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AGRICULTURAL RESEARCH ORGANIZATION IN THE DEVELOPING WORLD: DIVERSITY AND EVOLUTION

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AGRICULTURAL RESEARCH ORGANIZATION IN THE DEVELOPING WORLD: DIVERSITY AND EVOLUTION*

I. INTRODUCTION

In the publication "Considerations for the Development of National Agricultural Research Capacities in Support of Agricultural Development," ISNAR has observed that successful research systems result where there exist mutually reinforcing interactions among three groups of variables: the policy environment, the system's organizational structure, and a set of basic operational processes. These operational processes include the setting of objectives and priorities, resource acquisition and development, program development, the establishment of adequate scientific linkages, assuring the flow of information between research and extension workers, farmers, policy-makers, and the public, and monitoring and evaluating program implementation. Within this three-sided perspective the system's organizational structure provides the framework which links research and the broader social, political and economic environment, and conditions the implementation of the system's basic operational processes and thus the actual research activities performed.

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* The views expressed in this paper are those of the author, and not necessarily those of ISNAR.

In general terms, the organizational structure has to be seen as the institutional forms and mechanisms, by means of which research objectives and priorities are set, and human, physical, financial and information resources are mobilized for the operation of the research process. As such it can be considered as an additional resource, which can facilitate the functioning of the system, and multiply the impact of other available resources or limit the effectiveness with which these are used to achieve given goals. Characteristics such as the interaction with the system's clientele, the capacity to mobilize and develop resources, and even the capacity to actually implement certain types of research or research oriented to specific topics or areas will be greatly affected by the system's organizational format.

Recognizing the importance of the organizational structure does not imply the universal superiority of any particular format. The available information from agricultural research (and other fields of activity) shows that there is no one optimum method of organizing a system: a country's agricultural conditions, history, economic characteristics and socio-political traditions play a key role in shaping the optimum organizational structure for any given situation. However, it is possible to identify the general advantages and disadvantages of each organizational format.

This paper attempts to summarize the ways in which agricultural research systems in the developing world are organized, and examines some of the aspects that may have affected their characteristics and evolution. In doing so, it is hoped to clarify certain issues that concern those involved in the institution building process in agricultural research systems, particularly the nature of the relationship between

organizational format and the country's characteristics. It is hoped that this discussion will be a step towards the future development of guidelines for organizational structures in agricultural research.

This paper has 6 sections in addition to this introduction. The following section II considers the nature of the basic organizational options at the level of the national agricultural research systems and how widespread they are in the different developing regions. Sections III, IV, and V consider some of the main organizational trends in Asia, Latin America, and Africa. Section VI tries to point to the commonalities and differentiating elements in these trends. Finally, in section VII the main aspects discussed are summarized and areas for future work are highlighted.

II. THE BASIC ORGANIZATIONAL OPTIONS

From an analytical point of view, the organizational structure comprises the durable organizational arrangements through which responsibilities and authority are distributed and the reporting relationships. These relationships correspond to the patterns for division of labor: single versus multicommodity; basic versus applied research; research and extention; and coordination among the different units responsible for research. The organizational structure also includes the channels for interaction with the system's environment, which reflect the system's guidance and input mechanisms.

The analysis may begin either at the level of the overall system or at the level of the individual organization. Specific descriptive variables

at the system level are the types and numbers of organizations that perform research (degree of decentralization); their mandates (scope of work); their governance and resource acquisition mechanisms (degree of autonomy); and the patterns they follow in working with each other and with other relevant non-research organizations (planning/coordination and resource allocation mechanisms).

At the level of the individual organization, governance and resource acquisition mechanisms are the main differentiating characteristics. Using these as typological variables, agricultural research organizations can be summarized in five basic organizational types (1).

The Ministry Model: Research is organized in a line department(s) within the bureaucratic structure of a ministry (2). The basic feature of this format is that the unit responsible for research has a low degree of control over decision-making, particularly in matters concerning resource management. Funding usually flows from allocations within the national budget through the ministry treasury and administrative policies and procedures are subordinated to those of the ministry. Mandate, both in product and functional terms, is highly variable. Usually research and extension functions are located in separate units. There is no predominant base with respect to the product scope.

The Autonomous or Semiautonomous Institute: Research responsibilities are placed within an administratively independent organization. The basic characteristic of this format is a high level of control over decision-making with respect to program and administrative policy matters, which is exercised through an independent board of directors or governors. At the funding level, the autonomy allows the existence of an

independent treasury, which increases research management control over fund administration. Funding flows as a special budget line within the national budget, and in some cases funds are directly tied to specific sources of revenue (sales of given crops, export revenues, etc.). As in the case of the ministry model, functional and product mandates are variable. The first experiences with autonomous research institutions were with single commodities, however, latterly the broad mandate national research institute type has become quite widespread (3).

The University Model: Research is carried out in close integration with education within a university context. Extension activities may or may not be part of the same structure. However, the crucial feature of this approach is the integration of applied research activities oriented to technology generation within the educational enviroment. Because of the very characteristic of the university structure, this model has a high degree of both autonomy and decentralization. Funding flows through a variety of mechanisms from both public - national, state or commercial - and private sources (4).

The Agricultural Research Council. The agricultural research council model represents a variant of the autonomous research organization, emphasizing the coordination function rather than the direct implementation of research activities. Several different organizational arrangements are usually included under the general concept of the ARC. Autonomy and a high level of control over program policy matters, through an independent board of directors or governors, is the key distinguishing feature of the council model. However, specific functions assigned to them range from those of merely a review and advisory role to responsibility for the consolidation of budgets for all government

sponsored research, funding specific research projects and even directly implementing research, as is the case of ths Central Research Institutes of the Indian Council of Agricultural Research. From the point of view of mandate, the ARC almost invariably has a wide national scope of work and concentrates solely on research activities.

Private Sector Research Organizations. The basic characteristics of research organizations operating in the private sector domain are highly specific and concentrated mandates and program policy subordinate to the parent organization. There are two basic variations of private sector involvement in agricultural research: a) research departments of the industries manufacturing technological inputs seeds, agrochemicals, fertilizers, farm machinery, veterinary products and b) crop specific research associated with the agricultural producers associations. Autonomy in program and administrative matters tend to be low in the first type, where research efforts are usually directly integrated in the firms' overall production and market strategies; in producers associations, the second type, there is a greater similarity with the autonomous commodity institutes facing comparable conditions.

The above-mentioned "types" are very seldom found in isolation as pure forms; the usual situation is one where different types of research organization coexist. In such cases, the number and type of different organizations that conduct research and the coordination patterns and mechanisms that link them become the important differentiating features among systems. Two basic types of system can be envisaged: single organization systems, where the majority of research activities are carried out within one organization; and multiorganizational systems, where there are a variety of different organizations performing research

activities. The first type is generally directed from a ministry (ministries) or an autonomous research institute with a broad mandate. In the multiorganizational situation, the most important differentiating element is the existence or not of formal coordination mechanisms. Agricultural Research Councils are characteristic of the multiorganizational framework with formal coordination mechanisms; while university and private sector organizations are often typical of multiorganizational situations without formal coordination mechanisms.

Table 1 summarizes the current organizational formats of NARS for the majority of the countries in Asia and the South Pacific, West Asia and North Africa, Africa South of the Sahara, Latin America and the Caribbean (5). A brief look at the situation highlights the fact that no organizational format can be said to be predominant throughout the developing world. Quite to the contrary, a great deal of "variability" exists both within and across regions. In a cross-regional analysis two aspects to highlight are a) the concentration of the agricultural research in the Asian countries and b) of the autonomous or semiautonomous national institute model in Latin America. The ministry model (without differentiating between whether one or more ministries are involved, and allowing for some autonomous research activities) seems to be present in all three regions; however, it is more common in Africa. In Asia, the South Pacific, Latin America and the Caribbean there seems to be an association between the size of the country and the prevailing model; the smaller countries tend to carry out research within ministerial structures.

TABLE 1: ORGANIZATIONAL STRUCTURE OF THE NATIONAL AGRICULTURAL RESEARCH SYSTEMS IN 79 COUNTRIES OF THE DEVELOPING WORLD*

	1	2	3	4
ASIA AND THE SOUTH PACIFIC				
Bangladesh				X
Burma	X			
India				X
Indonesia	X			
Malaysia		X		
Nepal	X			
Pakistan				X
Philippines				X
South Korea	X			
Sri Lanka			X	
Thailand	X			
Fiji	X			
Papua New Guinea	X			
Solomons	X			
Tonga	X			
Western Samoa	X			
AFRICA SOUTH OF THE SAHARA				
Benin	X			
Botswana	X			
Burkina Faso			X	
Burundi				X
Cameroon	X			
Cape Verdes		X		
Central Africa				X
Chad	X			
Ethiopia		X		
Gambia	X			
Ivory Coast			X	
Lesotho	X			
Madagascar		X		
Malawi	X			
Mali	X			
Mauritania			X	
Mauritius			X	
Mozambique			X	
Niger	X			
Nigeria				X
Rwanda				X
Kenya	X			
Ghana			X	
Senegal		X		
Sierra Leone	X			
Sudan		X		
Swaziland	X			

	1	2	3	4
AFRICA SOUTH OF THE SAHARA (continued)				
Tanzania			X	
Zambia	X			
Zimbabwe	X			
Somalia	X			
LATIN AMERICA AND THE CARIBBEAN				
Argentina		X		
Bolivia		X		
Brazil				X
Chile		X		
Colombia		X		
Costa Rica	X			
Ecuador		X		
El Salvador	X			
Guatemala		X		
Honduras		X		
Mexico		X		
Nicaragua	X			
Panama		X		
Paraguay	X			
Guyana	X			
Belize				X
Peru		X		
Uruguay	X			
Venezuela		X		
Barbados	X			
Cuba	X			
Dominican Republic	X			
Jamaica	X			
Haiti	X			
Trinidad & Tobago	X			
WEST ASIA AND NORTH AFRICA				
Cyprus	X			
Egypt			X	
Morocco			X	
Syria	X			
Tunisia	X			
Turkey	X			

* Key to symbols overleaf

Key to Table 1: Types of NARS

1 Research carried out predominantly by ministeries (one or more; there are may be one or more autonomous efforts, restricted to specific crops).

2 Research carried out predominantly by an autonomous or semiautonomous agency with a broad mandate both in commodity and territorial terms (there are maybe also one or more single crop efforts and some research at universities).

3 Research is carried out by several different entities: ministries, autonomous and/or semiautonomous agencies, universities, without the existence of a central coordinating authority.

4 Research is carried out in a multi-organizational situation with a central coordinating body (Agricultural Research Council).

Source: Elaborated by author on the basis of primary and secondary information available at ISNAR.

In the next section we discuss the characteristics of these main organizational forms and their evolution over the last 20 to 25 years.

III. THE ASIAN AGRICULTURAL RESEARCH COUNCILS

The ARC model is one of the main features of agricultural research organization in the Asian continent over the last 20-25 years (6).

The particular characteristics and powers invested in the ARCs vary, but as indicated in the previous section, coordination and planning functions constitute the foundation of the research council idea. Specific functions may be:

* Review and advisory role in regards to the program and projects of other organizations.
* Responsibility for developing a long-term research plan.
* Preparation of a consolidated research budget for all agricultural research organizations for approval by the Government.
* Financing, monitoring, and evaluation of research projects of national interest out of own funds.
* Final decision on the allocation of all agricultural research funds among executing agencies.
* Responsibility for coordinating training for agricultural research.
* Responsibility for coordinating external technical and scientific assistance in agricultural research.
* Responsibility for coordinating external financial assistance in agricultural research.

In terms of legal status, ARCs are autonomous organizations, with full powers to set administrative policies and procedures. The highest

authority is the Board of Directors/Trustees, whose members are chosen, by legal requirement or in practice, not on a personal basis but according to their role as appropriate representatives of particular institutions or interest groups. Operationally, they usually include an executive office/secretariat with permanent technical staff which is complemented by ad hoc members from other organizations in the system mobilized for specific tasks.

Historically, ARCs have emerged in response to situations characterized, on the one hand, by a complex network of institutions with overlapping mandates, lack of skilled personnel and scientific critical mass in key organizations, unstable funding levels unrelated to organizational needs, neglect of important research areas, and inadequate responsiveness to national needs as determined by policy-makers; and on the other hand, by an agricultural or food situation severe enough to induce the government to attempt to bring agricultural research under control (7).

Following the creation of the Indian Council of Agricultural Research, ICAR, in 1964, a number of councils have been created, in Pakistan, the Pakistan Agricultural Research Council, PARC (1964), in the Philippines, the Philippine Council for Agricultural and Resource Research, PCARR (1972), and in Bangladesh, the Bangladesh Agricultural Research Council, BARC (1973).

In addition to these, the Malaysian Agricultural Research and Development Institute (MARDI) and the Indonesian Agency for Agricultural Research and Development (AARD) are frequently mentioned as having the ARC's basic characteristics. They differ substantially from the "model", however, since their central mandate is to implement research activities, and

their coordination function is quite limited. For example, AARD exercises no control or coordination over what happens in research outside the Ministry of Agriculture in the National Science Department Board and the Ministry of Research and Technology. Furthermore, the degree of autonomy of AARD is limited and it does not escape the ministerial structure in administrative and personnel policies (8). MARDI is an autonomous body with a governing board which has participation from both the private and public sectors. But, its functions do not include the coordination of research activities outside the program it implements directly (9).

Each of the aforementioned ARCs (ICAR, PARC, BARC, and PCARR) constitute the apex of the national agricultural research systems in their respective countries. However, they have varying degrees of formal power and involvement in research activities per se.

Beyond this there is a tendency to move away from being a body with merely coordinating and advisory powers to one with greater directional, executive control over the actual implementation of the research program. The force behind this trend appears to be the increasing conviction that without at least partial control over funding and the capacity to actually implement certain strategic components of the research program, the coordination function cannot be properly performed.

This trend is clearly present in the Indian case where the very creation of ICAR in its modern concept in 1964 corresponded to the desire to transform its predecessor organization, the Imperial (later Indian) Council of Agricultural Research in existence since 1929 into a more effective coordinating mechanism. In its pre-1964 conception, ICAR did

not operate or control any research facilities and was restricted mostly to making ad hoc grants to the various institutes, ministries, and other research organizations. Under those conditions, ICAR coordination functions were severely restricted. The changes introduced in 1964 included the transference to ICAR control of the Commodity Research Institutes and the central research institutes previously under the Department of Agriculture or the Department of Food. An additional institutional innovation was the creation of the Coordinated Crop Improvement Programs as the basic instrument for coordinating the research activities in the country's priority crops (10)

In its new - and present - format, ICAR brings together two functions. At one extreme is a self-contained "agricultural research institutes," implementing its own programs through its own research infrastructure. At the other, it is intended as a mobilizer of the entire Indian research capacity, and acts as the main linkage between the Ministry of Agriculture, the body responsible to Parliament for the agricultural development effort, and as the research community of the states and the agricultural university systems. Within this context, the autonomous nature of ICAR has allowed the creation of separate conditions of service for its personnel and the flexible management style necessary for successful research. Accountability is assured through its special relationship with the Ministry of Agriculture and the constitution of the board.

The pattern of development of the other councils mentioned has been similar to that of ICAR. However, the degree of control over their respective countries research activities varies. The closest to ICAR in these terms is PCARR in the Philippines. According to its constitution,

PCARR functions cover a wide field and include, among others, the development of objectives and definition of goals for research, the development of a national agriculture and resources program, the establishment of priorities, the development and implementation of a fund-generating strategy, programming, the allocation of all government revenues earmarked for research and provide for mechanisms for incentives for researchers, and, since 1977, the monopoly over relationships with international funding agencies and technical assistance organizations. The establishment, support and management of a national network of centers of excellence for the various research programs in crops, livestock, forestry, fisheries, soils and water, mineral resources, and socioeconomic research related to agriculture and natural resources, is also a function formally assigned to PCARR (11).

To implement its coordination function, PCARR has the power to review all research proposals in agriculture and natural resources, and to recommend research proposals to the Ministry of the Budget for funding. This power was recently bolstered by a policy of the Ministry of the Budget that only research proposals recommended by PCARR will be eligible for government funding.

The functions of PARC in Pakistan and BARC in Bangladesh are somewhat more restricted in terms of actual control over the research infrastructure and stay within the coordinating role. However, over the last few years both have incremented their powers (12). In 1978, following a catastrophic wheat crop (caused by yellow and leaf rusts), PARC was reorganized into an autonomous body with representation from various provincial and national sectors, and with a subcommittee of the council designated as the Executive Board. The strengthening continued

throughout 1981, when a World Bank credit was made available for the development of PARC headquarters, as well as the expansion and completion of the National Agricultural Research Center, NARC, facilities. The Pakistan Agricultural Research Council Ordinance of 1981 acknowledged the administrative and institutional advances made by PARC so far, with what could be construed as an enlargement of the mandate. Fully autonomous, PARC employees were then placed outside civil service regulations.

In Bangladesh a number of decrees, starting in 1976 and 1979 have placed practically all research activities legally under BARC. However, a number of the research institutes have retained control over their own sources of funding and their administrative councils (such as in the case of BARI, the Bangladesh Agricultural Research Institute).

The trend toward the constitution of ARCs in the committees mentioned has continued. At present a number of countries are moving toward the creation of similar structures. One example to be mentioned is that of Sri Lanka, where plans and specific proposals are advanced and already at the project preparation stage. Here the intention is to create a coordinating body to facilitate the priority setting and the coordination among the commodity institutes, units within ministries and universities currently involved in research activities (13).

The Sri Lankan experience represents an interesting summary of the ARC idea and evolution. The reorganization presently being discussed arises out of a preoccupation with the state of dispersal in agricultural research activities and the difficulty of organizing an integrated research effort on development problems, particularly in those areas that fall between the jurisdiction of different ministries. The situation is

somewhat similar to that encountered in neighboring countries when they initially established their ARCs; the response is also similar, favoring coordination and planning functions rather than direct control over research infrastructures and funding. What remains to be seen is whether or not the Sri Lankan coordinating body will stay as it is or move toward an increase in control and executive powers.

IV. THE LATIN AMERICAN NATIONAL AGRICULTURAL RESEARCH INSTITUTES

National Agricultural Research Systems in Latin America and the Caribbean clearly fall within two main forms of organizational structures: the ministry model and the autonomous or semi-autonomous research institute with broad national mandate (14). As shown in Table 1 these two models cover, in practice, the totality of the region. In a general analysis, there seems to be a certain correlation between country size and the type of system: all the larger countries have national research institutes, while the ministry strucutre usually appears in the smaller countries of South America, Central America and the Caribbean Islands. However, it is necessary to highlight the existence of a number of national institutes in countries such as Panama and Honduras which clearly fall within the small country category. Moreover, in a number of other countries, such as the Dominican Republic and Guyana, there have been recent developments toward the creation of national institutes (15).

These two forms of organization cannot be seen as alternatives, since in practice, almost without exception, the creation of the national institue has followed and replaced a structure of research based at the ministry of agriculture.

The early agricultural research efforts in most of the countries of Latin America developed on an ad hoc basis under a number of different, and often unstable, institutional arrangements. The initial experimental stations were usually developed as isolated efforts linked, in some instances, to ministries of agriculture or to their predecessors in the administrative structure (such as in the case of Pergamino and other experimental stations in Argentina); to agricultural schools (such as Palmira in Colombia); or to agricultural producers' organizations (such as La Platina in Chile and Cañete in Peru). During the 1940s and the early 1950s these initial undertakings were streamlined and essentially all research activities, with the sole exception of some export crop cases, such as coffee in Colombia, were centralized as line activities of varying hierarchy within the ministeries of agriculture. This was the predominant institutional model around the mid-1950s (16).

This form of research organization soon came under attack. The criticisms stemmed mainly from the ministries' essentially bureaucratic nature. Some of the most commonly expressed deficiencies were 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; and finally, absence of any coordination between organizations generating technology, and others responsible for implementing different components of agriucltural policy, prices, credits, services and others (17).

The national agricultural research institutes resulted from these preoccupations. The general model is common to them all: the legal and

administrative character of an autonomous or semi-autonomous public entity with a broad mandate covering a wide range of products, regions and types of farming situations. The basic objectives sought were to solve the problems created by the bureaucratic environment of the ministries; to allow for an improvement in the funding situation and conditions of service for research personnel; and at the same time to maintain research in the public domain, closely linked to agricultural development policy. Organizationally, the model adopted in most cases was one that combined centralized decision-making with respect to priority setting and resource allocation and operational decentralization through a network of experimental stations and commodity discipline program.

The efforts to create the national research institutes had large support from technical and donor assistance, and particularly that originating from what became to be known as the Point IV of the US Foreign Aid Policy. This assistance included crucial support for human and infrastructural development. Perhaps more important, however, was its role as a key element in the development of the National Research Institute model as a Latin American expression of the US experimental station system.

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; 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, which after successive modifications became the National Institute of Agricultural

Research Promotion (INIPA) in 1984; the Colombian Agricultural Research Institute (ICA) in 1963; and the Agricultural Research Institute (INIA) in Chile in 1964. This trend continued into the seventies with the creation of the Bolivian Institue of Agricultural Technology (IBTA); the Institute of Science and Agricultural Technology (ICTA) in Guatemala; the Agricultural Research and Development Institute (IDIAP) in Panama in 1975; and the National Institute of Agricultural Technology (INTA) in Nicaragua (since 1980 INTA of Nicaragua has been put back under direct control of the Ministry of Agriculture).

All these institutions share the same organizational characteristics mentioned above. However, variation exists with respect to some specific aspects covering their governance structure, mandates, and/or sources of funding.

In regards to the governance structure, all the institutes are organizations with a legal status of their own, reporting in most cases to the ministry of agriculture or its equivalent. A differentiating characteristic among them, however, is the existence or not of a board of directors or trustees responsible for policy guidance and management control. Of the above-mentioned institutes INTA of Argentina, ICA of Colombia, ICTA of Guatemala and INIA of Chile have boards; the remaining institutions do not have such a body and the director generals or the chief executive officers report directly to the ministries of agriculture.

The institute model has tended to bring together research and extension. However, in some instances such as INIAP in Ecuador, IDIAP in Panama and INIA in Mexico, the two functions have been kept separate, with extension remaining a ministerial function. Education was generally kept separate

from research and extension. However, in a number of cases - Argentina, Colombia, Peru, Uruguay, Mexico and Brazil - due to the need to develop a minimum critical mass of human resources, ad hoc attempts were made to develop in conjunction with universities, post-graduate training infrastructures. With the exception of Brazil and Mexico, most of them have been short-lived and unstable, and did not constitute an integral part of the institutional model.

Funding is also a differentiating factor. The original concept was to seek as much funding autonomy as possible. However, this was very seldom achieved as a permanent feature. The autonomy in regards to funding management has allowed the institututes to attract substantial amounts of donor assistance. Only INTA of Argentina has had a special funding treatment, receiving its resources through a tax of 2% on agricultural exports. Usually funds flow from direct allocations in the national budget with the result has been that, although some benefits have been derived from greater control and flexibility in budget management, funding instability continues to be a serious limiting factor in many cases (18).

The development of the Brazilian agricultural research system has followed a somewhat different pattern. Chronologically speaking, Brazil is the only major country in the region where the sixties brought no major change. More significant, however, is a difference with respect to the institutional model followed to create the Brazilian Corporation of Agricultural Research (EMBRAPA). EMBRAPA, established in 1973, is an institutional development similar to that of the research institutes in the other Latin-American countries: the objective is to set the national basis for linking Brazil to the international system and making research

an active instrument of agricultural development policy. As in the cases of INTA in Argentina, ICA in Colombia and other institutes, it was not an isolated event. It resulted and remains an integral part of a broader effort to influence agricultural development. The organizational format adopted is, however, different. EMBRAPA combines two separate sets of functions. On the one hand, there is the mandate to carry out research, for which it has a substantial research capacity of its own - the national commodity centers. On the other, it has the function of leading and coordinating, as far as objectives and priorities are concerned, a multi-organizational model, involving separate levels of administration in the public sector (federal and state) as well as in the private sector. In this context EMBRAPA is probably closer to the concept of the Agricultural Research Councils than to the rest of the national research institutes.

V. POST-COLONIAL AFRICA: IS THERE A PREVAILING ORGANIZATIONAL TREND?

By examining the information presented in table 1, one may be tempted to associate the current situation in Africa with the ministerial model of agricultural research organizations. This association is probably correct, but should be made carefully, and with a number of qualifications, especially in reference to the subsequent evolutionary trends that may be involved.

The first considerations relate to the colonial heritage. Colonial strategies in Africa vary widely, not only depending on the colonial power involved, but also from country to country within any given colonial heritage. Nonetheless, it is pertinent to attempt a summary of

the main phases which marked the evolution of agricultural research organization since the colonial era. Especially if the African experience is to be included in the effort to develop hypothesis concerning the relationships between organizational format and the environment of agricultural research (19).

The second considerations is that in a number of countries the national research institutions are in the early stages of development, and often just initiating the development of their human resources base. Consequently, any attempt to generalize trends on the basis of the current situation will not fully represent the results of the process approximation and interaction between organizational format and the environment, but rather an intermediate, unstable stage (20).

The main differentiating element among the colonial experiences (British, French, Belgian) in regards to agricultural research is the way in which research in the colonies and the metropolis were linked, and the type of relationship maintained after independence.

Under British colonial rule each colony was perceived as a distinct entity, to be ruled and developed in accordance with its particular characteristics. This militated against the centralization of research, and in some cases - particularly in food crops - also against the regionalization of research activities, although regional efforts were present in East Africa in the post Second World War period (21). This perception led to the creation of a department of agriculture in each colony with responsibility for research. Initially, the focus was on the suitability and comparative advantage of various crops and varieties. These efforts emphasized work on specific commodities and most of the

research stations created were commodity specific, and contributed in an important way to establishing agricultural research within the administrative structure of the departments and ministeries of agriculture.

At the time of independence there was a dual structure in situ, where research in the food crops in departments of agriculture coexisted with a number of autonomous, or quasi-autonomous, efforts servicing specific export crops, where planters or external commercial interests were significant. Since independence the modifications in the power structure and a very dynamic and often chaotic, social, political and economic environment constitute the basic framework for the evolution of the research structures. The main features are the "nationalization" of the structure with a rapid fading of British presence and the substitution of expatriate researchers with local research personnel, and a shift of research emphasis from export to food crops. Specific changes in agricultural research organization have followed these tendencies in the context of acute shortages of trained manpower and the need to protect some important export crops as sources of fiscal revenue. This sometimes prompted post-independence administrators to leave untouched the organizational arrangements in those commodities. The general trend, however, has been to mantain the preeminence of the ministry or ministries vis-à-vis other types of organization and in recent times to develop a central coordinating capacity, either by combining the different ministerial units involved in research under one roof, as in the case of Kenya or Tanzania with Taliro and Taro (22) or by formally assigning the
coordination role to a special unit or a Ministery of Research and Scientific Development (or similar), as in the case in Nigeria.

French colonial experience has been significantly different as agricultural research was highly centralized and closely linked to the metropolis through the GERDAT institutes, which had an applied orientation and a world-wide mission covering not only Africa but also the French colonies in other parts of the world (23).

The budget of these institutions, with headquarters in France, was met largely by the French tax payers. The stations abroad were outreach establishments of the specialized institutes. Staffed by expatriates, no consideration was given to creating an independent research capacity in the colonies either individually or regionally.

The end of French colonial rule in 1960 did not immediately change the characteristics of the French agricultural research presence in the ex-colonies, with which France maintained close economic, political and cultural ties. In most instances the activities of the various French agricultural research organisms in the former colonies continued under formal cooperation agreements with the national governments.

In terms of the organizational structure of the post-independence research system the most important feature is the growth of an indigenous agricultural research and agricultural administrative capacity within or alongside the agricultural research institutes staffed largely by and significantly funded as well as controlled by French organizations and nationals. As a consequence of this increased national participation, there has also been a shift from export to food crops, in the overall focus of the research system. This process has been greatly affected by the political evolution of the relationship with France and by the

resource situation in each of the countries. The particular array and distribution of responsibilities between ministries, agencies and institutes in each case results from how power distributions have shifted during the successive alternations of military and civilian rule. Although no clear evolutionary pattern can be identified, it is possible to mention some tendencies. These refer to the creation of the Ministeries of Scientific and Technical Research (Senegal, Ivory Coast, Cameroon, Central African Republic, Mali) in the 1970s and the development of the horizontal linkages among the research institutes working in a country to substitute for the vertical links that existed between the individual institute and its parent in Paris, which continued into the post-independence period.

For how long these dual structures, with heavy participation of the former colonial institutes, will last is difficult to say. Three essential issues are a) the nature of the priveleged relationships between the countries and France; and b) the evolution of the research capacities in the local institutions created since independence, particularly with respect to the availability of research staff with proper levels of training; and c) the willingness of national governments to bear the costs of its national research effort.

In the former Belgian colonies the situation is rather different. Again in this case the colonial strategy with respect to agricultural research has played a key role in determining the present situation. The research efforts initiated under the Belgian rule were based in the Institut National pour l'Etude Agronomique du Congo Belge, (INEAC), which had stations throughout the Belgian Congo, Rwanda, and (B)Urundi. Created in 1933, it was funded primarily by Belgian funds, but was highly

decentralized in terms of program development and implementation. At the time of independence, or soon thereafter, this infrastructure was transfered to the full and separate control of those independent states, and constitutes the basis of the national agricultural research systems in those countries. The salient feature of the evolution since then has been the inabilitlity to use the vast infrastructure inherited (Zaïre, Madagscar, Rwanda). Political problems, and lack of resources - human and financial - to substitute for the Belgian support as it was withdrawn have been the main deficiencies (24).

To summarize, the post-colonial structure of agricultural research in Africa appears to be characterized by the existence of a vast array of organizations, which mostly correspond to what was in place at the time of independence. The "nationalization" of those research structure has undoubtedly been the main task of the last 20-25 years. This process has taken place against a background of the different colonial heritages, which affected the type of institutions that were established in the new independent countries and the de-colonization strategies, which influenced the nature and pace of the nationalization. The array of agencies, ministries, universities, etc., are still confronted with many of the same problems prevalent in Asia and Latin America, when the processes that lead to the national institutes and ARCs were started: namely, too few human resources, unstable funding, duplication. In recent years efforts have concentrated on the development of the resources needed. At the organizational level the ministry model seems to be widespread, but it would be premature to talk about a well-established trend toward a "dominant" model as in the other regions.

VI. COMMONALITIES AND DIFFERENTIATING ELEMENTS AMONG THE PREVAILING FORMS OF ORGANIZATIONAL STRUCTURE

The issues discussed in the previous sections highlight evolutionary patterns of interaction between the research institutions and their environment, and how at any point in time the existing structures reflect the influence of a complex set of forces. They also provide a good basis from which to approach the discussion of the idea that there is no single "best" way to organize agricultural research, and that any format is not equally effective. Without going into a detailed discussion it is relatively easy to accept that agricultural research in Asia and Latin America over the last 20-25 years has been highly effective and has contributed significantly to the improvement of agricultural production and productivity. It suffices to point to the fact that today India maintains a buffer stock of around 25 million tons of cereals, to the significant improvements in rice production throughout Asia and Latin America, to the almost doubling of grain production in Argentina since the early 1970s, and to the Brazilian experience with wheat and soybeans. Although a one-to-one relationship is not argued, it is not difficult to associate those successes with changes in the organizational structures that allowed research to cope with the problems of the farmers. However, the organizational approaches adopted have been quite different. It seems relevant to ask, "What are the factors that prompted the evolution of the systems?" and "What were the differentiating factors?" Bearing these questions in mind, it is now proposed to examine the environment in which the processes of institutional change took place and then briefly discuss some of the factors that may have affected the

particular shape of the institutions that were created, specifically in regards to their degree of autonomy and centralization-decentralization.

The Context of Institutional Change

The process of institutional change is clearly affected by political, social and economic forces (25). For the purposes of this paper a detailed examination of how these function is not pertinent, it is therefore postulated that for effective institutional change to occur, a clear need must exist and the decision-makers have to see structural changes as a necessity to meet that need. If effective change is to happen there has to be political support and decision to assume the costs - political and otherwise - associated to that change. The changes that have taken place in Latin America and Asia since the late 1950s-early 1960s are interesting examples of the dynamics of these processes. At the same time they allow us to raise a number of hypothesis about the situation in Africa and its likely evolution. The important aspect to highlight is that, although the countries in the regions differ substantially in terms of resources and cultural and political traditions, the processes that lead to the establishment of the National Research Institutes and the Agricultural Research Councils have striking similarities.

Both the emergence of the National Institutes and that of the ARCs, and the cases of MARDI and AARD, resulted from situations where technology and consequentely research were seen by the relevant political system as a key solution to the problems confronted.

In both regions the need was made obvious by the poor performance of the agricultural sector and its inability to satisfy the requirements of food and export surpluses. In Latin America in some instances, such as Mexico, Colombia, Peru and Ecuador, national production was rising at a rate well below the increase in demand, resulting from population growth and the urbanization process. In others, such as Argentina and Uruguay, the stagnation of the agricultural sector generated balance of payment problems, which augured the appearance of even more serious difficulties as the industrial processes started to gain headway. In still other countries, such as Brazil, the situation of the agricultural sector was inextricably linked to both foreign trade and the domestic demand problems (26).

In Asia, most countries were confronted by both sets of problems, as they were highly dependent on food imports, which represented a major drain on foreign exchange and a substantial constraint on the overall growth of the economies.

In some years even to meet domestic requirements through imports was not possible, since it was difficult to purchase the grain irrespective of the prices. There were also logistical problems in transporting the food to where it was needed. Furthermore, there was a political dimension: the poor agricultural performance constituted a major factor of political instability. In Indonesia, the "rice crisis" of the second half of the 1960s can be linked to the fall of the Sukarno regime. In other countries there was an increasing realization of the dangers of depending on other countries for the food supply. India and Pakistan both experienced difficulties with US PL 480 foodgrain shipments during the 1960s, when the US stopped food aid or threatened to do so in order to

force these countries to make certain political decisions. In 1974 the food aid to Bangladesh was delayed in a shortage year, and the Bangladeshis perceived this as an attempt by the US to force them to break their trading relations with Cuba (27).

At the international level there was, as pointed out above, a growing conviction that these problems could be solved through new technology. Furthermore, by that time it was clear that the soils, climate, and the nature of the dominant crops were propitious to major technological breakthroughs. What was needed were institutions capable of producing and disseminating them (28). The existing structures did not meet the standard. In some cases there was a network of overlapping institutions, in others the existing structure was too dependent on political aspects. In almost all circumstances there were insufficient human and material resources.

These conditions set the stage for the domestic demand for research and the reorganization of the existing structures. Foreign assistance played a key role in facilitating the implementation of those changes. It did so in several important ways. First, by helping link the production and productivity problems with research and conceptualize the need for institutional change. Second, by providing foreign scientists and administrators to help identify and adapt the different institutional forms to the local needs. Finally by providing support for the implementation of the new structures. USAID, The Ford and Rockefeller Foundations, together with a number of American universities participated actively in these processes. In more recent times the involvement of The World Bank and in Latin America, IDB and IICA, are other important sources of ideas and support.

When looking at the situation in Africa there are two important differences in regards to the context of the institutional changes that have taken place over the last 20-25 years. The first is with respect to the local situation and the demand for agricultural research. Until recently there was no local demand for research at the political levels. The changes that took place resulted not from the decision to strengthen research institutions, but as part of the overall nationalization of the public administration that followed independence. The tendency in many countries has been toward a policy discrimination against the agricultural sector, and consequently there was no role for research. It is only in the past few years that some local initiatives have started to appear.

The second difference is with respect to the role of donor assistance in the region. As stressed above, external agencies have played a crucial role in both the conception and the implementation of the institutional changes that took place in Asia and Latin America. In Africa they have also had an active involvement, their role, however has been different, probably as an inevitable consequence of the different conditions that have to be faced here. Technical and donor assistance, has focused mainly on specific projects rather than on long-term institution-building programs. Furthermore, there is a high level of direct involvement in the implementation of the projects and of research activities proper, often within ad-hoc structures and not as part of the local research organization. In very few instances, and recently, they have started to emphasize institutional characteristics in their assistance efforts. An additional important differentiating feature is that while for the other regions there was - rightly or wrongly - the conviction that the problem

was technological and that technologies were available, in the African case there is no general agreement as to the role that technology can play in solving the problems nor as to whether or not techonologies are available to solve them (29).

Organizational Autonomy

Autonomy is one of the main features of the institutional changes that have taken place over the last 20 years. The reasons in support of an autonomous status for agricultural research are both technical and political. Technically, there is the need within the research agency to control decision-making in relation to certain key management variables and the establishment of policies and procedures that reflect the characteristics of research processes, personnel policies, including conditions of service and funding and budgetary administration.

In the political context there is the need to facilitate the interaction between research and the broad range of social sectors with specific interests in the technology generation process: agricultural producers and their organizations, agribusiness and the business sector in general, universities, and other research efforts.

The above technical and political requirements are usually better met by organizations with a fair degree of autonomy. Both the national institutes and agricultural research council models include in their conception a high degree of nominal autonomy (30). In practice, however, the degree of effective autonomy has been very variable, and in many cases is below what could be expected, given the legal status of the organizations.

The impact of the degree of autonomy seems to have been more decisive in regards to personnel policies and conditions of service than in connection with other areas. In a recent UNDP/FAO study of research systems in 12 countries separate conditions of service were found only in three (32); in all three of them research was carried out primarily by autonomous institutions. The evidence from Latin America in the National Institutes and in Asia with the ARC points in the same direction. In Latin America, although there is a lack of information about a number of countries, there also seems to be an association between the degree of autonomy and the control over personnel policy. In Brazil and Argentina, and to a lesser extent in Colombia and Chile, systems with fully autonomous systems separate schemes of service are in operation. In other coutries, such as Peru, Ecuador and Panama, which fall within the semi-autonomous category, researchers adhere to the general civil service rules. In the case of the ARCs, all autonomous institutions, at least ICAR and PARC, have been able to develop separate conditions of service for their employees. However, it is interesting to note that in both cases these conditions do not extend to the other institutions in the system they are supposed to coordinate. In Africa there is no clear pattern. In many countries, where research is within a ministry, researchers enjoy a separate status. While in others whose research institutions have an autonomous and semi-autonomous status, such as Rwanda, researchers remain within the general civil service system (32).

In regards to funding, greater autonomy seems to have improved conditions in regards to allowing more control over the budget and to link the management of funds to program decision-making. With respect to levels and stability of funding, however, the favorable impact of a greater

autonomy does not seem to have been generally substantiated, although there a few instances where increased external donor assistance is linked to an increase in the nominal autonomy of the research system (33). In a recent study of Latin American countries it was found that the year to year budget variability during the 1970s was very high, and did not relate clearly to the degree of autonomy of the system. Countries such as Costa Rica, El Salvador or Uruguay with research as a ministry activity, face a similar problem of budgetary instability to that of Panama, Guatemala, and Chile: countries with semi-autonomous organizations. One of the problems as regards funding is that although autonomy has allowed research organizations to establish their own treasuries and funding management procedures, funds come from national budgets and are subject to all the vagaries and constraints of public funds (34).

The main feature of autonomous organizations - and differentiating element between autonomous and semi-autonomous bodies - is the existence of a board of directors/trustees/governors as maximum legal authority, designed to provide overall policy guidance and management control. The basic function of the Board is to act as a buffer, providing protection from political interference and as a lobbyist to help mobilize resources.

It is difficult to assess whether or not the Boards have played the role they were intended for. Nevertheless, it is possible to highlight some issues, and especially with respect to the composition of the boards and how this might affect the role they can play.

In general there has been a marked tendency for the membership to be overloaded with ex-officio members from other public institutions. This

is certainly the case of the ARCs in Pakistan and the Philippines, and of ICA in Colombia and ICTA of Guatemala, as well as other institutes in Latin America and elsewhere. Without doubt this feature has served to limit the value of the boards as lobbyists and as a resource mobilizer, and in some instances has turned them into an additional burocratic burden for research administrators, rather than to act as a positive force. An important comparison to be made here is between the national institutes and the ARCs and the single commodity institute, where Boards have successfully been used as governance system. It is important to emphasize that the situations differ substantially. In the case of the commodity institutes a number of aspects facilitate the implementation of the idea of the Boards to provide protection, guidance and support for research. The most important is the existence of an already established lobbby of interests, producers, and exporters around a given commodity. The second is that there is a clearly identifiable source of revenue, which can be taxed in order to support research. In the case of the National Institutes and the ARCs several issues have to be considered. First, the broad spectrum of the national institutes and the ARCS and the absence of well-established or arranged lobbies, or even worse, the existence of conflicting lobbies, makes the constitution of a Board with clientele representation difficult. Second, the desire to mantain research well within the control of the public sector limits concept of the Board as guidance mechanism, making inevitable the compromise solution of a membership heavily loaded toward public sector representation..

Under these conditions and given the context within which the autonomous research institutions were conceived (dominated by the need to mobilize research capacities in terms of development objectives) it is not

surprising that frequently the Boards are not seen as playing a crucial role in conducting research organization. This perspective, however, has been changing, and currently there are reorganization processes underway in a number of countries, which place a heavy emphasis on boards of trustees as the essential element for a more autonomous, stable and effective operation of the research systems (35). In this case a number of conditions have made it possible for the boards to have a large proportion of non-public sector members representing the farming community, agribusiness, the scientific establishment and the like. It is still easy to see whether these changes are to have any impact on the effectivity of the boards.

Centralization versus Decentralization

The centralization-decentralization issue lies at the very center of the discussion about agricultural research organization. Agricultural research has a need for decentralization; not because decentralization is inherently superior from an organization point of view, but because it is responsive to the nature of the problem which the research systems address (36). Agricultural production is location specific, and agricultural technologies need to reflect this location specificity. However, diversity of agroecological environments is not the sole source of variability that has to be considered; technology is also a social variable. For research to be successful, its product has to have not only an effective biophysical adaptive capacity, but also the ability to accurately reflect the diverse socioeconomic, political and cultural constraints facing the farmers who make the adoption decisions (37). This characteristic of the agricultural production calls for a physical infrastructure and decision-making processes capable of reaching all

relevant environments and accurately reflecting the needs of the different clientele into the program development process. Both of these attributes appear to be better achieved through a decentralized organizational structure. Nevertheless, it is important to recognize that this need for decentralization has a counterbalance in the need to achieve also a minimum of program coherence, and to relate research to the other components of the agricultural development strategy. An additional important issue is that decentralized systems are more management intensive than centralized structures (38).

The debate as to how these issues have been dealt with in the cases of the national institutes and the ARC provides interesting insights into the relationships between environment and organizational structure.

As stressed in the previous section, the conditions of demand in each case were somewhat similar: poor agricultural performance together with the recognition that agricultural research was essential to alter the situation. The state of the existing agricultural research systems were also similar: weak institutions with inappropriate human and financial resources. Under these conditions the prevailing trend was towards a centralized structure, but there lacked the capacity to mobilize research in terms of a given agricultural development, and human and managerial resources were scarce. Consequently to minimize duplication of effort and decision-making levels was a high priority. The different nature of the structural responses to theses common problems can be explained in terms of the characteristics of the existing research infrastructures and the politico-administrative styles of the countries.

In Latin America the National Institutes followed an already established centralization trend. At the outset agricultural research was not a central government responsibility, although it became one in the 1930s and 1940s. This was due to the unified nature of the political organization in most of the countries and the financial weakness of the regions or provinces which prevented them from taking any substantial initiatives in this area. In the mid-1950s whatever research capacity there was was centralized in the ministeries of agriculture. The national institutes followed as a natural development, and the needs for operational deçentralization were handled through their internal organization strategy, which emphasized program development decision-making at the regional and local levels.

By contrast, in Asia and especially India, where the council model originated, there was a highly decentralized system in place. This had occurred when the Indian Department of Agriculture was placed under the aegis of provincial governments, and was furthered by the proliferation of research programs in the 1950s and early 1960s. The strengthening of the functions of ICAR was a response to the need to coordinate and to optimize the use the research resources in this context. It would have been unrealistic to have attempted to substitute the existing structure with a new institution of the type of the national institutes (39).

The dynamics of the Pakistan and the Philippine experiences are similar. Although the trends toward centralization have been greatly facilitated by political changes towards a more centralized form of government.

The influence of background and political system is further highlighted in the case of Brazil. As previously mentioned, very little happened in

Brazil during the 1960s. The problems confronted were similar to those of the other countries in the region, and it was exposed to the same ideas that prompted the creation of the national institutes. However, Brazil has a stronger federal organization, which made it difficult to move in the same direction. A major political change had to take place before EMBRAPA could come into existence, and even then centralization was limited as some of the existing state research systems remained outside the control of EMBRAPA (i.e. Sao Paolo) (40).

The size of the country and the diversity of the agricultural sector is also a relevant factor in regards to the centralization issue. It is difficult to conceive of a single organization able to manage the entire research effort in a land and population the size of Brazil or India.

VII. CONCLUDING REMARKS

This paper has been developed out of the proposition that organizational format matters and, while there is no one optimal way of organizing agricultural research systems, not all formats are equally effective. Without attempting to put foward a formally testable hypothesis, it was stressed that "optimality" results from political and technical fit within a given environment. An optimal format is one that provides an effective framework for the conduit of the essential management and research functions, while reflecting a particular country's agricultural conditions, economic characteristics, and socio-political traditions.

The previous sections reviewed the way in which agricultural research systems in the developing world are organized, and attempted to find

commonalities and differences which could help to advance the understanding of reslationships between organization and environment. In doing so a great diversity has been identified in the way in which agricultural research is organized. At the same time it would not be difficult to associate success stories with each of the four main types of systems presented in Table 1. This can at least be considered as some proof, albeit inadequate, of the validity of the proposition that there is no one best way to organize. It was also found that each of the formats reviewed results from evolutionary adjustments to changing environments where the pre-existing structures were not seen as effective ways of mobilizing the needed resources and delivering the products expected from research. This observation may explain the proposition that not all the formats are equally effective.

When comparing the evolution of the organizational "models" in Asia and Latin America it has been found that the efforts which lead to the development and consolidation of the ARCs and the National Institutes resulted from a confluence of forces and interests that created a favorable policy environment for research and institutional change. There were recognized needs, agreement about what the solutions may be, and the political decision to act. Research and technology diffusion were seen as solutions by the national leaderships, and the donor and technical assistance community was ready to help develop the institutional mechanisms needed to mobilize resources and implement research as an integral part of development policies. This presentation has hinted that conditions in Africa are not the same, or at least have not been so far. The contrast with the Asian and Latin American experiences may, however, be of value when discussing how to meet the challenge in Africa, particularly in relation to the time scale involved,

and the set of concomitant actions that should accompany the efforts in the agricultural research field.

The discussion of the evolution of the systems has concentrated mainly on how the different models originated, and how they were coherent responses to the conditions that existed at the time of their inception. The analysis of their evolution has been, however, very superficial. Several areas should be considered in future discussions, particularly in regards to how the "common" models have evolved and adapted to the different national enviroments. The comparison of the experiences of the different ARCs in what relates to the performance of the coordination functions vis-à-vis the expansion of their executive powers appears to be an area where more information could be extremely useful for new countries considering the council model. A further issue concerning the evolution of the systems is how they have coped with new developments. During the last 10-15 years conditions in the countries have changed substantially, and in many cases as result of the very success of the new forms of organizing research. One of those changes, not discussed here, has been the increasing role and importance of private agricultural research activities. The analysis of the implications of this phenomenum in terms of the organizational structure, and the role of certain formats such as the ARCs or the National Institutes remains an important area for investigation and discussion.

Finally, some specific structural dimensions were touched upon, such as the degree of autonomy and centralization-decentralization. Available evidence points to certain general patterns in regards to a country's stage of development, its political system and size. However, more detailed information is required before the nature of the parameters of

the optimal enviroment for each different type of organization can be examined. The analysis also points to the need for taking a closer look at a number of other issues, including the differentiation between autonomous and semi-autonomous structures, and the role and effectivity of the boards as governance mechanism.

NOTES

(1) In describing the different formats, no effort is made to provide a fully comprehensive typology. Each organizational type is presented to emphasize what ISNAR considers to be its main differentiating feature in terms of its impact on the performance of the essential management processes and the effectivity of the research activity.

(2) Usually the Ministry of Agriculture and/or Livestock. However, there are situations where other Ministeries are also involved: the most frequent cases are the Ministeries of Education (or Higher Education) and Science and Technology.

(3) An autonomous agricultural research organization meets the following criteria:

1. it has legal personality and its own Board of Directors/Trustees which overseas the execution of its mandate.
2. it has independence in the management of its budget, and it does not have to go through the financial service of a Ministry, even where it may formally report to the Ministry.
3. it controls its internal organization, as well as sets its own criteria for hiring, firing, and conditions of service (which may depart from civil service norms).
4. it has formal reporting obligations to some public body (e.g., President, Prime Minister, Ministry, Research Council, etc.) from which it is otherwise legally and operationally independent.

A semiautonomous agricultural research organization is an organization which has legal existence apart from that of a line division of a Ministry, but does not meet all the criteria necessary for definition as autonomous.

(4) Examples of this type institutional model are the US Land-Grant-Universities, and the Agricultural Universities of India and The Netherlands.

(5) Private sector research activities are not included in the table due to lack of information.

(6) See MOSEMAN, A., National Agricultural Research Systems in Asia. IADS, New York, 1971. Also, DRILON J. D., Agricultural Research Systems in Asia. SEARCA, College, Laguna, Phillipines, 1977.

(7) See RUTTAN V., Agricultural Research Policy. University of Minnesota Press, Minneapolis, 1982, Chapter 4.

(8) The Agency for Agricultural Research and Development of Indonesia. ISNAR, The Netherlands, October 1981

(9) See HASIM M. Y., The Agricultural Research System in Malasia , in Resource Allocation to Agricultural Research, eds. DANIELS D., and B. NESTEL. IDRC, Ottawa 1981.

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(10) See RUTTAN V. op cit. chapter 4 and JAIN H. K., India's Coordinated Crop Improvement Project Organization and Impact, Indian Farming, July 1984.

(11) See DRILON J. L. and LIBRERO A. R., Defining Research Priorities for Agricultural and Natural Resources in the Philippines in DANIELS D. and NESTEL B. op cit.

(12) See DRILON J. L. Agricultural Research Systems in Asia. SEARCA College, Laguna, Philippines, 1977.

(13) See Agricultural Research Group and ISNAR, The Agricultural Research System in Sri Lanka. Report to the government of Sri Lanka, ISNAR, The Hague, Netherlands, June 1984.

(14) See TRIGO E., PIÑEIRO M., and ARDILA J., Organización de la Investigación Agropecuaria en America Latina. IICA, San Jose, Costa Rica, 1982.

(15) See ISNAR The Agricultural Research System of Guyana. March 1982. Report of the ISNAR review mission to Guyana. Also El Sistema de Investigación Agropecuaria en la República Dominicana. July 1983. Report to the government of the Dominican Republic, ISNAR, The Netherlands.

(16) See for example ELGUETA M., Evolución de la Investigación Agricola en America Latina and MARZOCCA A., Los Pioneros in Las Ciencias Agricolas en America Latina. IICA, Editorial TREJOS, San Jose, Costa Rica, 1967.

(17) See TRIGO E., PIÑEIRO M., and SABATO J., Technology as a Social Issue: Agricultural Research Organization in "Technical Change and Social Conflict in Agriculture: Latin American Perspectives". Eds. PIÑEIRO M., and TRIGO E. Westview Press, Boulder, Colorado 1983.

(18) See TRIGO E., and PIÑEIRO M., Funding Agricultural Research in "Selected Issues in Agricultural Research in Latin America"40roceedings of a conference for Latin American Research Directors, sponsored by IFARD, IICA and ISNAR in cooperation with the Spanish Government. August 1983. ISNAR, The Netherlands.

(19) See EICHER C., and BAKER D., Research on Agricultural Development in Sub-Saharan Africa: A Critical Survey. Michigan State Unversity, East Lancing, Michigan, 1983. Also COOPER St. G. C. Agricultural Research in Tropical Africa. East African Literature Bureau, Nairobi, Kenya, 1970.

(20) See Agricultural Research Organization and Management in Africa. Report of a Seminar held in FAO, Rome, Italy, 1981. Advancing Agricultural Production in Africa. Proceedings of CAB First Scientific Conference, CAB 1984. Also, Strategies to meet Demands for Rural Social Scientists in Africa, ISNAR, The Netherlands, May 1982.

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(21) For example, the East African Agricultural and Forestry Research Organization (EAAFRO), which operated until the mid 1970s under the auspices of the East African Federation.

(22) The Tanzanian Livestock Research Organization and The Tanzanian Agricultural Research Organization, respectively.

(23) Le Centre Technique Forestier Tropical (CTFT); L'Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicauz (IEMVT); L'Institut Français de Recherches Fruitières Outre-Mer (IFAC); L'Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières (IRAT); L'Institut Français du Café et du Cacao et autres Plantes Stimulantes (IFCC); L'Institut de Recherches sur le Caoutchouc en Afrique (IRCA); L'Institut de Recherches du Coton et des Textiles Exotiques (IRCT); L'Institut de Recherches pour les Huiles et Oléagineux (IRHO)

(24) ISNAR Rapport d'une ISNAR/IITA auprès de l'Institut de Recherche Agronomique et Zootechnique de la Communauté Economique des Pays des Grands Lacs (Burundi, Rwanda, Zaïre). July 1981. Also ISNAR Le Système National de Recherche Agricole au Rwanda. December 1982. Report of the Mission to the Government of Rwanda. Also, ISNAR, Improvement of Agricultural Research Management in Cameroon. Report to the Ministry of Higher Education and Scientific Research of Cameroon, June 1984.

(25) For a detailed discussion of these forces see RUTTAN V., Induced Institutional Change, in BUISWANGEN H., and RUTTAN V. "Induced Innovation: Technology, Institutions and Development". The John Hopkins University Press, Baltimore, 1978. Also, ALVES E., Major Issues in Resource Allocation in ELZ. D. ed., "The Planning and Management of Agricultural Research". A World Bank and ISNAR Symposium, Washington, 1984.

(26) See PIÑEIRO M. and TRIGO E. Towards an Interpretation of Technological Change op cit. PIÑEIRO M. and TRIGO E., eds.

(27) see PRAY Carl E., The Institutional Development of National Agricultural Research Systems in South and South-West Asia. Mimeo, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul, Minnesota, March 1983.

(28) For a presentation of this view see Schultz T.W. Transforming Tradition Agriculture. Yale University Press, New Haven, 1964.

(29) For a summary of the arguments see MELLOR, J. W. The Changing World Food Situation. IFPRI Food Policy Statement, IFPRI, Washington, January 1985.

(30) Nominal Autonomy refers to the legal extent to which an organization can depart from the norms and practices of its parent. Effective Autonomy is the degree of autonomy actually exercised by the organization and can exceed or fall short of the nominal degree.

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(31) UNDP/FAO, National Agricultural Research: Report of an Evaluation Study in Selected Countries. 1984.

(32) For example see Institut du Sahel and Devres Inc., Bilan de Resources de la Recherche Agricole dans le Pays du Sahel. Volume II, Résumés des Rapports Nationaux, August 1984. Also SADCC and Devres Inc. Agricultural Research Resources Assessment in the SACC countries. Volume II, Summary of National Reports, January 1985.

(33) In a number of cases review missions have clearly stated the capacity to attract foreign assistance as one of the advantages of an autonomous structure. Two cases in point are MARDI, as reported by Moseman op cit. and that of the Dominican Republic (see "El Sistema de Investigación Agropecuaria en la Repùblica Dominicana." July 1983).

(34) See TRIGO E., and PIÑEIRO M. Funding Agricultural Research in "Selected Issues in Agricultural Research in Latin America", August 1983. Proceedings of a conference for Latin American Research Directors, sponsored by IFARD, IICA and ISNAR in cooperation with the Spanish Government.

(35) In Honduras and the Dominican Republic recent reorganizations have placed research under the responsibility of autonomous bodies with independent boards with majority representation of no-public sectors.

(36) See RUTTAN V., op cit. Chapter 4, also BONNEN J. T. Technology, Human Capital and Institutions: Three Factors in Search of an Agricultural Research Strategy. Michigan State University, East Lansing, Michigan, March 1984.

(37) See Considerations for the Development of Agricultural Research Capacities in Support of Agricultural Development. ISNAR, The Netherlands, 1984.

(38) See PAUL S., Strategic Management of Development Programs. ILO, Management Development Series No. 19, ILO, Geneva 1983.

(39) See RUTTAN V., op cit. chapter 4. Also PRAY C., op cit.

(40) See PASTORE J. and ALVES E., Reforming the Brazilian Agricultural Research System in ARNDT T., DALRYMPLE D., and RUTTAN V., Resource Allocation and Productivity in National and International Agricultural Research, University of Minnesota Press, Minneapolis, 1977.