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## PROYECTO COOPERATIVO DE INVESTIGACION SOBRE TECNOLOGIA AGROPECUARIA EN AMERICA LATINA (PROTAAL)

### INSTITUTIONAL ASPECTS OF AGRICULTURAL RESEARCH/ORGANIZATION/IN LATIN AMERICA, PROBLEMS, PERSPECTIVES AND POLICY ISSUES

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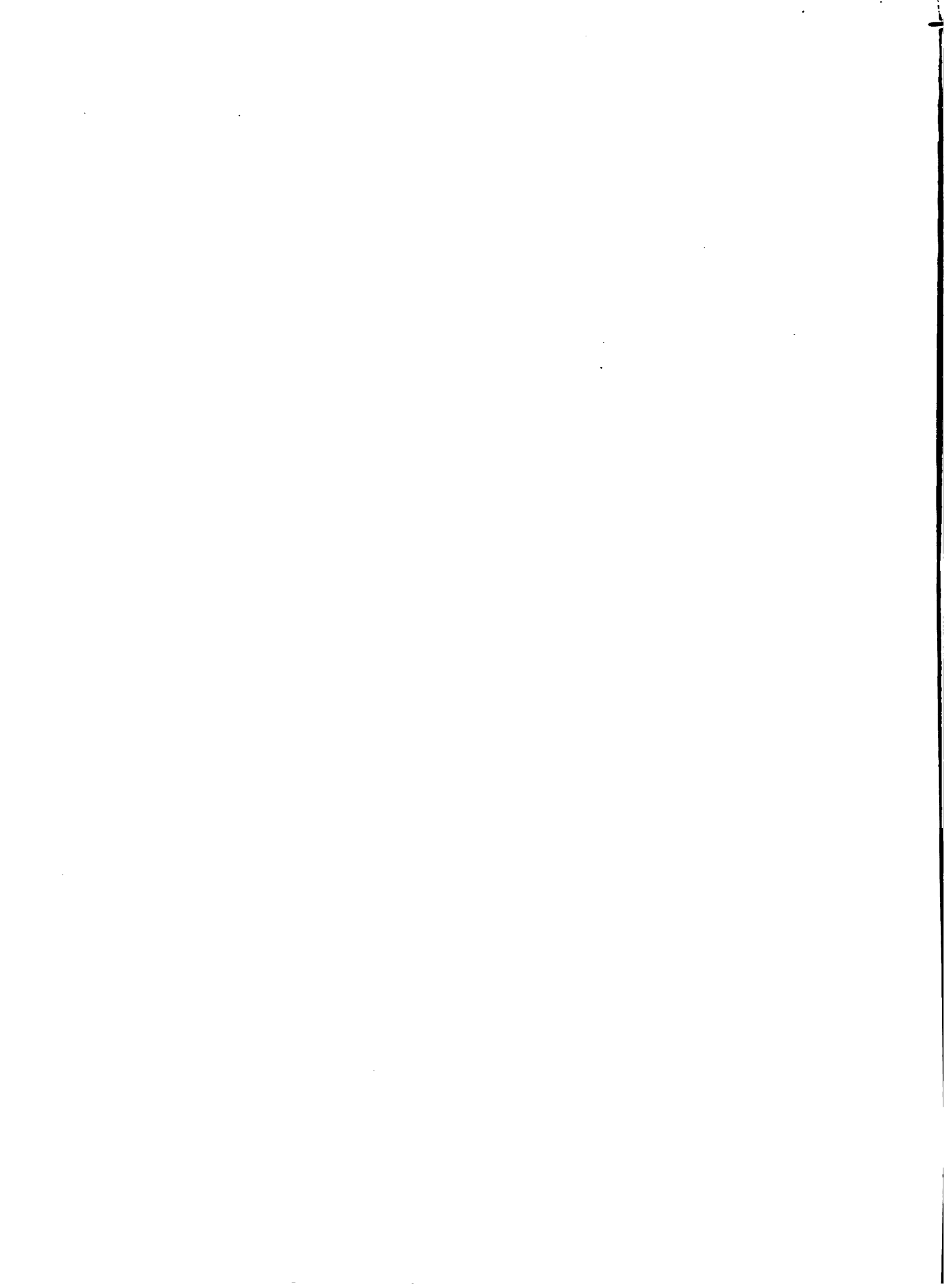
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I. INTRODUCTION

This paper presents ideas and questions about the problems facing the National Agricultural Research Systems in Latin America, and it is intended as a basis for a more general discussion on future actions in the area of Science and Technology for the agricultural sector.

During the last two decades, the technological question in Latin America focused primarily on creating, developing and operating National Agricultural Research Centers. These were and still are the principal centers for agricultural research at the national level; they absorb the bulk of human and financial resources available for this type of activity, and consequently are representative of the national capabilities in agricultural science and technology.

In response to its basic strategy of institution-building, IICA concentrated its efforts on developing these public organizations by providing technical assistance and cooperation.

The fundamental point made here is that the economic and institutional development that took place during the last two decades introduced transformations in the institutional context where technology generation and transfer take place. These transformations need to be incorporated into the strategies for support and technical cooperation for the technological component of rural development.

These transformations refer primarily to the private and semi-public organizations that operate in specific aspects of technology generation and transfer. Together with the National Institutes, these organizations now form a multi-organizational system replacing the (de-facto) State monopoly which existed at the beginning of the sixties when the latter were being developed.

These developments are inevitable in the evolution of the market economies which characterize most of the Latin American societies. They are considered positive factors in as much as the participation of different economic and social sectors in the technological process increases the amount of resources available. In a significant number of countries, however, the emergence of these new institutions caused the National Research Centers - once their initial stages of territorial occupation and institutional consolidation were completed- to suffer increasing conflict and contradictions in defining their objectives and their organizational structure.

Partly as a result of these conflicts, the Institutes appeared to lose political support. This affected their performance and, consequently, their competence vis a vis the new agencies operating in the system. The crisis situation gave rise to number of questions which must be resolved because of the central role the Institutes should play in the process of generating and transferring technology.

It is important to emphasize that although the Institutes are not only one of the components of the national technology generation and transfer system, the essential characteristics of the physical-biological research process and the organization of the agricultural sector demand that the State -and by extension, the Institutes which represent State participation in this field- play a major role in this field. Unless this role is performed effectively, the remaining components of the system will have difficulty on achieving their specific objectives. This indicates the importance obtaining a correct description of the nature and origins of the current institutional situation before attempting to implement actions in an effort to curb this process.

The progressive development of a multi-organizational system, in which member organizations simultaneously complement and compete with each other, requires that the element of complementarity be highly developed in order for the system to operate effectively. The functions of each component and the operative mechanisms tying them together must therefore be clearly and precisely defined. Likewise, the fact that the State has lost the monopoly, over research and transfer indicates the need to develop institutional mechanisms to ensure that the countries preserve their capability to determine

and orient their own technological process; that is, they need their capability to define and implement policies on science and technology for the agricultural sector.

Following is an analysis of the evolution of the National Research Institutes, the principal dimensions of their current problems and the principal factors determining this evolutionary process. This will support the assertion that the above mentioned institutional developments -creation of a multi-organizational system and crisis in the national agencies -are not isolated factors, but rather are parallel manifestations of phenomena specific to Latin American agricultural development.

The third section describes the emergence of the new organizational components and of some of the relationships between the process and the performance of the National Institutes. Finally, a summary is made of the elements that should be considered for implementing actions in the area of agricultural science and technology.

## II. NATIONAL AGRICULTURAL RESEARCH INSTITUTES IN LATIN AMERICA

### A. Origin and Development of the National Institutes

The institutional development of technology generation and transference activities in Latin America, particularly in the countries of South America, is characterized by two well-defined stages. They are distinguished by the magnitude of the research effort and by the degree and form of public sector participation. The first of these stages covers since the initiation of research activities, during second half of the past century, and lasts until the mid-1950's. It is characterized by a low level of research activities, carried out under ad-hoc and generally unstable institutional mechanisms.

Toward the end of this stage (the thirties and forties) the first experimental stations were organized. The situation, however, continued to be unstable because of the dependent nature of the experimental stations. Funding sources for research changed frequently, and the universities and schools of agriculture progressively became less important than the

institutions directly dependent on administrative power. As a result of this process, research activities were almost completely centralized in the Ministries of Agriculture.

This institutional format suffered from a number of limitations, generally due to the bureaucratic nature of the Ministries. The most important of these were: unreliable budgetary support; inability to target the problems and priorities of farmers; fragmentation of efforts; inadequacies between research, and technical assistance and extension; and lack of coordination between the research organization and those implementing the other components of agricultural policy required for the effective development of the productive process (prices, credit, services, etc.) (PROTAAL, 1977; Samper, 1977).

During the mid-fifties, certain factors substantially changed the situation, giving rise to the second stage of the process, characterized primarily by the decentralization of research and, in some cases, technology transfer (extension activities). These activities were shifted to decentralized, autonomous institutes generally patterned after the Experimental Station System of the United States.

The new institutional model was chosen to reflect the concept that technology is central to agricultural development, and the conviction that a broad range of potentially useful technology was available at the international level for the productive sector of Latin America. The problem, then, was to transfer this knowledge from the developed countries to the developing countries. It would be necessary to develop adaptable and flexible research infrastructures linking recipient countries with generating centers, a task which the Research Offices of the Ministries of Agriculture could not perform effectively because of the above-mentioned problems. This concept is summarized in T.W. Schultz's book, "Transforming Traditional Agriculture", upon which the United States' Point IV foreign aid program (initiated in 1951) was based.

This idea was reinforced by a significant amount of financial and technical foreign aid, which was used to develop new institutes by building physical infrastructure and training research staff.



Thus, with some variations between organizations, but always within the same general framework, INTA was created in Argentina in 1957, INIAP in Ecuador in 1959, INIA in Mexico in 1961, ICA en Colombia in 1962, and INIA in Chile in 1964. The trend towards decentralization was not limited to the technological institutions; it also affected other service areas such as marketing, credit, etc., complemented by sectoral planning offices responsible for coordinating overall sectoral policy.

In the seventies, EMBRAPA was created in Brazil, FONAIAP in Venezuela, IBTA in Bolivia, ICTA in Guatemala, INTA in Nicaragua and INIA in Peru. During this period, Venezuela and Peru depart significantly from the general model. In the first case, the private sector participates intensely through foundations like FUSAGRI. In the second, the innovation appears through the active participation of the University (the Agrarian University of La Molina).

From the point of view of organization, the Research Institutes, which became the basic elements of the systems in 1960, were decentralized, autonomous, and covered a broad range of products, regions and farmers. Functionally, they integrated research, especially applied research, with transfer activities, including, in some cases, post-graduate education (INTA and ICA). Slight differences in the integration of functions show up at INIAP in Ecuador and INIA in Mexico. At INIAP, technology transfer is not a formal function of the Institution, and in the case of INIA, the Institution does not conduct livestock research.

In most cases, the Institutes were administratively organized to include National Research Centers for subject areas or products, and responsible for developing basic research; the experimental stations and extension agencies performed applied and adaptative research and transferred new technological knowledge. This structure aimed to institutionally integrate the different stages of the technology generation and transfer process, and to tie the process directly to the production problems of the different regions and types of farmers.

From the operational point of view, programs by discipline and product were superimposed upon this decentralized structure. They provided a basis for developing activity programming, selecting priority actions, allocating resources and the coordinating national programs.

Within this context, in the early sixties a strong emphasis was placed on expanding research and technology transfer activities in the agricultural sector. Note that this stage grew out of the developments taking place within the Ministries which were receiving significant support from international agencies, who were following the United States policy summarized in Point IV of its foreign aid legislation. From this time on, and because of continued and increasing financial support from international sources, and larger national budgets, the stage known as "territorial occupation" was developed, with the creation of new experimental stations and extension agency networks. At the same time, broad programs were begun for training staff researchers; these in some cases included the development of national infrastructures for post-graduate education (ICA, INTA and La Molina).

In the early seventies, this sustained growth and the ensuing consolidation began to create problems in a significant number of countries, particularly in those where national research agencies had been created in the early sixties (Argentina, Colombia, Chile and Peru). Mexico was an exception to this process, and Brazil and Venezuela cannot be evaluated yet, as their research organizations were only created in the early seventies. In 1973, EMBRAPA replaced the Department of Agricultural Research and Experimentation, and FONAIAP was transformed into an Autonomous State Service in 1975.

The remaining sections of this paper present an analysis and description of these problems attempting to identify some of the causes of this institutional situation and to highlight the policy measures required for the national institutions to recover and fully fulfill their central role in the technological process.

B. The Conceptual Base of the Model: The State and its relationship with social groups involved in the technological process

One of the primary assumptions for an adequate performance of the type of research organization adopted in Latin American countries is related to the nature of the State's pattern of administration, and its ability to

implement technological policies which will stimulate technological change.<sup>1/</sup>

The technological agencies are decentralized public entities from the point of view of implementation, linked to State policy-setting agencies (Ministries, Planning Offices, etc.) for their general orientation. They specialize in generating and in some cases, transferring technology, which means that the policy-setting agencies must coordinate the tasks of different executing agencies to achieve the common objectives of agricultural policies. That is, aside from the generation and dissemination new technologies, price, marketing, credit, and other policies must also be developed and implemented to facilitate the adoption of new technology by the producing sector.

Furthermore, technological institutions must serve a broad range of products and recipients, the comprehensive scope of their action obliges them to respond to considerably disparate interests and problems, which could lead to an internalization, at the level of operational decisions, of conflicts arising from the diversity of interests manifested by the different target social groups.

In order for an institutional model with these characteristics to operate effectively, the State must be a highly coordinated and powerful, in relation to the civilian society from which it emerges, and thus capable to define a given strategy and implement it through State agencies. In the developed countries, the political supremacy of the industrial sector following the Second World War, led to the implementation of a strategy for modernizing agricultural production, which significantly increased yields. On the contrary in Latin America the situation has been characterized by the absence of a preponderant social group, and thus by the permanent presence of unresolved conflicts at the State level in regards to the overall strategies of agricultural development and modernization.

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<sup>1/</sup> In this context, technological policy involves scientific policy, aimed specifically at regulating innovative activity; and socio-economic policy, which has broader objectives than the technological question, as it affects the manner in which agricultural enterprises adopt new technology.

This is reflected in State activity as a whole, and has implications for the technological question. Unresolved conflicts at the State level reveal inconsistencies in the different policy measures implemented for different regions and products, and they hinder the effective incorporation of technology into these productive processes. Likewise, the various needs and requirements of the highly differentiated agricultural sectors are reflected in the technological institutions. Because no scheme existed for prioritizing beneficiaries, products or regions, institutions underwent a progressive breakdown in their ability to define operational priorities and effective relationships with their clientele.

In this line, two matters of singular importance are worth noting. In the first place, the productive structure of the Latin American agricultural sector is characterized by a great diversity of situations and the predominance of small farms. This creates serious limitations of the productive sectors ability to adequately express its technological demands. In the second place, the socioeconomic conditions within which small-scale farmer develop their productive activities make the technological variable only one of many components they need (prices, credit, marketing, health, housing, education). Thus, because they also lack trade or other organizations of small-scale farmers, their demands for technology are expressed only partially, and the research organizations themselves must seek to fill existing needs by using mechanisms created for "reading" the requirements of these sectors. These mechanisms, however, face the additional difficulty of having to decipher very different contexts of design and operation, which has further detracted from their effectiveness.

The presence of commercial sectors which can adequately express their demands has caused most research activities to concentrate excessively on the problems of commercial agriculture. This is due to the fact that the technological variable is more critical to this sector's activities. As a group they are better equipped to express their needs, and the research apparatus is more experienced and better adapted to dealing with their problems.

This fragmentation of Research Centers is one of their main limitations. As soon as it occurred, they abandoned their original mandate, thus

losing a good part of their connections and the political support they needed for maintaining the flow of resources required for developing and strengthening their activities.

### C. Principal Indicators of Current Institutional Problems

An indicator of the status of research agencies at the regional level is the magnitude of resources allocated for research and technology transfer throughout the continent (Ardila, Trigo and Piñeiro, 1980). An analysis of this kind, however must be carefully qualified since general figures for the region as a whole do not reflect differences in institutional situations, particularly in terms of the size of the countries and their potential for investing in technology.

A brief analysis of the evolution of expenditures for research from 1951 to the present, based on information gathered by Boyce and Evenson (1975) shows increase from US\$ 30 million in 1951 (1971 dollars) to approximately US\$ 115 million in 1974, and to more than US\$ 180 million in 1979 (Schultz, 1979). These estimates suggest an optimistic future for the region, but upon consideration of the significant growth of resource allocation in Brazil and Mexico -around US\$ 25 million annually between 1971 and 1974 alone- and the initiations of activities in some of the countries, particularly those in Central America, it becomes evident that general budgetary increases reflect primarily the relative weight of the different countries. The analysis of some cases in particular tends to provide more evidence of this.

Similarly, the study of the evolution of research expenditures in each country as an indicator of the institutional status of research activities also requires a certain degree of qualification for correct interpretation. This evolution alone may not faithfully reflect the institutional status or the support that research activities receive at a given moment, since the origin and mechanisms through which budgetary allocations move act to subordinate the significance of a given budgetary figure. Only if the funds come directly from the national budget, does their evolution accurately indicate State support of these activities. This analysis should also be complemented with information of the country's overall budgetary

situation, in order to determine how assigned funds indirectly determine research activities. In instances where the research budget is independent of the national budget and is tied to other specific sources, as in the case of INTA in Argentina, where resources reflect a fixed percentage of agricultural exports, the evolution of the budget is not a satisfactory indicator of the State's priority for research efforts.

Having clarified the validity of the budgetary analysis as an indicator of the institutional situation, we can now briefly summarize the evolution of the budgets the most important research institutes in Argentina, Peru and Colombia.

Table No. 1 presents the budgets of INTA, ICA and the Agrarian University of La Molina. In general, both INTA and ICA received similar budgetary support, showing steady increases during the sixties, and a dramatic reversal in 1970/72. The case of the Agrarian University is quite different since the cyclical nature of the budget makes it impossible to pick out any clear trend. In Colombia, the National budget provides ICA's funds, but these were reduced during a time of certain budgetary affluence which resulted from the "coffee boom" of 1974/75.

The case of INTA requires greater qualifications since its budget is tied to the volume of exports. At the beginning of the decade, the budget was reduced after a severe drop in the value of the exports. In 1970-73, expenses (approved budget) required practically 100% of the income. A political-institutional movement ensued, climaxing in 1973, when an increase was approved for the percentage of the value of agricultural exports destined for INTA, which went from 1.5 to 2%. From that time on, the situation changed substantially and, except for the initial increase registered in 1973 and 1974, the real amount of the annually approved budget declined for the institution. Between 1960 and 1975 the minimum value of the expenditure income ratio was 77%, normally running greater than 85%. Subsequently, this relationship decreased to 63% in 1976, 51% in 1977, and 67% in 1978 (Ardila, Trigo and Piñeiro, 1980). These figures indicate that both institutions suffered a clear loss of institutional support (Table N°1).

TABLE N°1: BUDGETS ALLOCATED TO THE PRINCIPAL AGRICULTURAL RESEARCH INSTITUTES IN ARGENTINA  
COLOMBIA AND PERU

YEAR	INTA (Argentina) Millions of 1977 pesos	ICA (Colombia) Thousands of 1970 pesos	LA MOLINA (Peru) Thousands of 1974 soles
1965	10,33	-	218.111
1966	11,71	61.250	325.888
1967	15,00	152.604	410.943
1968	16,18	155.617	293.581
1969	15,49	231.381	168.167
1970	17,84	294.921	282.675
1971	14,80	290.875	281.726
1972	14,28	378.603	285.176
1973	19,62	167.491	246.240
1974	23,36	290.559	194.856
1975	18,24	314.212	341.071
1976	15,51	301.818	438.998
1977	17,48	306.558	385.786
1978	20,48	257.273	391.137

Source: Ardila, Trigo and Piñeiro, 1980.

In general, these programs were developed within a strategy that included strong external support during the initial stage later replaced by national supports as institutional coordination progressed. The plan envisioned initially sending scholarship holders to study centers abroad, while a national infrastructure for post-graduate training, at least to the Masters' level was simultaneously being developed for eventually satisfying most of the country's training needs.

Table No. 2 describes the evolution of the training programs in Argentina, Colombia and Peru, overall as well as within national programs. Note that the training programs follow the same general trends as overall Institute budgets.

Following an initial stage of sustained growth during the late sixties and early seventies, an abrupt decline occurred which culminated in the closure of the programs toward the end of the decade. This closely follows the movement of external funding for training activities. In Colombia, Argentina and Peru, international support for training in the agricultural sciences grew until 1969-1973, when it declined until almost disappearing in 1978. This indicates inability or disinterest on the part of national agencies to substitute international funds with their own, as set forth in the original strategy. (Ardila, Trigo and Piñeiro, 1980).

An increasingly severe institutional crisis grew out of this situation, and the agencies were apparently unable to retain trained personnel on staff. As a result once training programs were no longer available, the number of trained personnel progressively declined.

This process is clearly reflected in the information found in Tables No. 3 and No. 4 on the withdrawal of personnel and the total number staff with post-graduate training at the end of each year. The migration process which has its own serious implications, diminished the operative capability of the agencies by draining their technical teams and by upsetting their programs. Similarly, considering that the productive capabilities of researchers increase in proportion to their work experience, the relatively high rates of staff turnover decrease the average work experience of any level of staff and markedly decrease their productive potential. According



(specific products of ecological regions), the support they could provide to national level activities was limited.

The larger organizations like INTA or ICA were thus forced to attempt to fulfill their own basic research needs, which further aggravated the agencies' resource situation, and caused internal conflicts as a result of their inability to functionally and doctrinally adapt to these types of activities.

On the second point, the seventies were characterized by constant changes in the organization and operation of the agencies and their duties. Perhaps, ICA in Colombia illustrates this point most clearly. The other two institutions underwent processes that, to different degrees, brought out the discrepancy between the original model and present conditions or demands. Functional difficulties arose because of the constant changes introduced into the organizational charts, but probably the most noteworthy and important fact about this process was that these changes were attempting to establish better ties between research activities and the concrete problems of the farming sector. Examples are the creation of planning units and the efforts made to regionalize and integrate research and technology transfer activities. It also placed into question, both at home and abroad, the agencies ability to achieve their objectives and contribute to increasing agricultural production and productivity and improving the standards of living of the rural population.

The last set of indicators regarding the institutional status of the Research and Technology Transfer Institutes involves the evolution of highly-trained human resources (critical mass), that can be considered perhaps the most important necessary condition for developing an effective research program. The research organizations in the regions, and the international agencies that support their creation and development are in agreement with this. Proof of this are the important training programs that were implemented prior to and following the creation of the National Institutes.<sup>1/</sup>

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<sup>1/</sup> Estimates place the amount that went into training programs in Colombia, Peru and Argentina at US\$ 30 million with approximately 50% coming from external sources and the rest, from national funds. (Ardila, Trigo and Piñeiro, 1980).

TABLE N°2: INTA, ICA AND THE LA MOLINA AGRARIAN UNIVERSITY: PERSONNEL ENTERING POST-GRADUATE STUDIES  
TOTAL AND IN NATIONAL PROGRAMS (1965 - 1978)

Year	INTA		ICA		LA MOLINA	
	Began Studies	National Program	Began Studies	National Program	Began Studies	National Program
1965	15	2	11	-	15	2
1966	22	3	22	-	13	2
1967	34	-	24	8	27	1
1968	28	10	35	7	24	6
1969	23	2	40	8	16	2
1970	21	5	51	15	20	4
1971	39	21	37	8	10	3
1972	24	8	110	59	10	1
1973	24	16	96	52	11	5
1974	4	-	57	40	13	5
1975	1	-	53	51	7	1
1976	2	-	28	23	6	2
1977	1	-	7	-	1	-
1978	-	-	4	3	-	-

Source: Ardila, Trigo and Piñeiro, 1980

TABLE N°3: INTA, ICA AND THE AGRARIAN UNIVERSITY OF LA MOLINA: STAFF WITH POST-GRADUATE TRAINING WHO WITHDRAW FROM THE INSTITUTION. ( 1965 - 1978)

YEAR	INTA	ICA	LA MOLINA
1965	-	1	-
1966	2	1	-
1967	1	-	2
1968	1	4	2
1969	4	4	1
1970	7	3	4
1971	9	12	4
1972	2	9	12
1973	4	15	6
1974	3	27	14
1975	4	45	9
1976	30	28	9
1977	3	16	8
1978	7	19	14
<b>T O T A L</b>	<b>77</b>	<b>181</b>	<b>85</b>

Source: Ardila, Trigo and Piñeiro, 1980

TABLE N°4: INTA, ICA AND THE AGRARIAN UNIVERSITY OF LA MOLINA: TOTAL STAFF WITH POST-GRADUATE TRAINING (MS OR PH.D) 1965 -1978

YEAR	INTA	ICA	LA MOLINA
1965	56	47	49
1966	70	60	68
1967	87	90	70
1968	105	100	77
1969	120	107	90
1970	133	123	104
1971	141	142	123
1972	169	163	124
1973	193	192	126
1974	209	256	128
1975	221	311	127
1976	197	336	120
1977	195	371	117
1978	189	382	102

Source: Ardila, Trigo and Piñeiro, 1980

the analysis by attempting to reconstruct the conditions of the fifties, and analyze the characteristics of the organizational model proposed at that time. In this regard three important elements should be noted.

In the first place, the creation and dissemination of new technology was the foremost component in the strategy for agricultural development at the time. Consequently, a favorable "environment" existed at the national and international levels for institutional development in this area. This took the form of significant support not only in financial terms, but also for the political decisions needed to create and develop the agencies.

Second, a general consensus existed about the need to incorporate technology for increasing production in agriculture. This consensus was supported by the availability of new knowledge (e.g. hybrid seeds) which is essentially neutral in its distributive effects. Developing technological institutes thus received the support of different agrarian sectors, without generating explicit attacks from the remaining groups. Support was also forthcoming as a consequence of the processes of industrialization and urbanization taking place during the fifties. This is summarized in ECLA's doctrinal position, in which technological modernization of the agricultural sector played a central role.

Finally, during the initial period, the rate at which basic knowledge was generated was insufficient for evolving field technology, and the unavailability of research personnel created low levels of interest and few opportunities for the private sector to develop activities.

Because of these elements, the model of decentralized public agencies (which replaced Ministry research structures that had complained of bureaucratic administrative obstacles to their effectiveness) appeared as a natural and effective response to current needs.

Furthermore, these characteristics create the classic situation where the State must assume the responsibility of developing technology. Thus, the State's quasi-monopoly which is implied in the concept of National Institutes, is a result of prevailing "contextual conditions", rather than a concrete definition of the role they should play in the technology

generation and transfer process. Note, however, that this situation arose as part of a number of insitutional developments dealing with more than just the technological question. A case in point is the creation of comprehensive and sectorial planning mechanisms that complement and strengthen the State's quasi-monopoly over technology and that include technology management in addition to other instruments traditionally managed within agricultural policy. 1/

This initial situation changed during the last 15 years as a result of certain institutional developments occurring within and external to the National Institutes directly related to the three elements described as characteristic of the sixties.

The first significant development took place in response to changes in the emphasis on the importance of technology as a variable to the development process. During the fifties, the incorporation of new technology was viewed as the key element to agricultural development. Later, more comprehensive actions like agrarian reform, and then rural development received the spot light. In these, technology still figured as an important variable, but it now became subject of specific requirements, having to do with ecological conditions, types of users, and other, which characterized each situation.

This change in the outlook and significance of the technological variable within the development process appears to have involved the progressive appearance of an inability in the Institutes model to adapt to Latin American reality. This poor adjustment present since the beginning, was unnoticeable as long as the Institutes set their own general technological objectives, and their actions primarily served commercial agriculture, whose characteristics, had more in common with the contexts held as a frame of reference for the adopted model.

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1/ INTA's idea, as a variable of economic policy, is clearly documented in the overall reorganization of the public sector. In the case of ICA, several similar references exist in different policy documents dating from the early sixties. (Piñeiro, et. al, 1979).

As previously noted, the National Research and Extension Institutes were modeled primarily after the Experimental Station System of the United States of America, which provided not only the general principles but also such operative guidelines as research by discipline and products, extension methods, and others. This model was originally developed in response to commercial agriculture and quasi-competitive markets for inputs and products. Researchers selected their research priorities based on market signals -the induction mechanism- that reflected the relative scarcity of factors, and the farmers made their decisions to adopt new technology on the basis of their profitability, also defined by these same market signals. Within this context, the traditional research and extension systems had proved their effectiveness, and this was implicit in the Latin American technological institutes.

Similarly, this change of emphasis on the priorities of the technological institutions required corresponding organizational change like the creation of mechanisms for providing an appropriate selection of research priorities in line with the needs of the new clientele (hitherto uninvolved in the technological process) and transfer techniques that effectively alter the market limitations which had inhibited the adoption of technology by small-scale farmers.

This situation produced two converging phenomena. On the one hand, the institutes went through a process of discussion and internal reorganization in order to adjust to their new duties. Changes had to be made in the organization of research, and greater emphasis had to be placed transfer activities and boosting production, at the expense of research work.

ICA in Colombia illustrates this process. Between 1969 and 1975, the percentage of total institute resources allocated for research decreased from 44.5% to 27.9%, while funds for rural development activities (for counselling small-scale farmers) rose from 13.7% to 27.7%.

This change in emphasis caused considerable problems in doctrines which reflected institutional traditions assigning great weight and importance to research and consequently, the composition of their teams,

made up primarily of research staff. 1/

The reorientation also implied the gradual abandonment of commercial agriculture as the priority target, and the institutes thus lost the support of the strongest political groups in the agricultural sector.

The second important development occurred as a result of unceasingly intense conflict over the non-neutral nature of technology. Here it is important to consider three matters directly related to the development of the agricultural sector and the general economy, which have a great impact on the emergence of these conflicts: (a) the industrialization that accompanied the development process increased the demand for food products and gave rise to new social sectors affected directly by the intensity and nature of the technological process, and consequently interested in being able to influence it. In particular, the urban-industrial and food marketing sectors were both interested in increasing production as a means of decreasing the prices of agricultural products; (b) some conflicts arose as a consequence of the implicit "biases" inherent in the new technology. This had to do with the relative intensity of the use of production factors. Meanwhile, the possibilities of incorporating new land into production, usually with the use of the same technology, became the primary source of production increases; and (c) the growing ties between the agricultural and the industrial sectors, as a consequence of increases in the use of industrial inputs in agricultural production and the development of agroindustrial schemes for processing production, involved two new social sectors with clearly defined interest into de technological discussion. These were concerned primarily with adapting technology to the requirements of their processing systems.

A third and last development which should be mentioned is the appearance of alternative sources of technology at the national level, through farmers' organizations, the activities of input industries, and agribusiness. This will be further pursued in the following section. In part, this development is a result of their greater accumulation of basic knowledge and

1/ The results of an opinion poll on the causes of the migration of technical specialists from the National Centers indicate the lessening importance given to research activities as one of the major factors affecting the decisions of individual technical experts. (Ardila, Trigo and Piñeiro, 1980).



trained staff. The appearance of these technology-generating mechanisms reveals the consolidation of a new institutional model, better adapted to the emerging "market conditions". The State's quasi-monopolistic position in technology generation and transfer changed to a structure of responsibilities shared by the State, through the National Institutes, and the private and international sectors, which not only reflected the natural evolution of the technology generation and transfer system in market economies, but also the lack of a clear State position protecting its monopoly in the area.

These three points indicate that an altogether different context had developed from the time the first National Institutes were created. They consequently were obliged to readjust their mode of operation, in terms of specific objectives and support apparatus. Examples are the importance given by ICA to rural development, INTA's efforts to regionalize its activities in Argentina and the growing importance of farm systems programs in a number of centers (EMBRAPA in Brazil, INIAP in Ecuador, etc.). These gestures emerge as agency initiatives within their existing doctrinal and organization framework, that is, without a formal recognition of the need to develop new organizational structures defining the objectives and goals of each component based on the needs and limitations of the context. 1/

This is the framework within the institutional problems of the National Institutes developed, characterized by reduced budgets, staff migration and questions regarding their effectiveness. However, it is noteworthy that technology generation and transfer activities in the countries in the region did not diminish, but on the contrary they increased as a result of the activities of the components of the emerging regional system of science and technology.

The next section deals with the make-up of this regional system. It is an important subject, requiring additional clarification, particularly regarding the nature of the new institutional developments and their impact on the performance of the National Research and Extension Institutes.

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1/ An exception to this may be the case of ICTA in Guatemala where much of these aspects were formally recognized and used as basis for a new organizational structure.

### III. PRINCIPAL INSTITUTIONAL DEVELOPMENTS OF THE LAST DECADES

It was noted that one of the most critical factors pertaining to the development of the current institutional problems of the National Research Institutes was the appearance of new organizations that competed with them in the generation of and transfer of knowledge.

This section deals with the principal institutional developments of recent years and briefly analyzes their impact on the performance of the National Institutes.

#### A. The Agricultural Inputs Industry

State activity for generating agricultural technology was justified by certain characteristics of the agricultural sector that provided no major incentives for the private sector. These are: (1) the small of agricultural enterprises makes it difficult for them to undertake research activities; (2) the high risk of biological research, and (3) the limited possibilities for private enterprise to appropriate the benefits of these activities. This doubtless influenced the model of the decentralized National Institutes which flourished in the late-fifties and the following two decades. However, the increased demand for production factors spurred by the agricultural expansion of the sixties and seventies, the progress that took place in the sciences and the basic knowledge produced as a consequence of the support provided to research during this same period, as well as the simultaneous development of legal mechanisms protecting the title for certain intellectual innovations, increased the interest (profitability) of the private sector in including certain types of research and technology transfer in their marketing schemes.

Initially, knowledge on certain basic matters like soil maps, working methods, and germplasm banks was extremely limited. As research programs developed, these were the first problems to be tackled and the profitability of research for the private sector consequently changed. This was not the result exclusively of the actions of the National Institutes, but of the impact of international developments and multinational enterprises as well. The contribution of the National Institutes, which

included training staff for private industry, was one of the most important aspects however. Evenson (1977) identified this initial stage as creating "technological potential" (groundwork), followed by the stage for making use of the potential (this is where private activity enters), until a point is reached where a new effort is needed for creating additional groundwork. Dynamically speaking, the ability of generate technological potential became the system's critical element.

The development of the seed industry during the sixties is a clear example of how public investment (the form of new knowledge and information, as well as staff training) changed the conditions of profitability, enabling the private sector to acquire an increasingly important role in the generation and transfer of technology. This is particularly true in certain stages of the process such as developing new varieties, experimental testing, and technology packaging, where it is possible to accurately predict the results, and thus reduce the risks of the investment. This type of participation is usually absorbed by the department of technical services of the input factors or even private research and experimentation centers operating independently of the enterprises.

The case of the agrochemical industry in general, and the poultry industries in Venezuela and Argentina in particular, are examples of direct participation. FUSAGRI (Farmer's Service Foundation) in Venezuela is a prime example of a successful Center financed by private industry but operationally independent. 1/

#### B. Technology Generation and Transfer by Farmers' Organizations

The same factors mentioned for the inputs industry, that is, the development of the agricultural sector and the possibilities generated by the new methodological knowledge and staff training carried out by the Research Institutes during their initial stages, set the scene in the late sixties, and more intensely in early 1970, for two types of institutional

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1/ For a more extended discussion of the role of private and multinational enterprise in the creation and dissemination of agricultural technology, see Marcano (1979).

developments to take place through which farmers' organizations began to participate in generating and transferring technology. Once again, the groundwork generated by the centers acted as a catalyst for the participation of certain sector of farmers in generating and transferring technology.

The first of these was the development of farmers' organizations for transferring technology following the format of the Consortia of French Agricultural Technology Experimentation (CETA). These attempted to replace the extension systems of the Research Institutes, and created farmers groups for the purposes of contracting private technical assistance. The first of these was created in Argentina in the late-fifties, under the name of Regional Consortia of Agricultural Experimentation (CREA). These became more popular during the next decade and particularly during the 1970's. They have extended to other countries, especially Chile and Uruguay.

The second development is more complex and farther-reaching. In it research and technology transfer activities are directly undertaken by the pooled efforts of farmers of specific crops. 1/

The late-sixties, and particularly the seventies, saw this type of activity increase markedly producing progressively more "separation by product" in research. The cases of rice and sugar cane in Colombia are interesting illustrations of this phenomenon.

Although research and transfer activities on rice began at ICA, they were gradually taken over by the technical services of the National Federation of Rice-Growers (FEDEARROZ), especially in the area of technical assistance. The presence of the International Tropical Agricultural Center (CIAT) as a center providing new varieties and technological resources apparently played an important role in how this process developed and consolidated.

The case of sugar cane differs somewhat from that of rice, but from the point of view of the National Institutes, their situations were similar.

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1/ This type of institutional organizations is not new. The Colombian National Federation of Coffee-Growers, for example, has run the Chinchiná Coffee Research Station for generating and transferring technology since the thirties. It began operations in 1932 and has been operating until the present as the only center conducting research on coffee in that country.

Most important among the differences was the creation of a Research Center (CENICAÑA) having ties with the public system (participation of State representatives on its Board) but absolutely independent in its funding and decision-making process from the State and the trade organization which created it (ASOCAÑA).

Finally, we should point out some particular characteristics of the legal status of the agencies created, and their relationship with the State structure, especially in terms of the funding, which enables to anticipate their expansion to other products and countries.

First of all, these developments took place in highly homogeneous situations, vis a vis the productive structures and the territorial concentration of productive units and, consequently, the consistence of technological interests. This is also the case for the CREA groups.

Second, and perhaps most important, these activities took place where it was possible to redirect public funds previously allocated to a public research agency (as in the case of rice) or to create new sources of public funding (sugar cane).

This indicates that these developments, although significant, will never substitute public activity. They are possible only in specific situations characterized by certain forms of productive structure and corporate organizations are possible. Furthermore, the fact that they were financed with public funds, usually siphoned from a specific allocation, suggest that mechanisms must be developed for orienting and controlling their use.

### C. International Centers

The third element of context we wish to discuss is the appearance and rapid growth during the last 20 years, of the model of International Agricultural Research Centers.

The development of this new institutional component is directly related to the successful efforts of the Rockefeller Foundation in agricultural research and productivity programs conducted in Asia and Latin America in the forties and fifties. The model is also based on the Research Centers operating during the colonial period, which obtained significant

results, especially with tropical products such as sugar cane, cotton, pineapples and others.

The rapid growth of the system can be noted in the remarkable growth of its budget: from US\$ 1.1million in 1965 to over US\$ 100 million at the present time. This is related to two main factors that are closely tied to the evolution of the National Research Institutes. 1/

The first factor was the awareness that given the importance of technology for the development process, it was possible to obtain high rates of return on research investment. Note, for example, the rapid dissemination of Mexican varieties of wheat and the strains of rice produced by the IRRI in the Philippines. The second factor involves the growing interest of multilateral agencies in finding alternatives to the model of inter-institutional contracts with counterparts, through which international technical assistance had been channeled for research and rural development. These had proven to be effective mechanisms for developing institutional skills (institution-building), but not for effectively developing more productive technologies.

The model of the International Center, then is a more effective mechanism for developing certain kinds of research, based on their greater stability and broader geographic range.

This new format took shape in Latin America in the International Center for the Improvement of Corn and Wheat (CIMMYT) in 1966, as a continuation of the Rockefeller Foundation program in Mexico; the International Tropical Agriculture Center (CIAT) in Colombia 1967, with the mandate for the humid American tropics; and the International Potato Center (CIP) in Peru in 1971.

The development of the International Centers, and particularly of those operating in this region, significantly contributed to technology-generating activities. Examples of these contributions are the dissemination of Mexican varieties of wheat; the important increases in the production and

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1/ Ruttan (1978) discusses these matters in greater depth.

productivity of rice in Colombia and Central American countries with the CICA varieties; the improvements in beans and cassava obtained by CIAT and their work in pasturage for the subtropical flat-lands. The development of the Centers however, also had parallel consequences not necessarily beneficial to the National Institutes.

The creation of the agencies, in itself meant a change in emphasis of the support provided by bilateral and multilateral institutions through the mid-sixties to the National Institutes.

It is unclear whether the appearance of the Centers caused a reduction in this type of support to national agencies. Several sources (Evenson, 1977 and 1978; Schultz, 1979) however assure that the growth of the Centers was paralleled by a reduction of support to the national agencies. Ruttan (1979) declares emphatically that this is so. At the same time, he calls attention to the urgent need to support these agencies as they are the key link in the international chain of technology generation and transfer.

Also, these Centers offered the institutional beneficiaries of technology (such as farmers' associations, manufacturers of production factors and others) an alternative source of knowledge, and may have contributed to isolating the national research agencies and reducing their political support. This may have played an important role in the development of FEDEARROZ in Colombia, which would have had great difficulty in getting off the ground without its relationship with CIAT. Certain developments in seed production in the private sector are also linked to the possibilities that opened up as a consequence of basic work performed by the Centers.

This impact was heightened by the fact that, at least initially, and perhaps as a result of the need to provide results to their community of donors the Centers sometimes established competitive rather than collaborative relationships with the National Institutes.

Another point worth noting is that the International Centers were created as "interest groups" vis a vis the National Institutes, and consequently their pressure to keep national activities consistent with their own programs was not necessarily in line with the priority objectives of the national agencies. This phenomenon of penetration is a consequence of

the important role played by the National Institutes regarding the productivity of investments in the international system, since they serve as natural links between the Centers and the productive system.

#### IV. SUMMARY AND CONCLUSIONS: RECOMMENDATIONS FOR THE DEVELOPMENT OF AN INSTITUTIONAL SYSTEM FOR SCIENCE AND TECHNOLOGY IN THE AGRICULTURAL SECTOR

The above sections have discussed ideas and evidence concerning two fundamental aspects of the problems of agricultural technology in Latin America. These problems have been articulated to initiate a discussion of research organization policy issues and related alternatives for technical cooperation.

First, the region has a rapidly growing system for the generation and transfer of technology. It includes International Agricultural Research Centers, National Institutes and finally, a number of private and semi-public institutions oriented toward specific aspects of the process. Second, emphasis has been placed on the deterioration of the primary component of this system, the National Institutes for Research and Extension, a phenomenon particularly evident in the most long-standing Institutes which can be seen as pioneers of the model that spread through the region beginning in the late fifties.

This last point is of special importance since in spite of the appearance of other components in the so-called regional system, the National Institutes are still the central link of the technological process and concentrate the most of the investments in agricultural research in each country. This is supported by three major factors: first, although private efforts to generate and disseminate technology have grown considerable, they concentrate primarily on transferring a certain type of technology, selected because of its potential for private appropriation of the benefits -and therefore its ability to make the investments profitable- or as part of the new inputs marketing programs. This type of activities do not cover: (1) the functions developing the groundwork without which the private sector's capability to create new technology will soon be depleted; (2) other very specific



activities which, because of their generic nature (methodological research for example) and the low probability of immediate results, are not likely to be assumed by the private sector; and (3) the development of certain types of technology not associated with the use of production factors, such as cropping practices, herd management, and others. The private sector has no interest in such technology as there is no possibility of private appropriation of the benefits. This is true in general terms, but it must be qualified in view of certain developments such as the CREA groups, which clearly enunciate the possibility of effective private participation in developing this type of technology also.

In the second place, the International Centers are not an alternative to the National Institutes. Their mandate is highly specific and complementary and it is physically impossible for them to achieve the kind of territorial coverage available to the National Institutes.

Finally, most of the new institutional developments are highly specific in their coverage and, in general, they are associated with the products and conditions of commercial agriculture and particular forms of corporate organization. 1/ This means that abroad spectrum of users is not being served by the new organizations, and therefore becomes the major responsibility of the National Institutes.

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1/ It is to note that the agricultural associations in Argentina, in spite of the fact that they are very powerful, have no active participation in the technological process, except as members of the Directors' Council of INTA. This contrast significantly with the experience in Colombia, where the associations appear to play a role of growing importance. There, the origin and certain characteristics of the organizations assume a special significance. The associations in Colombia are product-specific, and in the countryside, there is a long-standing tradition of providing users with services and of making their interests heard in political circles. However, the Argentine associations cover a wide range of products and even of kinds of producers, and their actions have never extended beyond the simple expression of political and sectoral interests. These differences are important because the product and farmer homogeneity in Colombia enables the associations to take a stand on the orientation of the technological process without generating serious conflicts inside the association. The diversity of interests in the Argentine associations would make it difficult to produce of a uniform technological platform for a Rural Society or for the Agrarian Federation.

All this highlights the importance of the National Institutes, not only because of the scope of national and international efforts for development, but also -and perhaps more importantly- because they affect the potential effectiveness of the operations of the overall system.

A key element in any discussion of the dynamics of research organization and particularly the National Institutes model is to determine whether or not the situation described above stems from the very nature of the institutional model involved. If it is a part of the normal life cycle of the organizations, the situation can be expected to appear in other countries, as well as, their organizations continue to develop. Otherwise, the situation could be stemming from institutional problems characteristic of the countries in which it is occurring.

In regard to the evolving policy issues -and related areas for technical cooperation- two factors defined in terms of the development of regional system for science and technology for the agricultural sector should be discussed. The first is to maximize the potential of each component of the system by defining its role and functions. The second involves the nature and characteristics of the mechanisms that interrelate the various components, in order to make maximum use of their complementary nature and to avoid duplications that prevent the effective use of scarce resources.

#### A. The Organizations of the Regional System

The scope of this topic is very broad, and it is difficult to discuss in general terms. We must first understand the special characteristics of each national system and the relative degree of development of private and semi-public alternatives for the generation and transfer of technology. Nevertheless, certain general comments can be made concerning the International Centers and the placement and functions of the National Institutes in the system. The nature and comparative advantages of each type of organization should not be overlooked.

The International Centers were developed in order to guarantee the continuous flow of highly productive biological technologies, and because of necessary when early efforts failed to strengthen national research

organizations (Ruttan, 1979). However, pressure has recently been mounting for these organizations to expand their activities beyond the improvement of varieties and the development of related technologies, to become true Rural Development Institutes. This is seen as a way of giving farmers the greatest impact of the investments being channeled through them. If this trend continues, it will be safe to say that the comparative advantages of the International Centers are being underused.

It is now understood that productivity increases do not depend totally on the presence of new technological knowledge. Institutional and political factors, such as policies for intervention in the factor and product markets, investments in infrastructure, etc., restrict any efforts to make real increases in productivity through the use of available technology. These factors lie outside the area of influence of the International Centers. Even the discussion and analysis of such matters is the exclusive prerogative of national organizations in charge of policy implementation. This is not meant to imply that, as a ongoing part of their programs, the Centers should not be developing and understanding of these restrictions in order to allocate priorities and resources.

International Centers, which give a high rate of return on investments, are a very effective mechanism for the development of genetic resources. In the future, it may be necessary to expand the range of topics they study. In such a case, the criterion for expansion should be to incorporate those areas which are stable, appropriate for concentrating highly trained technical resources, etc., and therefore offer comparative advantages. These advantages would go to waste if attempts were made to limit the centers and focus their attention on problems of economic roadblocks to the producers. adoption of new knowledge. Given the Centers' institutional nature and the origin of their funding, attempts to move into these areas could lead to conflict situations from the political standpoint.

Mosher (1977) discusses several possibilities for future functions of the International Institutes, and lists three options: (1) continue exclusively as research institutes; (2) expand outreach activities toward national research institutes and to cover national production programs; and (3) become service centers for national centers and programs, de-emphasizing

direct research and concentrating on assisting national institutes to be more productive. The first option would mean maintaining the present role and characteristics, whose effectiveness has already been shown. The other two options would mean entering into the general technical assistance field for which the centers, given their organization and governance system, seem to have no comparative advantages. For some situations -regions- these two later functions maybe in deep need, if that is the case a more sensible alternative would be to create or use regional centers or organizations with formal linkages to the countries so as to assure a proper identification of necessities at this intermediate level.

As for the National Institutes, it is very important to state clearly that the outcome of research, and consequently the top-priority responsibility, is to create new technological knowledge. This must be fully understood. The ability to use the resulting knowledge to bring about increases in agricultural production and productivity is limited by a series of institutional and political factors beyond the control of technological organizations which cannot and should not have to assume institutional responsibilities.

Therefore, technological organizations must be required to provide technology appropriate for each particular context, and a result, they should be judged by their effectiveness in this effort. To this end, they need to develop appropriate mechanisms for identifying their clientele and their specific problem areas, in order to guarantee the efficient allocation of priorities and resources. This does not mean they should cut off all transfer activities, but perhaps they should establish a conceptual difference between these activities and actual technology generation, which face a very different set of handicaps.

#### B. Mechanisms of Institutional Interrelationships

The mechanisms that interrelate various components of the system should be approached on two levels: the relationships between regional components (International Centers) and national components, and the relationships among the various national components.

The first type has been discussed implicitly in the above paragraphs, and it can be summarized as the need to establish effective channels for transmitting the information generated by the International Centers toward the National Institutes. It also includes feedback mechanisms by which the National Institutes inform the International Centers of the results of applying new technology to the various production situations in each country. This information should also serve in the progressive effort to adapt Center programs to the different sets of national problems.

In turn, the relationships among national component of the system occupy two different levels. First, it is necessary to establish operational mechanisms linking public, semi-public and private components, and enabling them to complement each other. Second, the existence of many organizations of different types requires a certain ability to orient all the various activities of the system. As long as National Institutes monopolized all work on the national level, this need went unnoticed. The orientation of technological variables, as an element of the development strategy adopted, was assured through the decisions on resource allocation inside the organizations themselves.

These factors, for defining the roles and functions of the system's components, and the mechanisms of interrelationship and orientation of their activities, stress the importance of a Science and Technology Policy for the agricultural sector. This would be the primary element of technological efforts on the national level. It also suggests the high-priority need to consider technical cooperation activities in this area and to re-define them for the overall technological system.



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