WORKING PAPER No.1

LATIN AMERICAN AGRICULTURAL RESEARCH

THE PUBLIC SECTOR: PROBLEMS AND PERSPECTIVES

International Service for National Agricultural Research

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The opinions expressed in this document are the sole responsibility of the authors.

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I. INTRODUCTION

In the last decade, Latin American agriculture has shown a surprising dynamism in both an increase in productivity and production of important crops, as well as in the development of institutional research systems in almost all countries of the region. The institutional development has been uneven both quantitatively and in the organizational forms. However, if one excludes the English-speaking Caribbean countries, the dominant organizational model is the National Agricultural Research Institute.

These institutes were established at the end of the fifties and represent a major institutional innovation, now characteristic of Latin America. The institutes are subordinate to the central government but have a high degree of autonomy and an ambitious mandate that covers a wide range of regions, crops, and problems. Their rapid development and leadership role in the agrarian modernization of Latin America is a reality.

The creation of these institutes, and the growing importance of technology in agrarian production, has coincided with the growth of other public and private institutions involved in development activities and the diffusion of technology. The emergence of this multi-institutional model, the growing complexity of agricultural technology, and the rise of the private sector suggest that the nature, priorities, and organizational forms of the institutes should be reassessed so as to ensure their effectiveness under the new conditions.

This is of particular relevance to the international centers and to technical assistance programs; new requirements as well as new possibilities for greater inter-institutional integration will be identified as national programs begin a new phase of development and consolidation.

The present paper analyzes these three related topics. Sections II and III first describe and evaluate the national research systems and their resources, then identify a series of problems related to public sector research. Section IV tentatively presents some possible organizational solutions to the enumerated problems, and in so doing outlines a new organization model. Section V analyzes national programs in relation to the International Research Centers and suggests their complementary nature. Finally, Section VI returns to the topic of the financing of the national programs in view of the current external debt crisis affecting the majority of the countries in the region and its significance for technical and financial assistance programs aimed at the consolidation of the national research systems.

II. THE NATIONAL PROGRAMS

1. The Dominant Model: The National Research Institutes

The institutional development of technology generation and transfer activities in Latin America, and particularly in the countries in the south of the continent, are characterized by two stages, clearly defined by the scale of the research effort and the degree and form of the public sector's involvement. The first stage dates back to the beginnings of

research activites, and the second from the middle of the last century until the mid-1950s, when in general research activity was relatively undeveloped and highly unstable.

The first experiment stations, aimed at the generation and/or transfer of new technological knowledge for key products, were established in the early thirties and were streamlined in the following decade. However, the situation remained unstable as their administrative dependence, and hence their financing, changed frequently. The universities and agricultural schools which played an important role in the first years of the century, progressively lost ground to the institutes, which were directly dependent on the agricultural ministries. Eventually, research activities became almost entirely centralized as line activities of the ministries of agriculture.

The institutional structure suffered from limitations resulting mainly from the ministries' essentially bureaucratic nature. Among the most important were the following:

- the lack of stable budgetary support;
- poor expression of the problems and priorities of the producers;
- lack of coordination of efforts;
- inadequate communication between researchers on the one hand and technical assistance and extension workers on the other;
- finally, absence of any coordination between organizations generating technology, and others responsible for implementing different components of agricultural policy, necessary for an effective development of the productive process -- prices, credits, services, and others. (Trigo, Piñeiro, and Ardila, Chapter 7; Samper).

The second stage started in the mid-fifties in response to important modifications in the economic and political conditions in Latin America. The result was the creation of decentralized institutes with autonomous administrations, which in some ways incorporated the United States' experience (the Experiment Station system).

The new institutional model emerged from two central ideas:

(a) the perception that the central element in agricultural development was the incorporation of technology,

(b) conviction that a wide range of technology, suitable to Latin American conditions, was available internationally.

Accordingly, the objective became that of ensuring the transfer of technology from developed to under-developed countries. To achieve this, infrastructure geared to adaptive research was needed, linking importer-countries with technology-producing countries (1), partly due to weaknesses of the Research Offices within the Agricultural Ministries.

From this process emerged the following institutions: the National Institute of Agricultural Technology (INTA) of Argentina in 1957; the National Institute of Agricultural Research (INIAP) of Ecuador in 1959;

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(1) This idea is summarized in T. W. Schultz Transforming Traditional Agriculture; it served as the basis for the developmnent of the foreign aid policy of the U.S.A., implemented in 1951 and known as point IV.

the complex CONIA-FONAIAP in Venezuela between 1959 and 1961; the National Institute of Agricultural Research (INIA) in Mexico in 1960; the Agricultural Research and Promotional Service (SIPA) in Peru; the Colombian Agricultural Research Institute (ICA) in 1963; and the Agricultural Research Institute (INIA) in Chile in 1964. All of which were based on the same general model: its administrative-legal character was that of a decentralized and autonomous public entity; the operational basis of their activities was the integration of functions (research and transfer (1)).

Although decentralized and autonomous, the institutional model satisfies the requirements for a wide range of products, regions and producer types, and reflects the view that agricultural technology is a public responsibility over which the State must maintain total control (2).

This trend towards modernization of technological infrastructure can also be seen in other situations where no new organizations were created. In Uruguay's Alberto Boerger Agricultural Research Center (CIAAB),though direct dependence from the Ministry was maintained, profound operational modifications were introduced. They affected both aspects of technology

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(1) In the cases of INIAP in Ecuador and INIA in Mexico there are slight variations on the basic model, as the transfer of technology is not formally incorporated into the functions of the Institutes.

(2) Two examples of this point of view are: firstly, the structure of the Directive Group of ICA, excluding the participation of the representatives of the trade unions (Piñeiro et al, Chapter 6); secondly, the tendency of the technicians of INTA to assume the function of representing the "social demands" for technology, this being interpreted as different from that of the agricultural producers (CIAP 6)

generation and transfer (with the integration of research and extension services), as well as education when post-graduate study was included in the Center for Temperate Zone Research and Study, created through the sponsorship of IICA in the early sixties.

Brazil's is an atypical situation. The sixties brought only slight changes, but in 1973 the Brazilian Corporation of Agricultural Research (EMBRAPA) was created. This organization has certain characteristics different from the other institutes mentioned, such as the exclusion of extension, a function assigned to a twin organization, the Brazilian Corporation for Technical and Rural Extension Assistance (EMBRATER). Perhaps the most important aspect is the explicit adoption of an institutional approach, characteristic of a multi-organizational type model, with the involvement of separate levels of administration in the public sector (national and state) as well as the private sector, and coordinated by EMBRAPA as far as priorities and objectives are concerned. One can question whether EMBRAPA is an extension of the 1960 institutional model or whether it marks the start of a new one which modifies the role of the State and public-private sector relationship in the process of technology generation and transfer (1).

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(1) The trend to create decentralized autonomous institutes finds its greatest expression in the period from the end of the fifties through to the early sixties, though it continues into the seventies with the creation of the Bolivian Institute of Agricultural Technology (IBTA), the Institute of Science and Agricultural Technology (ICTA) in Guatemala, the National Institute of Agricultural Technology (INTA) in Nicaragua and finally the National Institute of Agricultural Research in Peru.

From 1960 onwards, one can observe a vigorous expansion in research and technology based on this institutional model, with continued and expanding financial support from international sources, and with increased national budgets. The expansion process was based on the creation of new experimental stations and extension agency networks, and on institutes, which led to the development of national infrastructures for post-graduate training (Argentina, Colombia, Peru, Uruguay, Mexico and Brazil).

Other exceptions to the organizational model of the research institutes exist in Paraguay, Honduras, and El Salvador as well as in the English-speaking countries of the Caribbean. In the first three countries research has remained a relatively centralized activity within the Ministry of Agriculture. A similar situation exists in the Caribbean countries, though their special relationship to Great Britain and the strong ties that some have developed between themselves constitute an important difference.

The countries of the Caribbean rely on the University of the West Indies and a regional organization (CARDI) which jointly account for the large majority of the area's activities.

2. Evolution of Resources Allocated to Agricultural Research

Budget support and the availability of human resources for research are aggregate indicators of any given government's assigned priorities, as are how adequate the existing infrastructures are, and their potential.

TABLE 1: Latin America and other developing regions. Agricultural Research Expenditures in percents of agricultural GDP (Latin American countries, 1980, rest of the world 1975).

DEVELOPING REGIONS					LATIN AMERICA					
Regions	Regional Average	Low Income	Medium Income	High Income	Countries	Low Income 1975	Low Income 1980	Medium Income 1975	Medium Income 1980	High Income 1975	High Income 1980
Asia	0.16	0.15	-	0.18	Bolivia	0.09	0.34	-		-	
					Haiti	0.01					
Middle East	0.31	0.29	0.46	0.26	Brazil	-		0.54	1.15	-	
					Chile	-		1.19	0.81	-	
West Africa	0.57	0.65	0.32	-	Colombia	-		0.50	0.64	-	
					Costa Rica	-		0.40	0.24	-	
					Ecuador	-		0.41	0.35	-	
East Africa	0.43	0.38	1.47	-	El Salvador	-		0.18	0.50	-	
					Guatamala	-		0.09	0.39	-	
Latin America	0.43	0.04	0.42	0.52	Honduras	-		0.15	0.16	-	
					Jamaica	-		0.58	0.23	-	
					Mexico	-		0.16	1.36	-	
					Nicaragua	-		0.34	0.27	-	
Total 65 countries	0.31	-	-	-	Panama	-		0.90	5.33	-	
					Paraguay	-		0.12	0.28	-	
					Peru	-		0.50	0.33	-	
					Argentina	-		-	-	0.54	1.64
					Uruguay	-		-	-	0.44	0.59
					Venezuela	-		-	-	0.49	1.32

Sources: a) Data by regions and for Latin American countries in 1975: ORAM, P 1978.
b) For Latin American countries in 1980: ORAM, P 1984.

The following presents these variables on a regional basis, noting specific cases when permitted by the available information.

Table 1 presents agricultural research expenditures, expressed in percentages of the Gross Agricultural Product (GPD) in various regions of the developing world in 1975, and for countries of Latin America in 1976 and 1980. In general terms, four observations can be made:

- First, the levels of resources allocated to agricultural research in the developing world are markedly inferior to those invested in the more developed countries, which remain above 1.5% of the value of production (Boyce & Evenson).

- Second, Latin America's investement is comparable to other regions and markedly superior to that of Asia, where past experience and concentrated international agricultural research efforts have been similar.

- Third, there is a large disparity between Latin American countries. which cannot be attributed to income level differentials nor to the relative size and importance of their agricultural sectors. Eliminating low income cases which occur consistently at the lower levels, the remainder present totally unsystematic variations.

- Finally, in the majority of these countries, there is a notable increase in the funds assigned to research between 1975 and 1980.

TABLE 2: Latin America and the Caribbean: financial resources* allocated to agricultural research. Period 1960-80, selected years.

Sub-region	1969	1965	1970	1974	1980
South Zone (Brazil excluded)	33.956	32.728	34.795	47.726	43.747
Brazil	8.280	15.533	24.178	32.879	116.797
Andean Zone	15.629	20.000	43.053	57.392	61.910
Panama and Central America (Mexico excluded)	4.409	4.967	4.904	6.318	10.215
Mexico	4.666	5.218	9.723	14.637	43.357
Caribbean (Dominican Rep. excluded)	1.536	1.536	2.273	2.933	2.124
Dominican Republic	440	496	490	2.278	1.642
Latin America and the Caribbean	68.916	80.478	120.416	164.163	279.792

Note: * Hundreds US Dollars in 1975.
Source: PIÑEIRO and TRIGO

TABLE 3: Latin America and the Caribbean: human resources (professional personnel) devoted to agricultural research. Period 1960-80, selected years.

Sub-region	1960	1965	1970	1974	1980
South Zone (Brazil excluded)	365	816	1.045	1.196	1.364
Brazil	200	500	764	2.000	2.935
Andean zone	387	643	1.294	1.694	1.843
Panama and Central America (Mexico excluded)	144	305	283	333	383
Mexico	199	279	551	1.000	1.079
Caribbean (Dominican Republic excluded)	64	96	157	228	198
Dominican Republic	3	5	12	35	99
Latin America and the Caribbean	1.353	2.644	4.106	6.486	7.901

Source: PIÑEIRO and TRIGO

In a similar analysis, grouping Latin American countries by geographic region (excluding the Caribbean because of lack of information), the situation is more homogenous than might be expected, given the variations in the level of development and in the length of time that efforts have been made to formalize and structure research organizations. The situation in the south of the continent (Argentina, Uruguay, Brazil, and Chile) and in the Andian Zone (Peru, Ecuador, Colombia, and Venezuela) show higher investment and greater homogeneity than that of Central America. Paraguay in the south and Bolivia in the Andes are exceptions, explained by the late development of their institutional infrastructures.

Tables 2 and 3 show the status and evolution of budgetary and human resources in agricultural research, in selected years between 1960 and 1980, for the principal sub-regions of Latin America and the Caribbean (1). Aggregated information, though an important indicator, can conceal institutional situations with different characteristics. For this reason, a separate table presents the information on Mexico, the Dominican Republic and Brazil, whose size dominates the sub-regional totals.

In general terms, the region is characterized by the marked expansion in human and financial resources allocated to agricultural research. The outcome is a somewhat different picture if the sub-regions are analyzed separately, and still more so if one considers the situation country by country.

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(1) In grouping by sub-regions, the criteria used by IICA in its zoning has been applied.

The following facts emerge regarding the sub-regional level:

a. the apparent deviations from the trend noted in the southern zone, where total budgets for the four countries, following a peak in 1974, were reduced by 10%;

b. the levelling out of the trend in the Andean region, when in the second half of the seventies the total budgets continue to rise, but at a much lower rate than at the outset of the decade (1).

Central America, Brazil and Mexico present an inverse picture, showing a sustained growth throughout the period (2).

The situation in the Caribbean is similar to that in South America, although the doubtful quality of the information available precludes definite conclusions.

The situation as regards human resources available for agricultural research (see Table 3) is slightly different from that of financial resources; the sub-regional totals for the South Zone continued to grow after 1974.

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(1) This situation alters if Bolivia is excluded, as it is responsible for the total increments between 1974 and 1980, increasing from less than $500,000 to more than $7,000,000.

(2) It should be taken into account that the development of institutions in countries in Central America and Brazil began as recently as 1970. Therefore, this period marks the consolidation of these institutions, a phase which took place in the sixties in the other South American countries.

TABLE 4: ICA (Colombia), INTA (Argentina) and UNA (Peru). Evolution of post-graduate training. Period 1960-1984. (new students entering training program)

Year	INTA New Students	ICA New Students	UNA New Students
1960*	7	5	33
1961	17	9	7
1962	9	17	11
1963	18	14	17
1964	23	10	19
1965	15	11	15
1966	22	22	13
1967	34	24	27
1968	28	33	24
1969	23	40	16
1970	21	51	20
1971	39	37	10
1972	24	110	10
1973	24	96	11
1974	4	57	13
1975	1	53	7
1976	2	28	6
1977	1	7	1
1978	5	4	-
1979	13	-	-
1980	7	-	-
1981	1	-	-
1982	14	-	-
1983	1	-	-
1984	2	-	-
Total	355	630	260

Note: * This figure includes students from this year and years before.

Source: TRIGO, PIÑEIRO and ARDILA.

When comparing financial and human resources, both the Southern and the Andean sub-regions give a picture of stagnation and deterioration.

The cumulative investment outlook is clarified through an analysis of available information country by country. Of the sixteen countries for which there is any detailed information available, half of them experienced budgetary peaks followed by a sharp drop. This is illustrated by Costa Rica and El Salvador in Central America, Colombia, Ecuador, Venezuela and Peru in the Andean Zone, and Argentina and Uruguay in the Southern Zone. In some instances, the differences between the extremes were as high as 50%. Generally, there were notable annual variations, which suggest a general climate of budgetary instability.

One fact which deserves mention is that the majority of instances of instability were found in countries with older institutions (Argentina, Uruguay, Peru, Ecuador, Colombia, Venezuela, etc.)

The decline of the post-graduate programs organized and financed by the agricultural research institutes, and supported by substantial external technical and financial aid is another indication of the Institutes' financial problems during the seventies (1). Between 1960 and 1978 three of these programs - namely, in ICA, INTA and the Agrarian University of La Molina in Peru - invested more than 27 million US dollars, 45% of which was derived from external support (see Table 4).

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(1) This same situation exists in EMBRAPA, where the training program at the Master's level absorbs a large proportion of external resources.

The evolution and importance of these programs is reflected in the number of students who started post-graduate studies in each year (see Table 4). The increase in numbers was uninterrupted until the late sixties/early seventies and then dropped sharply (1).

III. REFLECTIONS ON NEW CONTEXTUAL CONDITIONS OF RESEARCH IN THE PUBLIC SECTOR

1. Introduction: Identification of the Problem

The public sector plays the dominant role in the agricultural research system, although in many countries, especially those enjoying a relatively advanced level of development, various types of private sector organizations must be taken into consideration. The public sector's performance has been notably successful, which largely accounts for the modernization of Latin American agriculture in the last decades, thereby completely justifying the creation and subsequent consolidation of the institutes.

However, three decades after the creation of the first national research institute, it can be argued that there is a need for organizational change in Latin America to permit a continuous process of adaptation to the new

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(1) For a detailed analysis of these processes, see Trigo, Piñeiro and Ardila - Chapters 4, 5 and 6.

agricultural conditions and to the changing needs of scientific and technical development.

Without pretending to make either a limited or an exhaustive list of these new conditions, or implying they are important in all countries of the continent, this study will concentrate on seven types of problems that appear to be reasonably representative of the situation regarding institutions in Latin America.

2. Agricultural Modernization and Private Sector Development

The creation and development of the national research institutes as part of the activities of the public sector corresponded to a practical reality: the majority of the countries had a weak research structure and the State seemed to be the sole medium to generate the necessary level of activities. This situation was a natural consequence of the scant possibility for appropriating privately the benefits derived from research, due to the predominance of agronomic technologies and the embryonic state of industrial development. This basic characteristic of agricultural technology as public property generated by the State has in recent years been changing as a result of the modernization process itself.

From a historical view point, the first important change is the rapid mechanization in the field of commercial agriculture. This took the place of the agricultural labor force, modified the production process and facilitated the incorporation of new lands and more productive techniques.

TABLE 5: Institutional Components of the System for Generating and Diffusing Technologies.

TYPES OF INSTITUTIONS

1. National Institute of Agricultural Research
2. Departments and institutions of research in provincial and state governments
3. National Commodity Institutes
4. Universities
5. Other public sector institutions
   a. Marketing and processing oligopolies (agro-industrial complexes)
   b. Manufacturers of technological inputs
      1. Seeds industry
      2. Chemicals
      3. Fertilizers
      4. Machinery
      5. Veterinary Products
   c. Agricultural products
      1. Large firms
      2. Associations
      3. Producer associations
         i) CREA, CETA
         ii) Cooperative groups for technical assistance
   d. Foundations

The second and perhaps most important change was the increase in technological inputs (seeds, fertilizers etc.) in the production process, now the principal vehicle of technological change.

These inputs have as principal characteristics that of enabling the private appropriation of the benefits derived from technology. Consequently, they also prompt the appearance of new social actors who actively participate in developing technology and basically spreading its use (and sale) to agricultural producers.

Simultaneous to this process of industrialization, other very different kinds of private institutions, such as producer associations, also played an important role in the process of technical change.

Thus, the institutional model takes on distinctive characteristics in many countries of the region and becomes far more complex than at the time of the original National Research Institute model, when it was virtually the sole institution for the diffusion of research and technology. Private sector involvement in the innovative process manifests itself in a variety of ways, institutionally and economically, which in turn affect the specific objectives of the research and the organization that is adopted to comply with the said functions. Though the private sector operates in a virtually infinite number of forms, four will be characterized here in order to analyze its role in the innovative process (see Table 5).

The first of these is the large scale oligopoly, which controls the processing and/or marketing of agricultural products and in which control

is dependent on technology (1). A classic illustration is the broiler industry, in which the enterprise controls the provision of chicks and the sale of the final product. In this instance, technology is the key, as much in commercial competition as in the subordination of the economic actors within the complex.

The second and quantitively-speaking most important form of involvement is in the production of technological inputs. The majority of inputs used are produced by the industrial sector and the result of research carried out independent of the agricultural sector proper.

The production and distribution of these inputs are executed by private corporations with important ties to large multinational corporations. This connection with the transnational sector results from the purchase of national companies, which are then converted into subsidiaries of the transnational corporations. Subsidiaries generally are specialized in one or more inputs (or capital goods), farm machinery or germ-plasm for example, though parent companies are diversified corporate conglomerates.

Research, whether basic or applied, can in certain instances be very expensive. In the case of private sector research into agricultural and agro-chemical machinery, the companies have access to more resources than has the public sector. This sub-sector is probably a typical example of the private appropriation of benefits through the conversion of technology into a merchandise.

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(1) An agricultural complex is defined as the set of economic functions which includes production, processing and distribution of one or more products with similar characteristics.

The third type of private organizations is the one directly related to agricultural production, such as large farm corporations or producer associations that do research and/or technology transfer.

Finally, a fourth form of private organization is of the foundation type. This usually has ties with the productive sector itself and results from the initiative of institutions with philanthropic interests, and responds to special circumstances.

The increase in the number of different types of institutions participating in research and technology transfer activities presents new problems. The first of these concerns the need to establish operative mechanisms to bring the public, semi-public and private components together to achieve the system's objectives.

The second pertains to the diversity of organizations and the need to develop mechanisms which can to some extent guide the activities of the system and assure that no important clientele group is left out. Both aspects will be considered in the next section.

3. Development and Technology and Basic Science

Another consequence of the modernization process is the growing dependence on new information and technologies generated by complex and costly basic research. This has a series of organizational consequences for national research programs.

The national institutions were created with the main objective of developing technology adapted to the particular conditions of their own countries. This research was to be based on the industrialized countries' technology and on basic research available in their public sectors (mainly universities). One consequence of this perception was that institutes were limited in their activities in the field of basic research, at least according to the spirit of the legislation that created them.

At the same time, the autonomous nature of the institutes, their independence from the Ministries of Agriculture and their size compared to other research institutions, resulted in growth and development in a direction quite independent of the rest of the country's science and technology systems.

While the institutes were in a period of growth and development, their principal activities focused on adapting existing technology, developing agronomical practices and improving varieties; there were no important consequences in terms of increased effectiveness.

As technology became more complex and more dependent on science, both the isolation of the national scientific system and its inherent scientific weakness have become limiting factors to the institution's efficiency in its specific task of technology development.

On the other hand, the growing preeminence of complex technologies, and their heavy dependence on basic science, have created conditions for the accelerated development of a private sector of transnational origin, as access to technology developed in industrialised countries, and certain

economies of scale, are central elements affecting the capacity to compete in technological input markets.

These conditions create new problems for the countries at a relatively less advanced stage of development. The risk is no longer just the importation of technology unsuited to their needs. The main problem, although not immediate, is nevertheless real; it lies in the possibility that commercial practices or international conflicts might render inaccessible the basic information necessary for the development of new technology. This vulnerability suggests a need for a basic scientific infrastructure, able to interact with or replace the international scientific system, should the need arise. This infrastructure should either be part of the National Institutes, or closely linked to them.

4. Institutional Capacity for the Definition of a Technological Policy

The institutional model of the national research institutes was partially inspired by the CEPAL school of economic thinking of the fifties and early sixties. Without describing the general characteristics of the CEPAL model or its influence on institutional development in Latin America, this paper will concentrate on highlighting one of its main characteristics; namely, the consideration of the State as a central instrument for the transformation of society in general and the agricultural sector in particular. Hence, the need for a powerful public sector, within which the institutes were responsible for the generation and dissemination of technology, whilst other support services were to be provided by similar specialized institutions.

This approach was based on two ideas. The first was linked to the then correct assessment of the general weakness of national entrepreneurial capacity, the technological backwardness - particularly in agricultural production - and the supposed resistance to technological modernization by many agrarian sectors. The second was linked to the vision of the State as the representative of more general social interests, and consequently the logical authority for definition and articulation of measures conducive to economic and social development.

These ideas suggested an organizational model in which the ministries or departments of agriculture should have the capacity to design agricultural policies (including technology), which would be carried out by decentralized institutes, coordinated by the ministries as the normative units of the system.

In the majority of the countries, the ministries' capacity to determine and coordinate agricultural policy was not developed adequately. Consequently, the research institutes, lacking clear and precise research priority directives, had to incorporate this function into their own structures. But they lacked the organizational and operational capabilities needed to perform this function, and internal tensions naturally developed from the ensuing political discussions in connection with priority-setting and allocation of resources.

With the recent expansion of the private sector and the increasingly complex nature of technology in agriculture production (phenomena described in previous sections), this function has become much more important and more complex to perform. Two elements deserve to be

mentioned. First, the emergence of private research components linked to the industrial sector, often of a transnational character, which creates a new situation and necessitates the incorporation of elements not previously considered to be part of the agricultural policy - such as the legislation of patents, or the origin of capital determining the intesity and nature of technology supply. Second, the State's functions as coordinator and generator require both a precise knowledge of the work developed by all the organizations involved, and a clear definition of comparative advantages in order to concentrate activities in areas of greater relative priority.

5. The Participation of the Users of Technology

The CEPAL model had another natural correlation in relation to the organization and administration of research institutions. They were to be strongly linked to the public sector and to be administered by representatives of the public sector; they were to be active instruments of a national policy aimed at transforming and modernizing the agricultural sector, including rural organizations. As a result these were to participate only in a limited way in the administration of the research institutions.

This concept represented an important departure from the institutions that had inspired those who proposed the national institutes model. In the federalized system of the US Land Grant Colleges, and to some extent in the French model, operative decentralization and greater regional product specialization permits a strong socio-policitical bond with producers of each region. This is translated in a specific social practice: producers

have effective power of decision and vote in defining the research activities, and in the corresponding allocation of resources. This is not a secondary but a fundamental characteristic of the institutional model, and does not depend on opportunities, nor on specific production structures; in turn, the producer's interests are tied directly to the survival of the organization as a whole. This local specificity and joint effort, related to the priority setting and resource allocation, has not been present in the case of national research institutes of Latin America.

After three decades, the original concept - probably correct at the time of its formulation - should be reconsidered in the light of the new developments. The first argument to support this view is connected to certain characteristics peculiar to technology and to the research and extension institutions.

In other areas in the agricultural domaine - such as marketing or land reform - it is possible to argue that the participation of producers in the management of the institution represents an obvious conflict of interests, giving producers an advantage in relation to other sectors of society who also have vested interests in their functions.

In the case of the technological institutions, this argument does not seem so important and is counterbalanced by clear advantages. The Institutes would be more efficient if the users could express their technological needs clearly and consider the research organization as their own, rather than an active instrument of agrarian policy, often perceived as hostile to agricultural interests.

A second argument is of an empirical nature and refers to the great transformation the agricultural sector underwent, and the receptivity of agricultural producers towards the innovative process.

6. Bureaucratization and Administrative Control of the Public Sector

The national institutes created in the 1950s and early 1960s were conceived with the intention of giving agricultural research a certain degree of administrative and technical autonomy from the central power. However, an examination of its actual functioning suggests that, in the majority of cases, this autonomy is insufficient to allow the necessary administrative flexibility and the development of an environment favorable to scientific creativity (1). This situation resulted from two inter-related processes.

The first originates from outside the Institutes proper and is related to the growing degree of bureaucratization and centralization of the public sector in a number of Latin American countries; an especially strong trend during the seventies. The public sector's legal and administrative complexity, and the high degree of centralization in decision-making is a fact. Institutional policy regarding salary levels, working hours, foreign travel restrictions, etc. is affected. These restrictions, common to all the institutions, respond to the global criteria of public administration aimed at control of expense and personnel. They are

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(1) A survey of technical personnel who had resigned from positions in research organisms of three countries in the continent indicated that inadequate working conditions are the principal reason for their resignation (see Trigo, Piñeiro and Ardila).

particularly pernicious to research institutions, which by nature have special needs.

The second element is partially an internal issue: a poor participation in the development of the agricultural policy has left the institutes without clearly defined research priorities and a lack of guide-lines for their own institutional policies, and has contributed to the development of an image where they function as a "free wheel" within the policy system. This image in certain instances has lead to the natural and inevitable reaction on the part of administration to try and control the institution through administrative instruments. This involves the creation of innumerable situations requiring decision-making and monitoring with the result that management becomes increasingly bureaucratized.

This trend has particularly serious implications for the productivity of researchers as it subordinates them to an administrative system incompatible with the needs of scientific enquiry. Because of the size of the Institutes, the extent of the geographical area they cover, and the diversity of the problems covered by their mandate, decisions are made which reflect no true appreciation of the realities of the situation and are formulated on the basis of inappropriate information.

7. Origin and Stability of Funding

The funding for agricultural research activities has come mainly from public funds allocated from national budgets (1).

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(1) It has frequently been suggested that this funding mechanism is one of the determining factors in the budgetary instability noted earlier.

The main characteristics of this financial set up have been:

a. the public nature of the funds and the fact that they originate from general taxation. This has meant that agricultural research has had to compete on an equal footing with all other public sector activities;

b. the allocation of funds is generally made for the whole institution without consideration of the final use of these funds, which is an internal decision of the organization itself.

Of course, there existed and still exist several important variations as to the way in which resources are acquired, and how their allocation is decided. In this respect, the most significant examples are INTA of Argentina, where up to 1981 and since May 1984, the funds came from a tax levied on agricultural exports; CEPLAC in Brazil and FEDERACAFE in Colombia, engaged in cocoa and coffee research respectively, where funds were derived from taxes levied on these products; and CENICAÑA in Colombia, involved in sugar research, which is funded on a formula based on sugar exports and price differentials between the internal and external prices of sugar (1).

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(1) These global outlines of institutional financing are complemented by specific sources such as those received by ICA through the Ley 5ta. of 1974. The specific programs that the Rice Federation of Colombia conducts with the brewers industry, the research programs in pasture that Ecuador's INIAP is conducting with the support of the Association of Mountain Cattle-Farmers, etc. are other examples.

TABLE 6: Latin America and Caribbean: year to year variations in budgets assigned to agricultural research. Period 1970-1980.

	1971/1970	1972/1971	1973/1972	1974/1973	1975/1974	1976/1975	1977/1976	1978/1977	1979/1978	1980/1979
NORTHERN ZONE:										
Costa Rica	2.91	1.06	0.64	0.76	1.27	1.11	1.10	0.95	1.21	0.97
El Salvador	1.21	1.17	1.26	2.23	0.97	1.80	0.90	1.24	0.62	0.88
México	1.36	1.57	1.66	1.07	1.48	1.15	0.83	2.70	1.13	1.13
Nicaragua	1.04	1.03	0.83	1.06	1.15	1.08	1.10	0.84	1.08	1.07
Guatemala	-	-	0.82	1.47	1.02	0.96	1.16	1.06	1.20	1.02
Panamá	1.22	1.18	0.97	0.97	0.76	0.70	1.16	1.02	1.69	0.95
CARIBBEAN ZONE:										
Barbados	1.07	0.87	0.86	0.89	0.88	0.98	1.00	1.16	1.35	0.88
Jamaica	5.57	1.06	1.54	1.08	0.96	1.03	0.88	0.71	0.60	1.09
Guyana	-	-	-	0.93	1.36	0.71	0.35	-	-	-
ANDEAN ZONE:										
Bolivia	1.01	0.80	1.02	1.02	0.95	0.09	1.75	1.12	0.91	0.87
Colombia	1.14	0.98	1.01	0.92	1.01	1.05	0.86	1.26	0.92	0.94
Ecuador	1.33	1.30	1.09	0.92	1.02	1.02	1.01	0.82	1.13	0.80
Venezuela	-	-	-	-	-	-	1.13	1.03	0.85	1.16
Perú	0.77	1.06	1.07	0.96	1.39	0.91	0.56	0.89	0.92	0.92
SOUTHERN ZONE:										
Argentina	0.84	1.10	1.25	1.20	0.79	0.94	1.02	1.05	0.99	1.08
Brasil	-	-	1.21	-	-	-	1.02	1.06	1.25	1.00
Chile	1.11	1.02	0.57	1.07	0.91	1.27	0.99	0.10	1.03	1.03
Paraguay	-	1.11	-	-	-	-	-	0.99	1.04	2.06
Uruguay	1.07	1.07	1.23	1.11	1.25	0.78	1.16	0.88	1.32	1.06

Source: TRIGO and PIÑEIRO

An alternative scheme, recently utilized by INIA in Chile, formally combines two types of financing: global at the institutional level; specific project funding at the program level. This scheme establishes a basic level of funding to cover personnel and some operational costs, which is decided by traditional national budget allocations; any remaining operational costs are financed by directly interested parties via contracts and agreements on specific research projects. The formalization of a mixed (private-public) funding mechanism for research is an important institutional innovation with implications for the role of the public sector in technology generation, and with specific research administration requirements.

It is important to note that despite the use of several different funding models, the bulk of the funds for research comes from general tax revenue allocated through the national budget, the case of Argentina being probably the only important exception. This, plus the fact that research investment generally receives a low political priority (due to the long-term nature of benefits usually widely distributed among various social sectors), has resulted in a considerable instability of the budgets assigned to agricultural research. Table 6 shows the extent of this phenomenon during the seventies. In certain countries, during that period, the annual fluctuations in the amount allocated to the agricultural budget varied by more than 100%.

Given the long term nature of research, this instability is particularly detrimental: high variability means in some cases the loss of non-replicable agronomic information, or the need to discontinue multi-seasonal experiments, which cannot be repeated once funding levels have returned to normal.

IV. ELEMENTS FOR A NEW INSTITUTIONAL MODEL

The situations and problems mentioned suggest a number of elements that could serve as a starting point for reconsidering a new institutional model, better suited to the specific needs of scientific development in the light of the current Latin American conditions.

a) The first element is the degree of administrative and financial independence required to guarantee financial stability and create working conditions conducive to scientific innovation. In the case of Latin America, there is a need to create a legal framework which allows a reasonable level of independence from the central administration. This does not signify an absence of normative mechanisms ensuring a linkage between research priorities and the global development policy, but administrative independence to define organization patterns and a more flexible funding procedure.

b) Second, a clearly defined administrative department for the formulation of technological policy to act as a normative framework for agricultural research activities. The formulation of such a policy is a highly political issue and consequently closely linked to the political powers. Similarly, given the special characteristics of scientific and technological activity, the scientific community and different clienteles of agricultural research also need to participate in this process. Consequently, the organizational mechanism best suited to this task would seem to

be a Technological Policy Council, in which all relevant social sectors and the scientific community take part, but which has no direct responsibilities for the actual carrying out of research activities or the dissemination of technology. This body, however, should have direct and explicit means for implementing its policy decisions. There are several alternatives, but in the light of Latin American systems, financial mechanisms seem to be the most appropriate, potentially effective and deserving of further consideration. It involves the creation of a specific fund, under the control of the Council, to underwrite research activities within the context of a national research plan, reflecting global policy priorities.

c) Third, successful research requires a certain critical mass of human and financial resources to achieve the required area specialization to allow some depth of thought, and, to capitalize on the synergistic effects resulting from the discussion of diverse theoretical and methodological perspectives. However, a flexible administrative and managerial system is also necessary to enable authority to be founded on consensus and scientific leadership, rather than on a formal administrative hierarchy. These conditions seem to be more easily achieved in relatively small institutions with a certain degree of thematic specialization, and with a clear and precise relationship with the users of technology. To satisfy these requirements, the research system might consist of a number of independent operative units, with limited and specific mandates defined on either a thematic or a regional basis.

d) Fourth, the integration of the users of technology into the processes of priority setting and program development. The need to develop institutional mechanisms that facilitate linkages between researchers and users has already been argued. Nevertheless, this is mainly, although not exclusively, a feature of agrarian productive systems. In the case of institutions dedicated to more basic research, it is important to establish linkages with the consumers: these being, in general, research institutions devoted to the development of technologies. Consequently, the governance mechanisms of the operative units of the research system must be considered in terms of professionals collaborating with the principal users of the institutional product.

e) Effective operational linkages with the international scientific community. In relatively less-developed countries, the inevitable dependency of research on scientific knowledge generated in developed countries and international research centres is a well-known fact. However, despite recognition of this problem, it is generally thought that knowledge can be transferred through the traditional mechanisms of scientific exchange: namely, publications, international conferences and the like. Though useful and important, these mechanisms would appear to be inadequate in view of the increasing complexity of new technologies, the partial privatization of technological development, and the proliferation of research centers. In this sense, from the experience of the industrial sector as regards institutional mechanisms and activities directed by international

transference of technology, (though enjoying little success generally), some important lessons could be learnt and other alternatives for future mechanisms deduced.

These five principles of organization illustrate the possible modifications which could be introduced into the current organization of the agricultural research institutes. Obviously, the pragmatic nature of the modifications requires a careful analysis and solutions adapted to the needs of each country. This is specially true in regard to firstly the forms of interaction between the institute and the productive sector and secondly, the mechanisms for the formulation of technology policy.

V. NATIONAL PROGRAMS AND THEIR INTERACTION WITH INTERNATIONAL AGRICULTURAL RESEARCH CENTERS

In addition to the new contextual conditions described in previous sections, a subject that deserves special attention is the relationship between the National Programs and the International Agricultural Research Centers. The latter have had a major impact on the activities of the National Programs and, through them, on the agriculture of developing countries. It is therefore important to analyze the possible trends and the changes in emphasis in the activities of the Centers, their comparative advantages and the type of links that the National Programs can develop with them in order to fully benefit from their potential contributions.

The first International Research Centers were created with a mandate to improve some of the most important food crops in the world. The basic idea was that by assembling a group of highly qualified researchers with adequate funds, the Centers could have an important impact on the yield and general productivity of these crops. This function was considered a medium-term objective, and programed to last until the national programs reached a level of development sufficient to assume responsibility.

The creation of the first Center took place over twenty years ago; there would now seem to be a growing consensus of opinion that the task is a long-term one, and that the International Centers should become more or less permanent with time, fulfiling a complementary function to that of the National Programs, possibly having to vary their content and priorities as they develop.

Even though some Centers, and especially those created in the seventies, have received broader thematic mandates, partially defined in terms of regional problems, it appears that the effectiveness of a Center has been linked to the presence of clearly defined mandates, restricted to the improvement of a few species of world-wide importance. These are tasks for which their organizational structure is particularly well adapted (1). Thus, it is reasonable to expect that the majority of the Centers will evolve towards activities organized around the improvement of certain crops of world-wide importance. However, it is unnecessary to debate the

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(1) For a discussion of the theme, see for example, Piñeiro, Martin - TAC 1984

question further here, as the three Centers with Headquarters in Latin America have mandates adapted to this organizational scheme.
It is important to remember that the efficiency of the International Centers in varietal crop improvement is based on four central elements:

a) The concentration of an interdisciplinary team of high scientific standing with adequate funds in a small unit involved in the problems of research;

b) The ability to collect international genetic variability with ease and speed;

c) The possibility of selecting genetic material collected and/or created by cross-breeeding in a large number of ecological conditions;

d) The possibility of achieving two harvests in the same year by working simultaneously in the two hemispheres.

These elements, characteristic of the organization of International Centers, cannot be duplicated by national programs. For this reason, a natural complementary relationship has been developing between the Centers and the national programs: the former concentrate their attention on the improvement of germplasm with relatively wide-ranging adaptability, whilst the latter work on selecting that most suitable to their ecological conditions and follow the process through to the production of seed and final dissemination of new technologies to farmers.

In recent years, there has been in certain countries of Latin America a very rapid development of seed production in the private sector, especially in those species for which hybrids are common. This has partly displaced the public sector in certain areas involved in improvement and production (1).

Recently, two new elements have reaffirmed the possibility of the private sector's involvement extending its interests into self-pollinating varieties such as wheat: first, the adoption by a number of countries of legislation which provides greater protection for the genetic material of these species; second, the possibility of the appearance of commercial hybrids. Furthermore, the development of bio-technology could generalize the use of sophisticated techniques, which might revolutionize the organization of current procedures.

It is important to note that the new possibilities in autogamous species, as well as the development of biotechnology, create opportunities for the private appropriation of benefits from research. The result is greater private sector interest, already producing important investments in this area.

The development of private sector participation, and the growing dependence of applied research on basic science, create new conditions for the International Centers both in terms of their function and their relationship to the national programs.

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(1) It is interesting to note that development in the private sector, which is largely of a transnational character, has been based on the capacity to reproduce the conditions that generate the comparative advantages of the international centers.

Much of the basic information which is now generated by the universities and other organizations in industrialized countries' public sector - and therefore available to both the Centers and the National Programs - could in future become trade secrets, protected by patents and/or commercial practices. Another consideration is the National Programs' difficulty in keeping abreast with new developments and in gaining access to the scientific advances in the rest of the world.

The implication is that the International Centers might play a fundamental role in the National Programs' pursuit of scientific progress. In this function, they could serve as a link and channel for the transfer of scientific advances, in much the same way they now serve National Programs in the improvement of germplasm. Their role would be similar to that of transnational headquarters dealing with their branch offices. Thereby the Centers would contribute to the development of national capacity in the improvement and production of seeds. This would provide an answer to those countries looking for an alternative to total dependance on the transnational sector.

VI. FINAL REFLECTIONS: CONSOLIDATION OF NATIONAL RESEARCH AND THE NEED FOR EXTERNAL FINANCING

The necessity and importance of initiating a new effort towards the consolidation and adjustment of national agricultural research programs to new contextual conditions, and to the needs of scientific development was discussed in previous sections. This is necessary not only to resolve the problems of food and agricultural production, but also because it is an issue central to the economic and social development of the countries of the continent.

TABLE 7: Resources received by INTA, Argentina, EMBRAPA, Brazil and INIA, Chile. 1978-83.

	INTA	EMBRAPA	INIA
	1974 US dollars	1974 US dollars	1974 US dollars
1978	72.362	85.868.585	6.375.027
1979	79.478	93.648.944	6.599.091
1980	70.853	90.527.479	7.401.650
1981	59.804	95.357.478	9.094.796
1982	21.851	124.378.175	6.178.006
1983	24.064	68.340.009	5.039.433

Source: Prepared by the authors on the basis of information provided by INTA, EMBRAPA, and INIA.

However, this effort cannot be implemented without an important contribution of external resources to the region, especially now when the external debt means a tight financial situation in many countries.

The heavy debt, and the consequent devaluations in a number of the countries of the region, have had an important effect on the financing of research organizations. Table 7 gives as an example the budgets of three countries' national research institutes, who all allocate a significant proportion of funds to research, and have heavy international debts (1). This tendency is probably indicative of the situation in general, and of the trend in most of the countries at the present time. Consequently, the urgency and importance of reassessing and adjusting the research organizations coincides with the most serious budget crisis in recent history.

This situation illustrates the importance of current foreign aid programs (2), as well as the opportunity for new and ambitious institutional development projects in the agricultural research area, which would permit Latin American countries to modernize and consolidate their skills in the scientific-technical field.

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(1) It is important to note that the purchasing power of the budget has not necessarily suffered proportionally to the large devaluations against the dollar.
In the case of INTA in Argentina, the return of economic self-sufficiency in 1984 will mean a budgetary recuperation and its independence of the foreign debt problem in the future.

(2) The IDB, as well as the World Bank have active loan and technical assistance programs supporting agricultural research activities at the national level. IDB between 1971 and 1980 granted loans to 8 countries, for a total value of 25 million US dollars, for non-repayable technical cooperation projects, distributed among 20 projects. The World Bank has granted two loans of 96 million US dollars. Among the bilateral aid programs, the one of greatest importance is that of the USAID in 1980, with 25 projects being carried out, total commitment until 1985 being almost 70 million US dollars.

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