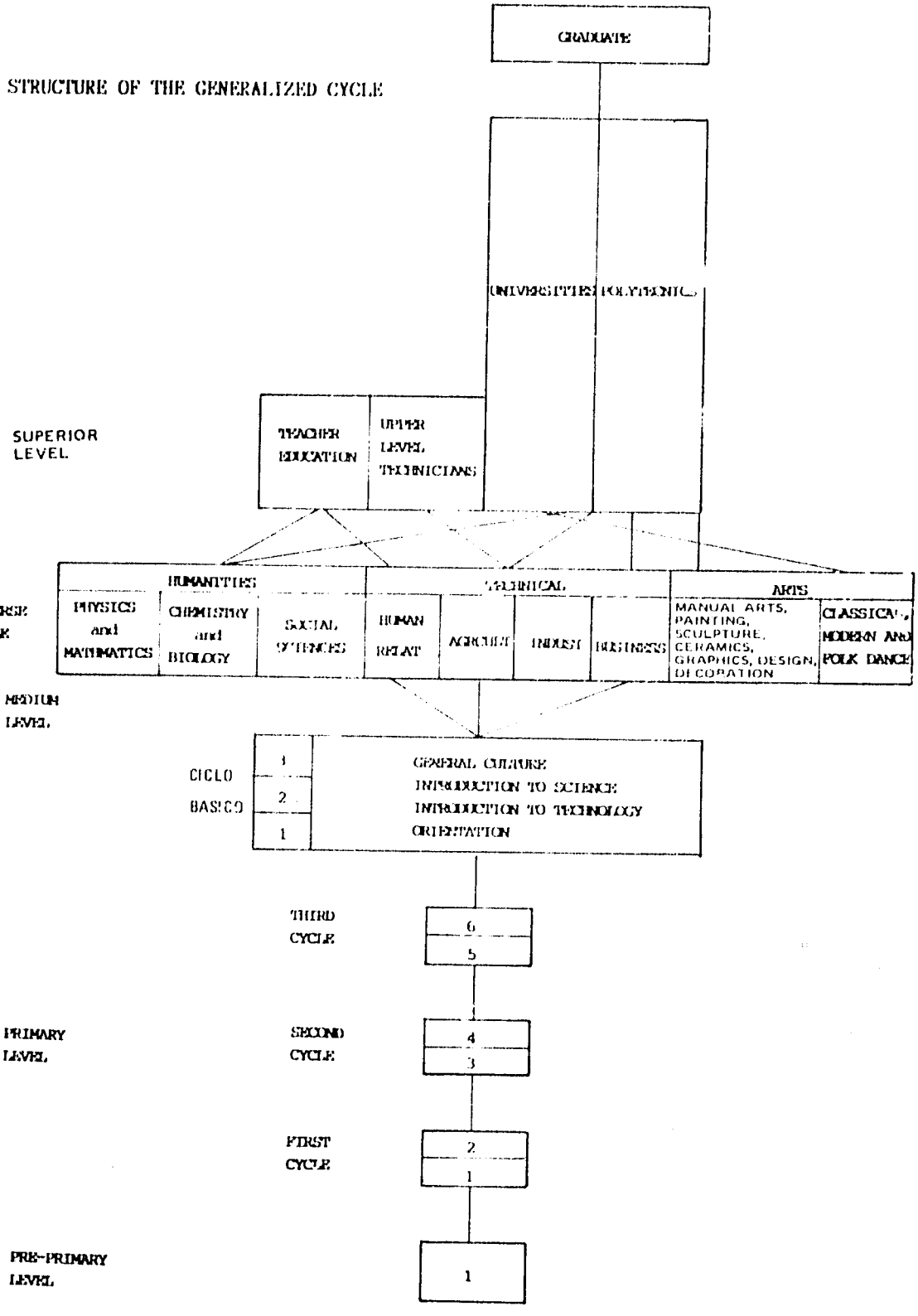
GENERAL STRUCTURE OF THE ECUADORIAN EDUCATIONAL SYSTEM

by levels, terms, courses or grades

(regular)

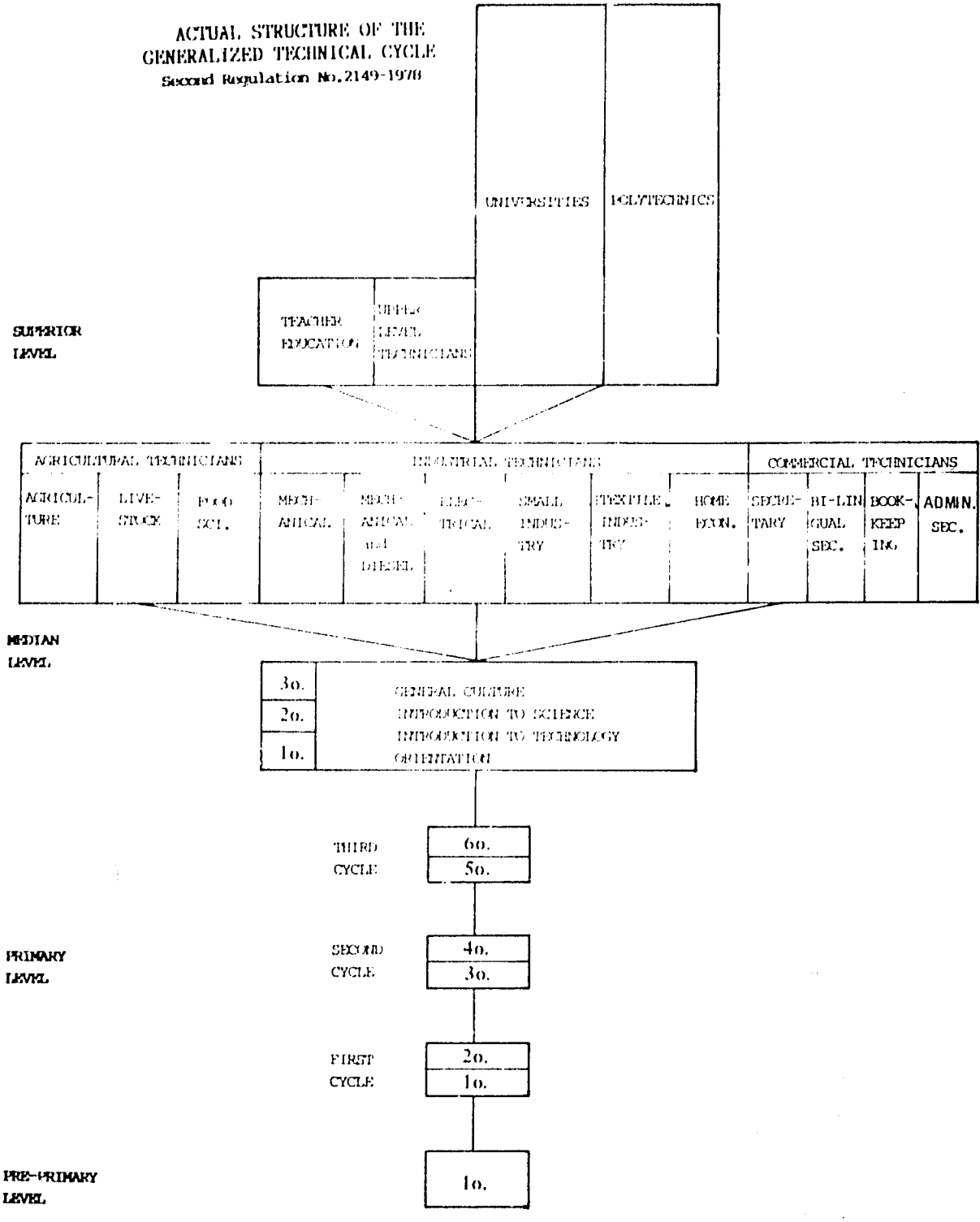


STRUCTURE OF THE GENERALIZED CYCLE



ACTUAL STRUCTURE OF THE GENERALIZED TECHNICAL CYCLE

Second Regulation No. 2149-1970



APPENDIX N° 4

Data on Plan for Agricultural Extension 1/

Proposed Division of public/private responsibilities by clientele and time.

ENTITIES	Clientele		Time Period		
	Technical Assistence 2/	Support 3/	Short 0-3 Years	Medium 4-6 Years	Yong 7 Years
			(percent)		
PRIVATE ORGANIZATIONS					
CARITAS		3,4	5/95		
CESAR	4		95/5	80/20	50/50
CPR	4,5		90/10	70/30	50/50
Cent. Reg. Capac. Campesinos	4		70/30	60/40	50/50
Escuelas Radiofónicas Pop. Ecua.	3,4,5		0/100	0/100	0/100
FEPP	4		90/10	75/25	60/40
Fund. Desar. Rur. Bretheven Un.	5	5	0/100	0/100	0/100
FED (Zona Norte)	3,4,5		95/5	90/10	85/15
Fund. Nac. 4 F	Todos		50/50	40/60	30/70
Fund. Natura	Todos		80/20	60/40	50/50
Plan Padrinos	3,4,5		30/70	20/80	15/85
Cuerpo de Paz	2,3,4,5		80/20	80/20	80/20
CARE	4	4	80/20	80/20	80/20
FECOOPAM	5	5	50/50	60/40	20/80
Meals for Millions	4,5	4,5	50/50	40/60	30/70
Save the Children	4	4	40/60	40/60	30/70
Average			57/43	48/52	40/60

..... continued

Appendix 4: (Continued)

ENTITIES	CIENTELE 2/	Time Period: Short 0--3 Years	Medium 4--6 Years	Long 7 Years
			(percent)	
ENTITIES OF MINISTRY OF AGRICULTURE				
PROTECA	Todos	80/20	60/40	0/100
CREA	2,3,4,5	20/80	40/60	50/50
CRM	Todos	0/100	0/100	0/100
IERAC	2,3,4,5	80/20	90/10	95/5
INCRAE	Todos	30/70	40/60	50/50
INERHI	Todos	60/40	65/35	80/20
INIAP	Todos	100/0	100/0	100/0
ENDES	Todos	99/1	99/1	99/1
Average		59/41	62/38	72/28
ASSOCIATED INSTITUTIONS				
SEDRI	3,4,5	0/100	0/100	0/100
FODERUMA	4,5	95/5	95/5	95/5
CEDEGE	2,3,4	0/100	0/100	0/100
PREDESUR	Todos	60/40	60/40	60/40
BNF	Todos	98/2	99/1	100/0
ESCUELAS AGRICOLAS	Todos	90/10	85/15	60/40
CAJAS RURALES	Conscriptos	90/10	90/10	90/10
Average		62/38	61/39	58/42
CLIENTELE				
1. Large		30/70	20/80	10/90
2. Medium		80/20	60/40	50/50
3. Small		80/20	70/30	60/40
4. Communes		90/10	80/20	70/30
5. Cooperatives		90/10	60/40	40/60
6. Producer Associtions		80/20	50/50	20/80
7. Business		10/90	5/95	5/95
Average		67/33	49/51	36/64

1/ Ecuadorian Agricultural Extension Service.
2/ 1. Large, 2. Medium, 3. Small, 4. Communes, 5. Cooperatives, 6. Producer Associations, 7. Businesses.
3/ Donations of equipment, materials, oil/fuel, etc.

APPENDIX N° 5

PROPOSAL FOR AN AGRICULTURAL RESEARCH FOUNDATION

A. Introduction

It is generally agreed that agricultural science is indispensable to sustained agricultural development. The major engine for growth is technological change which is the product of agricultural science. Several elements are absolutely essential to a viable program in agricultural science: (1) the hiring, retention and continuous professional improvement of well-trained and experienced scientists (2) a permanent commitment to technical change; (3) sustained financial support; (4) to respond to social, political and economic issues; and (5) and administrative structure directed by scientists but responsive to the clientele. It is proposed that a private, independent, not-for-profit foundation be formed to meet these conditions. The foundation will be called "The Agricultural Research Foundation of Ecuador". The foundation's mission will be "to improve agricultural science research, extension, and education for the benefit of Ecuador".

B. Why a Foundation

Because existing public laws, policies, and programs do not provide these essential elements, a private, nonprofit foundation should and can be designed to resolve issues of training and retention of scientists, substitution of private for public sustained financial support, adherence to a long-term continous commitment, and scientific talent that plans, implements, and evaluates a system responsive to but not dictated by political, economic, and social issues.

What the Foundation Will Do:

The major purpose will be to produce a continous stream of new technologies, to test and transfer such knowledge to existing public and private extension agencies, and to structure and jointly administer a new graduate school. The foundation will be responsible for developing and sustaining the agricultural science base required to achieve increased rates of agricultural development in Ecuador.

The new foundation will also gradually phase out government production of certified seed and plants and the sale of animals and semen. Instead, focus will turn to be producing seed, plant, and animal inputs for the private sector to increase and distribute.

The foundation will be restricted to a liaison function with public and private extension activities. The foundation will not assume the public extension function but rather focus on serving the public extension function. Also the foundation will not take responsibility for undergraduate education. A liaison relationship will serve the professors and fortify research and extension activities of selected universities.

The foundation staff will consist of of some of the previous INIAP staff, as well as new professionals, and will focus on research-extension liaison and graduate educa-

tion. The new extension liaison specialists will assist in developing and testing practical technical packages, provide technical assistance to private and public extension agencies, and conduct training programs for private and public extension agencies.

D. **How the Foundation will Function:**

The foundation will be governed by an independent board of directors, The first board will be appointed by the Ministry of Agriculture; thereafter, new members will be selected by the existing board. All members will have limited terms on the board.

The foundation should have a full time chief executive officer (CEO), who will be responsible for the general organizational structure necessary for the foundation to carry out its mission and purpose. The board could reserve the right to approve all personnel recommended by the CEO for professional staff positions.

From the beginning, the foundation must have independent financing and credibility sufficient to attract professionals, restructure existing research activities, and add extension-liaison as well as graduate school professionals. In its formative years, the foundation. The endowment would be expected to increase from external donors, private donations, and, possibly, a tax on agricultural commodities specifically allocated to the capital account of the foundation.

The foundation will be responsible for operational policies on:

1. Establishing an independent salary schedule for all research, extension liaison, graduate-school, and service personnel;
2. Establishing foundation policies on rewards, promotoins, transfer, and terminations;
3. Establishing a human-resource development program for research and extension liaison personnel;
4. Establishing a set of communication activities for the research and extension-liaison programs;
5. Establishing mechanisms for linking research, extension-liaison, and graduate-school personnel to the external scientific community. This should include linkages with indigenous institutions, international agricultural centers, external scientific institutions including universities, and other international scientific organizations;
6. Establishing a system for providing research grants to selected academics and researchers. The objectives of such grants must be related to the foundation's program objectives, and appropriate evaluation mechanisms must be formulated.

E. **Foundation Governance and Structure**

The most essential condition for the success of the foundation will be the integrity of its governing board. Maintaining the foundation's independence, free of government or self-interest, is extremely important. This independence critically depends on the foundation having a substantial, assured financial resource base and independence from funding subject to political pressures. This does not mean the foundation should be insen-

cials.

sitive to national needs and priorities as defined by the people through their elected offi-

As designed, the foundation can be effective only by developing and sustaining partnerships with public-sector organizations and agencies. It is dependent upon these organizations to effectively carry out its programs but must not be captured by this dependence. It must maintain the right to use its resources in support of the most effective program approach according to the judgement of the board.

Figure 5 suggests an overall structure for the foundation.

At least four committees should be formed by members of the Board:

Planning: to annually review the priorities and contents of programs.

Development: to obtain restricted and unrestricted funds.

Finances and audit: to determine the financial state and distribution of recurrig budgets.

Nominations: to select, evaluate, and present all candidates to be employed by foundation, as well as new members of the board.

Finance

Several important elements are associated with the financial aspects of a foundation quite apart from effective use of the institution's resources. Both an adequate, stable income and the source, type, and balance among sources are important. Annual earnings from a capital endowment fund, "unrestricted", could be under the control of the board of director. The foundation will also actively seek additional "restricted" endowment funds, i.e. grants from external sources, public or private; use of annual earnings from restricted funds will likely be specified by the donors.

The relative proportion of unrestricted and restricted funding as well as the source and type of restricted funding can greatly affect the foundation's performance. A common temptation of board and management is to favor external funding (restricted) since it leverages the unrestricted funds to allow foundation activity. However, a high level of restricted funding relative to unrestricted funding can divert the foundation from its original purpose and programs, despite the best intentions of the board and management. As restricted funding sources grow, the unrestricted base becomes narrower. Thus, the institution become vulnerable to the loss of those outside funds. It is pulled toward performing activities dictated by the outside funder and becomes less capable of charting its own course as it was initially set up to do.

Other Conditions

For the foundation to represent national and regional politics, three options or alternatives are available:

1. The foundation should incorporate in its by-laws such requirements as meetings between board members and officials of any new government to become familiar with the new politics and directions.
2. By-law requirements should also state that any advisory committee of the board include members of any new government, as well as previous board members.
3. The foundation should structure strong research programs capable of anticipating future problems. This would obviate the majority of problems proposed by any

new government. A gradual reduction of development activities will strengthen research with truly anticipated capacity . A development type crisis should not affect well-programmed research activitites.

To minimize the feeling of political assignments, the Minister can name an ad hoc comittee composed of leaders in the private and public sector to nominate three candidates for board position.

The board should also plan to establish a program of board assignments for 4 years. Of the eight board members, two could be assigned per year and one of them to be reelected or replaced; two more for two years, and one of them to be reelected or replaced; two more for three years, etc. The selection of the assignments for one, two, or three years should be unforeseen, but both should not come from the same section in the same year.

Two serious points currently occur regarding position and salary scales. One is the inadequate focus on the retaining people instead of bringing in more highly qualified personnel. The other is naming positions as scientists although they are administrative to retain the higher salaries of scientists. Thus the transfers of personnel from INIAP or another entity into the foundation should not be automatic but very selective.

Table 5.2 provides a consideration of salary steps from USDA. A new graduate (Ing. Agr., etc.) or a technician with some experience should start around grade 11. A P. D. just graduated would probably begin at grade 12. Promotion through the stages or grades will be based on professional skills, publications, etc. One may start in whichever grade or stage according to his or her reputation, responsibilities, etc. Administrators and top level professionals could be included in the highest grades.

Figure 5-1. Proposed Organization for the Agricultural Research Foundation of Ecuedor.

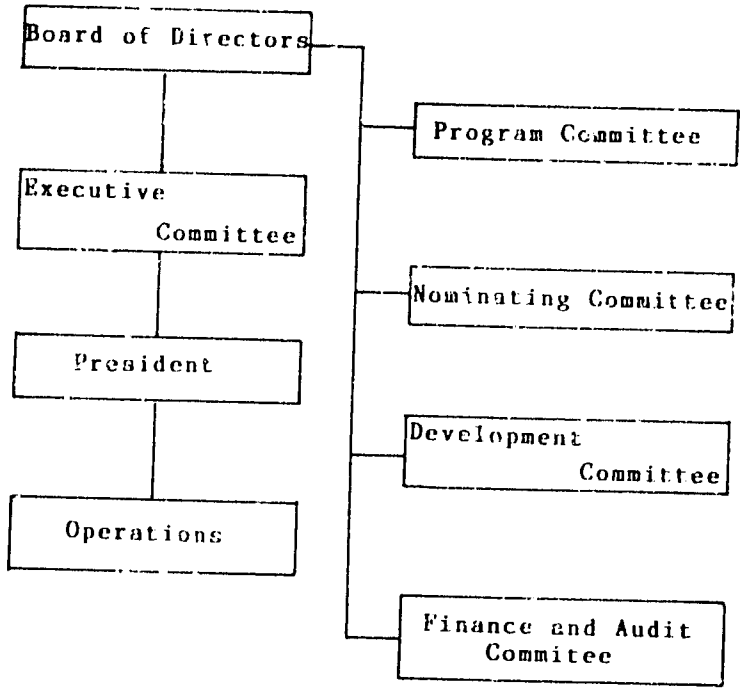


Table 5.2. Relative USDA Salary Scale.

Rating	Step									
	1	2	3	4	5	6	7	8	9	10
					Profesional grades					
11	100	103	106	110	113	117	120	123	126	130
12	120									156
13	142									
14	168									
15	199	204	211	218	224	231	238	244	251	257
16	232	240	248	255	263					
17	272									
18	319									

APPENDIX N° 6

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