WORKING PAPER No. 32

Overview of the Organization and Structure of National Agricultural Research Systems in Asia

Y. D. A. Senanayake

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International Service for National Agricultural Research

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CAB Descriptors:

Organization of Research; Research Institutes; Government Research; Research; Asia; Pacific; Bangladesh; Fiji; India; Indonesia; Japan; Malaysia; Nepal; Pakistan; Papua New Guinea; Philippines; Republic of Korea; Solomon Islands; Sri Lanka; Taiwan; Thailand; Western Samoa.

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SUMMARY

This review of the organization and structure of national agricultural research systems (NARS) covers five countries from South Asia, four from South East Asia, three from East Asia, and four from the South Pacific.

These countries are diverse in size, population, economic status, level of agricultural development, and status of agricultural research. Hence, the structures and functions of the NARS are quite varied. In many countries, support for agricultural research is below one percent of the agricultural gross domestic product.

From the 1960s to the 1980s, agricultural research in the region changed dramatically. Reorganization, which established apex bodies, led to strengthening of the NARS and increased investment in agricultural research. Research manpower also increased considerably.

The unique "council" system of Asia resulted from the restructuring of the NARS over the past 25 years. ICAR of India became a model for research councils established in Bangladesh (BARC), Pakistan (PARC), the Philippines (PCARRD), and Sri Lanka (CARP). These councils have important differences, but they were created for the same purpose, that of making management of agricultural research more autonomous. Managing- and coordinating-type councils are discussed.

The autonomous research institute model is also common in Asia (AARD of Indonesia, MARDI of Malaysia, and RDA of South Korea). The NARS in the Pacific region, Nepal and Thailand still follow the Ministry of Agriculture model.

The organization and structure of the Asian NARS have been quite dynamic. Many of the systems have undergone changes in structure, mandates, coverage, commodity focus, and functions. These changes were introduced to make the apex bodies and the NARS more effective and efficient. It allowed them to rapidly develop research capacity to utilize the increased resources provided by the government and external donors. The changes are discussed in detail in this overview paper.

The functions of the apex bodies include: policy formulation, research coordination, priority setting, program planning, funding, program implementation, monitoring and evaluation, infrastructure and human development, information dissemination, and technology transfer. The structures to carry out these functions are similar: governing council or board, secretariat, scientific panels and commodity teams, and technical committees. Details of the composition of these bodies are also provided.

Inter-institutional research collaboration in NARS needs to be strengthened. The mechanisms used by apex bodies for this purpose are varied. The national coordinated project scheme has been used as a model by many NARS. There is a need to tap the resources of universities to support agricultural research.

Strong linkages with international agricultural research centers (IARCs), as well as with regional centers, have been established by the Asian NARS. IRRI, ICRISAT, and AVRDC are located in Asia. Other IARCs have established regional centers. The work of these IARCs has strongly influenced national agricultural research -- in the area of programs, in training of manpower, and in the structure of the NARS.

The NARS of Asia and the Pacific are expected to remain dynamic in the future. Although the problems of the past -- the need for more food for more people, low incomes among the poor, production in marginal areas, degradation of the environment -- will remain, new challenges will face the future NARS. New issues will call for new initiatives in modern biotechnology, sustainability, information technology, etc. Further expansion of the NARS calls for new management approaches and improved managerial skills.

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ACRONYMS

AARD	Agency for Agricultural Research and Development (Indonesia)
AFFRC	Agriculture, Forestry and Fisheries Research Council (Japan)
AVRDC	Asian Vegetable Research and Development Center
BAR	Bureau of Agricultural Research (Philippines)
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BIOTROP	Regional Center for Tropical Biology (Indonesia)
BRRI	Bangladesh Rice Research Institute
CARP	Council of Agricultural Research Policy (Sri Lanka)
COA	Council of Agriculture (Republic of China, Taiwan)
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
DARE	Department of Agricultural Research and Education (India)
IARC	International agricultural research center
ICAR	Indian Council of Agricultural Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFPRI	International Food Policy Research Institute
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
JRI	Jute Research Institute (Bangladesh)
MARDI	Malaysian Agricultural Research and Development Institute
NARP	National Agricultural Research Project (India)
NARS	National Agricultural Research System
NARSC	National Agricultural Research Services Center (Nepal)
NCSRD	National Council for Scientific Research and Development (Malaysia)
NICCA	National Institutional Cooperation Committee in Agriculture (South Korea)
NWFP	North West Frontier Province (Pakistan)
PARC	Pakistan Agricultural Research Council
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PGIA	Postgraduate Institute of Agriculture (Sri Lanka)
RCC	Research Coordinating Center (Indonesia)
RDA	Rural Development Administration (South Korea)
SEAFDEC	South East Asia Fisheries Development Center (Philippines)
TARC	Tropical Agriculture Research Center (Japan)
TPPRB	Technical Programme Policy and Review Board (Philippines)
UPLB	University of the Philippines at Los Baños

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1. INTRODUCTION

AGRICULTURAL research in Asia dates back to the latter half of the 19th century. Efforts to organize a research system and establish the framework for its functioning were initiated in Japan towards the turn of this century. Beginning in the 1920s, under the influence of the colonial administrations, research capability to strengthen the plantation economies was expanded in many countries of South and Southeast Asia. Institutions were few, the research canvas was small, funds and manpower required for the tasks at the time were adequate, and the organization of research was relatively simple.

After the Second World War, the emergence of many independent nations in Asia changed this scenario. Wishing to expand agriculture and become self-reliant in staple food production, all governments began to support research on food crops as well as plantation crops. This movement was accelerated by an awareness, among planners and politicians, of the agricultural production miracle of the Western nations -- a revolution that had been catalyzed by appropriate technologies generated by research. The flow of information on the favorable returns-to-investment of agricultural research in the Western countries stimulated the growth of agricultural research in Asia into the national systems we know today.

Although the national agricultural research systems (NARS) are complex, their organizational framework in the Asian countries, as in other countries, is identifiable. It includes:

- agricultural research institutions which are exclusively public or private, or have a degree of shared responsibilities;
- agricultural educational institutions whose primary responsibility is to provide the research system with scientific and technical personnel, but which also contribute to national agricultural research output through their own research;
- central servicing facilities for research that provide information, analytical assistance, and data processing;
- producers' organizations which support research on their specific needs.

The above organizational framework of a NARS is comparable to Venezian's (1982) categorization. In Asia, each country's commitment to agricultural research in the past and its resource endowment have determined the availability and level of development of these four broad categories of institution. The distribution of the four in a NARS is guided by the history of rural settlement planning, subsequent agricultural development, and the history of agricultural research growth (no more than seven decades in most Asian countries). In many countries, the components of the national agricultural research system were, until recently, concentrated in the more urbanized and developed regions. This contributed to the problems of rural agricultural development.

The exception was Japan where research capacity was balanced between agricultural scientists employed in urban research institutes and field technologists serving in rural prefectures. Together, they helped change the base of Japan's economy from agriculture to industry.

Japan's experience with distributing the components of the organizational framework took place before the Second World War. Since the 1950s, this strategy has been modified and adopted by neighboring countries, particularly South Korea and the Republic of China (Taiwan) where, again, it has given rise to successful economic development. The significance of shifting agricultural research from a predominantly urban to a more rural setting, as well as the accelerated development it triggered in Japan, were largely missed by development planners until recent times. The rest of the Asian countries are now following the trend.

Dispersing agricultural research into the four categories mentioned earlier involves the introduction of essential structures in each category. When structures are added, the NARS becomes quite

extensive. The structural requirements in the four categories extend from the national level at the apex of the system, through the institutional levels midway, to the implementation levels at the base. They form a complex web of inter-linked facilities with a high degree of division of labor. The structural features regulate the flow of formal activities within the system, while the linkages within them and external to them channel the flow of information, products, and resources into and out of the system. Together, the structure and organizational process mold the operational aspects of the research system and its capacity to perform stated functions and achieve its expected goals (Sachdeva, 1988).

Structures and organization would be sterile without human intervention. Scientific manpower is an essential component, capable of producing the desired outputs from the structures of a NARS (Jain, 1986). While highly trained scientific research personnel and support technicians are an input to the NARS, they are also one of its outputs. Other resource inputs such as finances and materials complete the basic requirements for the system to function.

This review examines the structure and organization of NARS in selected Asian countries and the South Pacific. The five countries of South Asia, four of Southeast Asia, and three of East Asia were selected for several reasons. They represent the diversity of the systems discussed, their recent growth has been dynamic, they vary greatly in size, and they are geographically distributed over latitudes ranging from the harsh equatorial tropics to the milder temperate regions. The four South Pacific Islands were included because they represent a model discussed in this review which was common to most Asian countries in the past.
Figure 1 shows the geographical location of the countries covered by the review.

In the developing countries -- and to a great extent in the developed ones -- the organizational framework of a national agricultural research system, with its structures and people, is a public investment. Its strengths and weaknesses, its growth and cessation, can be influenced by a government's perception of what a NARS can do to the political, social, and economic stability of the country. Investments in agricultural research in all countries in the region under review have been growing rapidly (Oram & Bindish, 1981; Schuh & McCoy, 1986; Ruttan and Pray, 1986). In most countries of the region, NARS have responded visibly to alleviate food scarcities; and in some countries, they are taking new export initiatives.

However, the NARS cannot be complacent about the success achieved so far. Current economic realities suggest that planners and financiers within government hierarchies will not be very receptive to NARS managers' requests for more funds to increase the organizational framework and expand its structures. A critical look at the organization and structure of NARS at this time should provide insights into how to get the most from the existing systems. It behooves the new generation of NARS leaders to respond to this task.

2. *THE COUNTRIES*

ASIA, including the Middle East, covers 2.8 billion hectares, or about 21 percent of the world's land area. About 14.5 percent of the continent's land is arable, but only 0.9 percent is permanently cultivated. The Asian region contains over half the world's population and 70 percent of the global agricultural population. It leads the world in output of the following commodities (Asian Development Bank, 1988):

Crops	%	Livestock	%
Jute	95.4	Buffalo	97
Rubber	93.6	Ducks	65
Rice	92	Pigs	47
Coconut	86.4	Goats	45
Oil palm	75.6		
Tea	72.9		
Groundnut	67		
Cereals	58		
Cotton	48.1		
Pulses	47		
Roots and tubers	40.5		
Sugarcane	40.2		

Population and Economic Data

The countries reviewed in this report -- 12 countries of South, Southeast and East Asia, plus four South Pacific Islands including Papua New Guinea (Figure 1) -- cover about one-third of the land area of Asia. They account for a significant, if not major, proportion of the production of commodities noted above. India outstrips the remaining countries in respect of population and land area (Tables 1 and 2).

The combined population of the countries under review was about 1.5 billion in 1986, two-thirds of that in South Asia. The resulting pressure on land reflected by population density is high. With 721 people per square kilometer, Bangladesh is the most densely populated. Relatively high densities are also found in the three East Asian countries with China (Taiwan) leading the group. With only seven people per square kilometer, Papua New Guinea is the most sparsely populated.

The countries of South and Southeast Asia are continuing to improve their health services, and infant mortality rates have been declining. As a result, population increase in terms of total numbers is enormous even though the actual population growth rate is declining. The increased pressure on land and on future agriculture will be equally enormous. The need for intensive, sustainable agricultural systems, which are ecologically less damaging despite population pressures, is evident.

The data on Asian urban populations and literacy rates show that the South Asian countries have, on average, larger rural populations and lower literacy rates (Table 1). Sri Lanka's high literacy rate is an exception. Furthermore, the economically active agricultural population, as a percentage of the total economically active population, is also highest in South Asia (Table 3). The figure ranges from 50 percent in Pakistan to about 92 percent in Nepal, with these agricultural people representing the rural populace.

The significance of these facts is that the transfer of agricultural technology is a more difficult

task in South Asia, and the demands placed on extension workers are greater. Transfer messages have to be simpler and clearer. Personal contact and village-level demonstrations, in this context, are more important than mass media communications.

Among the countries of Asia, Japan, China (Taiwan), and South Korea (the three East Asian countries included in this overview paper) have the highest per capita Gross National Products (GNPs), electricity consumption, and proportions of urban population. The three indicators are inter-related and signify the development of their market economies.

Next are the four Southeast Asian countries: Indonesia, Malaysia, the Philippines, and Thailand. Their ranking suggests they are on the threshold of economic development. Nepal and Bangladesh, in South Asia, rank lowest among the Asian countries for the three development indicators.

In the countries of the South Pacific, population density is low, life expectancy at birth is relatively high, and per capita GNP is also higher than in most South and Southeast Asian countries. Thus, there is considerable scope for agricultural development and growth, particularly in Papua New Guinea, Fiji, and the Solomon Islands.

Land and Production

Table 2 shows the land area of each country, its use, and data on key production indices. Thirty percent of the review countries' total land is used for arable crops, 3 percent for permanent crops, 3.5 percent is permanent pasture, and 25 percent is forest and woodland. The proportion of these categories in each country varies considerably. When groups of countries are considered, the proportion under arable land is 42 percent in South Asia and about 13 percent each in Southeast Asia and East Asia. The order of country groupings is reversed with respect to forests and woodlands: the East Asian countries have 70 percent, followed by 22 percent in Southeast Asia, and 15 percent in South Asia.

These differences among subregions relate to the past histories of agriculture within the three subregions, their durations, intensities of production, and the degree of consciousness of environmental issues.

The ability of Japan and South Korea to maintain high proportions of forests and woodlands in spite of their high population densities is encouraging from environmental and ecological perspectives. The higher proportion of urban populations, the adoption of intensive agricultural practices, and a certain degree of mechanization have helped these countries to boost agricultural production from a smaller arable land base.

Agricultural production indices for crops, livestock, and cereals (predominantly rice) in all of the review countries except Sri Lanka were higher in 1986 than in the 1979-81 period (Table 2). Sri Lanka had a shortfall in crops and livestock, which was partly due to internal instability and poor rainfall during 1986 in some parts of the country. The latter affected the rainfed perennial export crops such as tea, rubber and coconut, plus livestock production. However, rice, which is partly irrigated, was buffered against the climatic stress.

Agricultural Research Expenditures

Studies on investment in agricultural research have revealed that resource allocation has increased in the three subregions of Asia (Ann Judd *et al*, 1987; Oram & Bindish, 1981). A comparison of the total expenditure per scientist person year (SPY) for 1959, 1970 and 1980 shows, that although the rates of increase for the three regions vary, there has been a consistent commitment to increase investment (Table 4).

Expenditures on agricultural research as a percentage of gross domestic product (GDP) for the five-year period 1980-85 show that all countries have had a consistently low proportion of investment, ranging from .04 percent in South Korea and the Philippines, to .40 percent in Papua New Guinea (Table 3). With respect to percentage of agricultural gross domestic product (AgGDP) too, the levels are below one percent except for Japan (2.84 percent), China (Taiwan) (1.55 percent), Fiji (1.34 percent), and Papua New Guinea (1.7 percent). Malaysia is borderline with 0.97 percent.

In Japan and China (Taiwan), the higher expenditure as percentage of AgGDP is related to AgGDP's small contribution to GDP: 3.24 percent in Japan and 6.45 percent in China (Taiwan). However, in most countries in Asia the expenditure on agricultural research as a percentage of AgGDP has been far below the 1 percent recommended by international agricultural agencies and donor agencies.

Expenditures per economically active agricultural person and per hectare of agricultural land also show that investment in research was higher in East Asian countries than in the other review countries, the exceptions being Malaysia and the South Pacific countries. In the South Pacific, the high values of several indicators of expenditure are probably skewed because the countries have a high proportion of expatriate staff. Their costs, plus foreign aid flows to development projects that contribute to agricultural research expenditures, could account for these increases.

3. THE THEORETICAL APPROACH

ORGANIZATIONAL theorists would like to believe there is a single kind of agricultural research organization -- such as a scientist working in a laboratory with a small isolated research team. Even in the smallest country in Asia or the South Pacific, however, this situation (where there is not even a minimum of communication linkages) no longer exists. On the contrary, there are different kinds of research tasks requiring different types of organizations and structures as well as different kinds of managerial processes.

Organizational literature would erroneously treat each organization, regardless of size, as if it were a single entity. But it would be fallacious to treat a large ministry of agriculture, for example, as a single organization. It is not. Rather, it is a 'multi-organization' in which each of its centers of research is itself an organization.

Thus, research organizations have become complex over time. Like organisms, they have evolved from simple features. They interface with three types of environment: contextual, transactional, and internal. They have three organizational levels: higher, middle, and lower. They are subject to several hierarchies of management: senior, intermediate and junior. And they are required to transform resources into outputs by line managers at various structural locations (Sachdeva, 1988). Complexity increases in a NARS as organizational outputs are further subdivided by program category (such as commodity) and as they in turn are identified in different types of structures such as coordinating units, specialized research centers, and provincial stations. Interfacing with these different components are formal and informal decision-making mechanisms for carrying out the operational functions of a NARS such as programming, priority setting, coordination, monitoring, reviewing, evaluation, and resource allocation.

Complex organizational variables have been conceptualized by Galbraith (1977) in the well known Pentagon model. It cites five major variables in the management of an organization: tasks, structure, people, information-decision processes, and reward systems. A more recent conceptualization is the McKinsey 7-S framework. It modifies the pentagonal framework to a hexagonal one consisting of the following: styles of management, structure, systems, strategy, staff, and strengths, with a central focal point on shared values (Peters and Waterman, 1982). Both models emphasize coherence among the different variables which are complex and difficult to fit together. Furthermore, maintaining coherence is difficult because the environment and the organizations are ever changing.

Kast and Rosenzweig (1985) state that formal organizations are planned structures with a deliberate attempt to establish patterned relationships among components that will meet objectives effectively. Such organizations are represented by printed charts and other formal documents that delineate certain functions and responsibilities and the relationships between them. (In informal organizations, on the other hand, many interactions are not stated in a formal manner. They are not planned explicitly but arise spontaneously out of the participants' activities.) A formal system, then, is an organized unitary whole consisting of two or more independent components, parts, or subsystems and separated by identifiable boundaries from its surrounding environment.

Thus, Kast and Rosenzweig define an organization as:

- a subsystem of its broader environment with
- a goal-oriented arrangement having people with a purpose, including a technical subsystem where people use knowledge, techniques, equipment, and facilities, and
- a structural subsystem where people work together on integrated activities, and
- a psychosocial subsystem of people in social relationships, and coordinated by
- a managerial subsystem to plan and control the overall endeavor.

In the area of research, developments in science and technology have increased the trend toward

specialization. In turn, specialization requires increased sophistication not only in scientific methodologies, equipment and facilities, but also in methods of coordination and integration. Increasing complexity in a system like a NARS, as well as within an organization, makes management more difficult. For example, between researcher and research manager, there can develop differences in value systems. The researcher may strive for effectiveness of a process or product, i.e., the search for perfection, while the manager, whose job it is to allocate resources, may be more interested in efficiency, i.e., the cheapest way to develop the process or product. Differences in value systems may also permeate the management of different institutions.

Thus, organizational design and structural features will never be complete. Changes are on-going. Indeed, it is not a desirable solution to achieve a stable design. It should be a development process to be kept active. Like the analogy of the organism mentioned before, evolution continues to give better recombinants and even mutants. These are selected as the building blocks of the future organizations, while the poorer recombinants are rejected.

The importance of organization and structure in an evolving NARS is evident from the preceding discussion. ISNAR has recognized this. In its strategy, which addresses 12 critical factors (Table 5) in the building of effective and efficient NARS, the components dealing with structure and organization form the central core (ISNAR, 1987).

The structure and organization of a NARS include the size of the system, the infrastructure and its internal framework, mandates and responsibilities of the institutions, linkages with policy-level bodies above the NARS and the farmers below, and external linkages. These factors are critical to improving the effectiveness and efficiency of a NARS. But in order to identify improvements to keep the system vibrant, they have to be examined in light of existing conditions and possible future research agendas.

This review compares the NARS of three of Asia's four subregions, namely South Asia, Southeast Asia, and East Asia, and also considers the situation in a few developing countries of the South Pacific. It examines system governance at the national level, program and administrative management at the institutional level, and research management at the implementation level.

The term "organization" is examined in relation to its dichotomous meaning. It is seen as a set of social mechanisms in which human beings come together to achieve stated objectives through division of labor (i.e., organizations). The term also refers to activities consciously directed or channeled through the established organizations (i.e., organizing). The two are used interchangeably in the following discussion of organization and structure.

4. ORGANIZATION AND STRUCTURE

Historical Setting

Agricultural research in Asia and the Pacific Islands originated in this century. The exception was Japan, where the central government played a key role in establishing an agricultural research infrastructure towards the latter part of the 19th century. This was emulated by the prefectural governments in the country towards the turn of the century.

In the rest of Asia, agricultural research was linked to specific commodities for export, primarily to the Western countries. Single-commodity research institutions were established for export crops such as tea, rubber, coconut, and sugar. The pioneering research administrators of the period structured these institutions along patterns they were familiar with. Invariably, these reflected a discipline-based divisional structure having a hierarchical system of administration. Mixed-commodity research had low priority in the context of a nation's agricultural research; it therefore received little attention, if any, from government planners and the treasury.

For most Asian countries, the years of the Second World War and the decades that followed were unsettling. Some had been ravaged by the war; others were undergoing the transition to independence from the colonial rulers. Reconstruction, restructuring, and rethinking preoccupied the political and administrative leadership of the times. From the mid-1950s, however, there were also the added pressures of population growth, imbalances in food and nutritional requirements for the growing masses, attendant economic uncertainties, and social upheavals. All these factors contributed to a rethinking of the direction of agricultural research -- a rethinking that transformed it from isolated, ad hoc, institution-based efforts, to a national, system-based activity.

The mid-1950s saw historic changes in agricultural research on the Indian subcontinent. Strong leadership by research administrators, political will on the part of the Indian government, and the interaction of foreign agricultural researchers and research managers with their local counterparts laid the foundations for an Indian NARS. In retrospect, it could be argued that these events triggered similar changes in many Asian countries and, indeed, in the rest of the developing world.

The basic elements for organizing and structuring a NARS are invariably found in any nation, no matter what its size. The transformation of these elements into an organic form, displaying levels of organization, their structures and links, gives a NARS its unique identity. The rest of this chapter reviews the Asian experience in restructuring agricultural research with a national focus. It also identifies the organizations and structures that perform the functions of system governance, program and administrative management, and research management

Functions of NARS

The main functions of a NARS have been detailed in a recent review by Jain (1989). He classifies them broadly into two categories: governance functions and research functions. The former include budget allocation and management, resource management, determining personnel policies, and deciding on centralization. Research functions are: formulation of research policy; research programming; resource allocation; research coordination; program implementation, monitoring and evaluation; and communication.

The organizations and the structural elements in a NARS have to perform the various management functions at three levels (Hariri & Sachedeva, 1988). First is the national level. Here system governance is indispensable in establishing coalitions, securing resources, and building credibility within and outside the system through effective strategic planning, organizing, and implementing. Next is the institutional level where research programming, its implementation, monitoring and

review are operational functions. Third is the implementation level where national micro-level priorities are set, effective experimentation is carried out, resources are efficiently managed, and collegial relationships among researchers are fostered. It is also at this level that research outputs are disseminated or transferred to end users in acceptable forms (Table 6).

NARS Governance and the Apex Organization

Structurally there are four types of national organization at the apex of the NARS in the countries under review (Table 7). In Asia, the council type and the autonomous agency predominate, while in the South Pacific Islands, the ministry model is used.

The evolution of the council type and autonomous agency in all countries except India is recent, within the last 25 years. These types of apex organizations were introduced into the systems primarily to make the management of agricultural research more autonomous. They were intended to reduce the stifling bureaucratic impediments to research so common under the ministry model from which they evolved. The traditional ministry model was considered to be too hierarchical in structure and too archaic in management to provide the leadership needed to guide the expanded system foreseen by many research managers of the time.

In the sections that follow the distinguishing features of national-level organizations are briefly described, and the pros and cons in relation to their governance functions are considered.

Three types of agricultural research council have become prominent during the last three decades: managing, coordinating, and funding types. However, in this review, only two types are cited.

Managing Councils. These bodies, the strongest in the NARS, perform a variety of functions. They determine research policy and programming in consonance with the government's overall agricultural development objectives. They organize research in their own establishments as well as in cooperation with others. They provide the major portion of funding for the system. They catalyze infrastructural and scientific human resources development to service the system. And they interact closely with the transfer of technology.

In a government where there is a devolution of administration through state or provincial governments, a managing council could become the effective linkage between the center and the periphery. Although the mandates of such councils are broad in scope, their ability to perform a more complete managerial function may vary according to their own level of maturity and according to the availability of research managers and agricultural scientists to support the system.

The Indian Council of Agricultural Research (ICAR, see Chart 1) is the strongest example of a managing council in the developing world. It has had a relatively long evolution, dating from 1929 (Drillon, 1977), plus a foundation of credibility and a surfeit of trained personnel. The Pakistan Agricultural Research Council (PARC), established in 1964, is still evolving into a managing council from a coordinating type (Chart 3). The Agriculture, Forestry and Fisheries Research Council (AFFRC) of Japan can also be classified as a managing council (Tanaka, 1983). It too has a broad mandate -- planning, coordination of research activities, administration and supervision of national research institutes, and assisting research activities pursued in various institutes owned by prefectural governments.

Japan's AFFRC stabilized quickly and apparently has not been restructured since its establishment in 1961. In contrast, India's ICAR introduced major changes in 1974 and PARC has reorganized itself twice, in 1979 and 1981. The evolution of PARC into a true managing council has been slower than the other two primarily because it lacked the infrastructural and scientific human resource base that the other two possessed when they were formed. Another historical reason has been that the linkages between the central apex body and the peripheral provincial administrations and their lead agencies (such as provincial departments of agriculture) were weaker. India and

Japan, in contrast, were stronger in those respects due to the evolution of central federal agricultural research institutions and peripheral state or prefectural research organizations over a long period.

Coordinating Councils. The mandate of these bodies is narrower, limited primarily to coordination functions such as the preparation of a national research plan and programs and periodic review of the progress and outputs of the national research system. Coordinating councils normally do not have direct administrative and funding obligations to the various research institutions and therefore have limited capacity to give leadership at the implementation level.

The creation of three of the coordinating councils -- PARC in 1964, the Bangladesh Agricultural Research Council (BARC) in 1973 (see Chart 7), and the Sri Lanka Council of Agricultural Research Policy (CARP) in 1987 -- was related to the need for better coordination of research. With agricultural research dispersed among several federal government ministries, there was a lack of coherence in planning and resource utilization. The dispersal of research institutions among different ministries in Bangladesh and Sri Lanka is evident from Charts 8 and 12. The situation was worse a few years ago. Both countries have recently relocated important lead departments within the Ministry of Agriculture.

In Pakistan too, agricultural research is conducted by several federal agencies and provincial research institutions (Chart 4). The ministries are responsible for financing the institutes within their control and for the determination of research policy, priorities and programs. They may rely on PARC for help in this work and overall coordination (PARC, 1986).

These coordinating councils are able to advise and assist the federal and provincial governments with the expansion and improvement of their research capacities and capabilities. By effectively coordinating research, a council develops its credibility and confirms the necessity of having such a structural entity within a NARS.

China (Taiwan) has evolved a strong and effective coordinating council, the Council of Agriculture (COA). Its mandate is wider than that of the coordinating councils in the other Asian countries mentioned, for in addition to research COA is also responsible for the development of the agriculture sector. It had its origins in the Joint Commission on Rural Reconstruction (JCRR), which was created in 1949. JCRR later became the Council for Agricultural Planning and Development (CAPD) but was renamed the Council of Agriculture in 1984 when it was merged with the Bureau of Agriculture under the Ministry of Economic Affairs. This integration was a bid to centralize policy-making matters and related operations in the field of agriculture (COA, 1985).

The Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) is a coordinating council that derives its strength from its ability to fund agricultural research done in different institutions within the NARS (Chart 9). (In fact, because of this budgetary clout, which comes via the Department of Budget and Management, PCARRD is classified by Jain [1989] as a funding council.) PCARRD has generated substantial funds for the use of the national research and development system. Ideally, it should have control over the disbursement of all funds or the major share of the budgetary provisions allocated by government. It should also have its own research stations in order to provide direction to research based on a national focus, which is a prerogative of a national peak-level organization.

PCARRD has provided much assistance to the development of R&D in the universities and state colleges, in effect, using them as a research base. It does not have its own research infrastructure; hence its role is research management and coordination instead of project implementation. PCARRD has been able to give much needed direction to develop and consolidate a NARS in the Philippines over the last 17 years in relation to national priorities. This is because of strong leadership by the principal executive of the apex body and the formation of an effective secretariat manned by a group of highly motivated heads of divisions. PCARRD's mission has been eased to some extent by the fact that research projects submitted by universities, the Ministry of Agriculture, or other

- recommendations of the joint Indo-American teams from 1960 onwards to change the structural features of agricultural education, research and extension education in the States through the development of agricultural universities modeled on the Land Grant University System of the United States;
- setting up of a Department of Research and Education (DARE) and Agricultural Scientists Recruitment Board (ASRB) in 1974 (Chart 1);
- formulation of the Agricultural Service Board in 1975.

There are three main lessons for other countries to learn from the structural changes to a national-level organization like ICAR. First is the importance of change. Even though ICAR evolved over a period of almost 50 years and is a prototype of the council model, it has periodically modified its structure. Secondly, the changes were agreed upon after several joint reviews by leading research managers and their peers in the Indian agricultural research system and international agencies. Thirdly, there is no one, perfect organizational structure. The modifications described above were directed towards consolidating the functions of a large NARS to become a more effective one through time.

Each of various examples of national-level organization based on the council model originated in specific internal situations. Political interests and considerations at the national and regional levels, pressure groups among agricultural research institutes and scientists, and interest groups among other ministries and agencies -- all these factors contribute to the crystallization of a national-level organization into a form acceptable to all parties. Performance of the organization through the years and establishment of its credibility in the eyes of all parties that impinge upon it determine its restructuring and possible shift to another and stronger organizational form. China (Taiwan) illustrates such a change. From 1979, it had a Council for Agricultural Planning and Development (CAPD), which in 1984 was changed to a Council of Agriculture (COA). It is a cabinet-level organization (equivalent to a ministry) and administers all affairs related to food, crops, forestry, fisheries, and livestock.

The transition from an older ministry model to a national-level coordinating organization such as a council or autonomous agency has been made by the majority of larger countries in Asia. This was necessary because of the expansion of NARS goals, programs, infrastructure, and manpower. Apex bodies have made it possible to coordinate, service, and manage the increasingly complex NARS. Continuing under the ministry model would have stifled the NARS' growth and performance.

Thus, the restructuring of the Indian NARS during the decade 1956-65 was quickly perceived as a model to emulate by the research managers of the other larger countries who were planning to embark on an expansion of their NARS. In the space of barely 10 years, the other larger nations of South and Southeast Asia had peak-level national organizations in place. In all of these countries, this goal was realized with the assistance of international aid agencies.

Thailand and Sri Lanka are two exceptions. The former, a large country, has not followed the trend of the other large countries in the region. Rather, it has continued to accommodate its NARS under the ministry model and restructuring in the eighties has maintained the status quo (Chart 15).

Sri Lanka, a comparatively small Asian country with about half the land area of Nepal and one-seventh that of Papua New Guinea, has added a coordinating-type council which at present is funded through the Ministry of Agriculture. Compared with Nepal and Papua New Guinea whose NARS operate under the ministry model, Sri Lanka has a longer tradition of agricultural research, dating from 1919. This enabled the country to develop a good network of commodity research institutes and research stations and a critical mass of researchers after the fifties.

Until the mid-1970s in Sri Lanka, R&D on agriculture, forestry, lands, irrigation, and fisheries were under the Ministry of Agriculture. After that, there was a multiplicity of ministries

organizations have stood a better chance of being funded by government if they were approved in advance by PCARRD. The council also approves the utilization of external funds for agricultural R&D.

Ministry Model. Among the 12 Asian countries under discussion, the ministry model is used only in Nepal in South Asia and Thailand in Southeast Asia. It is, however, the model from which the councils evolved in many countries over the past three decades.

In Sri Lanka, CARP is still in its formative stages, so the functions of policy determination, research programming, funding, and so on are still handled within the ministry framework. In the small Pacific Islands, where agricultural research systems have limited capability, the ministry model persists and will continue to do so in the future. In these countries, the research division of a lead department, such as agriculture, normally oversees program determination, priority setting, and implementation functions. It has to depend on the ministry for its resources and therefore is vulnerable to management decisions at higher levels and is usually frustrated by the bureaucratic approach common in such situations.

Autonomous Agencies/Institutes. Three countries have strong national agricultural research agencies/institutes that are largely autonomous though subject to the directions of the ministries concerned. Comparable to the council model of the South Asian region, these are: the Agency for Agricultural Research and Development (AARD) of Indonesia, established in 1974 (Chart 10); the Malaysian Agricultural Research and Development Institute (MARDI), established in 1967 (Chart 11); and the Rural Development Administration (RDA) of South Korea, formerly called the Office of Rural Development (ORD) which was formed in 1962. The Malaysian and South Korean NARS have features of the ministry model; that is, certain key research institutes -- in Malaysia, those responsible for research on rubber and oil palm, and in South Korea, those responsible for tobacco and ginseng -- are under ministries other than agriculture. In all three countries, these lead organizations are the principal ones that assist with policy-making, programming, and implementation of agricultural research on crops and livestock.

Organizational Diversity at National Level

The preceding discussion highlights the great variety of peak-level national bodies in the NARS of Asia. In fact, of all the regions of the world, Asia may have the greatest diversity of apex organizations. This diversity reflects the particular colonial history, educational development, political evolution, and even cultural roots of each of the countries of the region.

The lead given by India in developing a stable and functional council has been emulated by most countries in South and Southeast Asia. Historical relationships favored the acceptance of the council model in the larger South Asian countries such as Bangladesh and Pakistan. ICAR had its origins in 1929 in the form of the Imperial Council of Agricultural Research, following the recommendations of the Royal Commission on Agriculture in 1926 (Menon, 1971; Subba Rao, 1988). Its name was changed to the present ICAR in 1947 and the council served principally as an organization to disburse research funds without effective administration and coordination of research at the national level.

Five important interventions helped to mold ICAR into its present form (Menon, 1971; Subba Rao, 1988):

- recommendations of the joint Indo-American teams during 1954 and 1959 on agricultural research and education, stressing the need for changes in ICAR for effective functioning;
- recommendations of the Agricultural Research Review Team of 1963 for changes in ICAR to make administration and coordination of research more effective and for constituting a new council to be headed by an eminent scientist with close links to the Ministry of Agriculture;

responsible for agricultural research. This resulted in a lack of coordination of research policy determination, facilities development, recruitment and training, resource allocation, and so on (ISNAR, 1986). The objective of creating a Council of Agricultural Research Policy, therefore, was to introduce into the NARS a structural feature that would develop a national research plan and research programs, determine common policy guidelines for all ministries and agencies undertaking research, review research projects, advise the government on the development of infrastructural and resource requirements, initiate inter-institutional collaboration in research, and carry out other coordination functions. The organizational similarities of the NARS in Sri Lanka and Bangladesh are evident from Charts 8 and 12.

Unlike Sri Lanka's NARS, those of Nepal and Papua New Guinea are relatively small and operate under one ministry. It is therefore premature to consider a national-level apex organization.

Bangladesh, with a greater land area and population than Sri Lanka, opted for a coordinating-type council (BARC) about 15 years ago. It did so for much the same reasons as Sri Lanka, namely, that the research institutions were dispersed among several ministries and a national-level coordinating structural feature was needed in the NARS. As in the case of Sri Lanka, the older commodity research institutions and research units in the different ministries were not receptive to a structural change that would result in a controlling influence on the management of the different institutions.

Like CARP in Sri Lanka, BARC is placed within the Ministry of Agriculture. But it differs from CARP in that some of the large central research institutions, such as the Bangladesh Agricultural Research Institute (BARI), the Bangladesh Rice Research Institute (BRRI), and the Jute Research Institute (JRI), are subordinate to it. BRRI was established before BARC but later brought under the latter's coordinating influence. Next, the council assisted with the creation and development of BARI. More recently, the JRI and the Bangladesh Institute of Nuclear Agriculture (BINA), previously under separate ministries, have been relocated under the Ministry of Agriculture with the objective of better coordination of research.

Types of Governance

Four of the larger apex organizations of the managing and coordinating types -- in India, Pakistan, Malaysia and the Philippines -- have governing boards or councils to manage their affairs. Two other managing-type bodies, in Indonesia and South Korea, do not have such a structural feature. Rather, they are under the direction of the principal executive of the organization, the director general (Table 8). The governance of three other apex organizations -- the coordinating type in Bangladesh and Sri Lanka and the managing type in Japan -- is by the members of the council.

In Sri Lanka and Japan, the chairman is elected from among the council members. Leadership, therefore, can be either strong or weak, depending on the person elected. This system can also suffer from a lack of continuity over a reasonable duration due to administrative and political changes. Sri Lanka's CARP, for example, had three chairmen over the period of one year and a half. This is a major disadvantage for such an organization during its formative years. Although Japan also follows the elective system, it has protected itself against this kind of leadership disruption by ensuring that the chairmen and council members are scholars and experts in research pertaining to agriculture, forestry, animal husbandry, and fisheries (Tanaka, 1983). The council has no *ex officio* members.

Other apex organizations in Asia have *ex officio* chairpersons. Among them, the Indian example is unique. The chairman and principal executive of ICAR not only holds the additional post of secretary of the Department of Research and Education (DARE) but is also a distinguished senior agricultural scientist. This provides a strong link with the government's political and administrative leadership and with the NARS of the country (Chart 2). In the Philippines, the chairman of PCARRD's governing council is the Secretary of the Department of Science and Technology.

Enabling Legal Enactments of Apex Bodies

Apex organizations cannot function effectively without a legal mandate enabling them to exercise their powers and making them accountable to government. Such a mandate also defines the agency's specific commodity areas to avoid operational frictions between it and other apex agencies.

The enabling legal provisions of the apex organizations created over the last 25 years are listed in Table 9. In Bangladesh, Indonesia, and the Philippines, the enabling legislation has been provided by presidential orders or decrees. In countries with parliamentary government, acts of parliament have been used, as in the case of India, Sri Lanka, and Malaysia. In Pakistan, the legal provisions were introduced by government ordinance. In those other countries of Asia and the Pacific where the apex organization is a ministry, prevailing laws and administrative regulations have served the purpose.

Periodic revisions of rules, bylaws, and regulations under the relevant legal enactments took place in India in 1963 and 1976, in Bangladesh in 1976, in Indonesia in 1979 and 1983, and in the Philippines in 1982 and 1987 (ADB, 1988; BARC, 1979; Balaguru & Raman, 1989; Subba Rao, 1978). These revisions were made for various reasons: to give an apex body greater flexibility to carry out its functions (as in BARC in 1976), to make it more autonomous (as in AARD in 1974 and 1983), or to change the composition of the members of the governing board or the council (as in PCARRD in 1975 when natural resources was added to its mandate).

Amendments to the rules and bylaws of the constitution of ICAR in 1975 consolidated its linkages with the government. As mentioned earlier, the director-general of ICAR was appointed secretary of the new Department of Research and Education. This enables ICAR to bypass the former Department of Agriculture when it needs to consult the higher echelons of government.

Areas of Research Covered by Apex Bodies

Crops and livestock are the principal areas of research under the jurisdiction of apex organizations or, in the case of countries with no apex body, of ministries (Table 10). The emphasis on these two areas of agriculture perforce has helped all of the countries reviewed to embark on cropping and/or farming systems research as well. There are some exceptions, however. Commodities such as sugar in Bangladesh, Fiji, and Thailand, tobacco in Pakistan, Thailand and South Korea, rubber and oil palm in Malaysia, and cotton in Pakistan are outside the scope of the apex organization or ministry concerned. These exceptions are attributed to the historical development of strong commodity research institutions that service economically significant export commodities. The articulate managers of these institutions have been able to prevail upon the decision-makers to maintain the status quo.

The next area of widest coverage is inland fisheries which has a strong link with farming systems research. Another area is discipline-oriented research on physical resources such as land, soil, water and their utilization, conservation and renovation.

Forestry research is included in the mandate of half of the 10 NARS apex bodies found in the region. In India, it is under a different apex body, the Indian Council of Forestry Research (ICFR). In Malaysia and South Korea, forestry research is conducted by institutions under the direction of other ministries (FAO, 1986; ADB, 1988). In Thailand, where the ministry model is in operation, forestry research is the responsibility of the Department of Royal Forests under the Ministry of Agriculture.

An examination of systems research done in all the countries reveals a substantial amount of agroforestry research being conducted in single-crop or mixed-crop research institutes. Their studies

are focused primarily on either fuelwood-crop combinations or fuelwood-fodder-crop-livestock interactive research which have the blessing of the agricultural apex organizations.

In the Pacific Islands, agricultural research is weak and studies are almost exclusively in the area of testing and evaluation, or adaptive and applied research. In these countries, almost all agricultural research has been on food crops and, for the most part, has been a spillover from inquiries connected with agricultural development projects funded by foreign donor agencies (ADB, 1988; FAO, 1986; ISNAR, 1981, 1983, 1985).

Functions and Responsibilities of Apex Organizations

The enabling legal enactments state the functions and responsibilities of apex organizations. Table 11 summarizes the principal functions of the apex organizations in the countries under review. Thailand and Nepal have been included for comparison of a large and a small country, respectively, that do not have an apex organization. Nepal has attempted to perform some of these functions in recent years by the formation of a National Agricultural Research Services Center (NARSC). A comparison of its functions was also considered useful for this review.

An examination of the table reveals the strengths and weaknesses of the apex organizations of different countries regarding their performance of functions and responsibilities essential to agricultural research. Countries that do not have an apex organization, like Thailand and Nepal, are weakest in this respect, and the same could be said of the Pacific Islands. Lack of coordination, lack of definition of research priorities, and too much centralization have been cited as weaknesses in a recent review of Thailand's research system (FAO, 1986).

Coordinating-type councils like BARC in Bangladesh and CARP in Sri Lanka are also weak in many respects. CARP is new and needs more experience to reduce its weaknesses. But the table also shows that it has no mandate for many areas such as priority setting, funding, and infrastructure development, which may make it a weak apex organization in comparison with the others in the region. The weaknesses of BARC and CARP also stem from the fact that agricultural research is still dispersed among different ministries (Charts 8 and 12). Therefore, important functions such as program planning, research coordination, implementation, and evaluation suffer from lack of direction.

In some areas of responsibility, Pakistan's PARC also displays weaknesses. These result from the fact that some agricultural research organizations are in ministries other than agriculture and that the provincial governments have considerable influence in the area of agricultural research. However, structural changes introduced since the beginning of this decade as a way to strengthen PARC's enabling ability should eventually reduce the weaknesses. The Ordinance of 1981 made PARC autonomous and the establishment of National Coordinated Research Programs opened up important channels for cooperation and complementarity between the federal and provincial research arms.

Among the apex organizations, ICAR carries out the most complete set of functions, including funding support to train people at the postgraduate level through a network of agricultural universities across India. When agricultural universities were established beginning in the sixties, ICAR was given the responsibility of assisting in their development. Of the universities' three main functions, namely education, research and extension, ICAR funds the research component. In so doing, it has both developed the research infrastructure of the universities and provided operational funds for conducting experiments.

The Philippines has also funded postgraduate research at universities and assisted in the development of the research infrastructure through a system of national and regional research centers attached to universities. Other larger apex bodies such as PARC, MARDI, and AARD have provided assistance for postgraduate scientific training by providing opportunities abroad under aid

projects of multilateral development agencies such as the World Bank and UNDP, as well as under bilateral aid agreements.

As mentioned earlier, PCARRD of the Philippines is a coordinating council with budgetary clout. It has provided considerable leadership and organizational ability in executing a wide range of functions encouraged by its enabling enactments. Although the council does not have its own research infrastructure, it has been effective in research coordination, program implementation, management at the implementation level, and technology transfer. Its share of the total national budget for agricultural research has been only 20 to 25 percent. Any reduction in this amount could weaken PCARRD's role (Javier, personal discussion). However, in addition to the projects it funds itself, PCARRD also recommends to government all other agricultural research proposals submitted by various organizations in the country. In approving research proposals that conform to national R&D priorities, PCARRD plays a strong coordinating role.

Besides ICAR, the apex organizations of Indonesia and Malaysia in Southeast Asia and those of Japan, South Korea, and China (Taiwan) in East Asia have been quite effective in executing their responsibilities. Any gaps in their work, such as assisting with in-country postgraduate research, providing support grants, or transfer of technology, are not entirely neglected in the countries concerned. They are met by other agencies in the same ministry, as in the case of technology transfer, or by other ministries, as in the case of higher education and postgraduate research.

Three relatively weak areas stand out in Table 1: program planning, support for postgraduate research in universities, and the transfer of technology. Improvements in all three areas could expand the contribution of a NARS. Future trends of research clearly indicate that the universities cannot be ignored much longer. Drawing them into the national agricultural research effort, as ICAR and PCARRD have done in the past, would be a cost-effective approach for the apex organizations.

The above discussion indicates that the introduction of apex organizations into NARS has provided a structural mechanism to carry out the agricultural research functions essential to national development. The success of individual organizations in meeting their responsibilities has been influenced partly by experience and partly by the amount of power given them by the enabling legal enactments. Specific structural features that have assisted the organizations in their tasks, as well as those that have hampered their effectiveness, are examined in the next section.

Structures Providing Technical Support to Apex Bodies

Apex bodies have adopted four broad types of structure to provide them with technical support. They are the secretariat, scientific panels or equivalents, committees, and coordinating centers. These structures have been modified according to the specific needs and accumulated experience of the apex organizations.

Secretariat. With over 250 personnel, Japan's AFFRC has one of the largest secretariats. Its five key divisions are planning, coordination, R&D, equipment and facilities, and research promotion (Chart 6). PCARRD too has a large secretariat with a staff of about 300 and 10 division.

Scientific Panels/Councils. Scientific panels and scientific councils are used in ICAR and MARDI, respectively. In the formative years, the governing body of ICAR was assisted technically by four standing committees. These dealt with agricultural research, animal science research, economics, statistics and marketing research, and agricultural education. Each of these committees was in turn supported by a technical panel. Under the present structure, the governing body gets technical support from scientific panels plus seven technical deputy directors general whose input reaches the governing body through the director general (Chart 1).

In Malaysia, the governing board and the director general of MARDI receive technical advice from a scientific council (Chart 11). The director general is assisted by three deputy directors general responsible for commodity research, research support services and development, and administration.

Technical Committee. PCARRD of the Philippines, PARC of Pakistan, and RDA of South Korea have used technical committees to assist the governing bodies. During the formative years of PCARRD in the 1970s, a formal body called the Technical Programme Policy and Review Board (TPPRB), now called the Technical Advisory Committee (TAC), with horizontal links to the governing council and the executive director, was structured into the organization. In addition, the governing council had support from the PCARRD secretariat which had among its staff 10 research directors, each responsible for a area. Since 1982, the TAC has operated as a technical advisory body, providing advice to the executive director of PCARRD (Chart 9). Also, 32 National Commodity R&D Teams support the secretariat and provide technical advice to the executive director.

The organizational structures of BARC and PARC do not show formal technical support bodies. However, technical committees in various disciplines, represented by scientists from the concerned institutions in the country, provide technical support, as do the full-time members or member directors of the two councils.

The absence of formal technical support bodies in BARC and PARC is exacerbated by the fact that both organizations have operational difficulties that hamper their effectiveness. In Bangladesh, the problem is the dispersal of agricultural research in various ministries. In Pakistan, a large part of agricultural research in all provinces but one, North West Frontier Province (NWFP), is still under the director of the provincial departments of agriculture with all their bureaucratic budgetary, organizational, and promotional procedures (ISNAR, 1987). In NWFP, the agricultural research institutions are under the agricultural university.

South Korea's RDA has a National Institutional Cooperation Committee in Agriculture (NICCA) which evaluates the validity of research objectives, methodology, scientific value, and economic feasibility (ADB, 1988). It is chaired by the administrator (head) of RDA and consists of researchers in specialized fields, professors in national universities, extension experts and administrative personnel.

Coordinating Centers. Indonesia's AARD has five research coordinating centers (RCCs) for each of five key areas: food crops, horticultural crops, industrial crops, animal sciences, and fisheries. These centers provide technical support to the director general (Chart 10).

In addition, the Center for Agricultural Data Processing (CADP) provides backup technical information. With respect to industrial crops and sugarcane, the management boards responsible for research on such crops have to provide this service. In many respects, the role of AARD's RCCs resembles that of ICAR's deputy directors general and BARC's member directors, as they all serve a coordinating function.

Nepal and Thailand are among the countries that do not have an apex body. Recent structural changes in the ministries of agriculture of these two countries are nevertheless encouraging. In Nepal, a National Research Coordination Committee (NRCC) has been formed. It has direct vertical command links to the secretary of the ministry and to another new body called the National Agricultural Research Service Center, or NARSC (Chart 13). In Thailand, an office of specialists comparable to a technical mini-secretariat has been formed under the director general of agriculture (Chart 15).

Besides these formal structural features, the acts, ordinances, or decrees under which the apex

bodies function provide for the appointment of ad hoc committees. These can be used to consider any technical matter on which the governing council or the board may wish to seek advice.

Enabling Structural Links of Apex Bodies to Governments

For an apex organization to carry out its mission successfully, the individuals and organizations in the NARS must be committed and motivated. But also of great importance are the structural links that enable the chief executive or governing body to communicate with the hierarchy of political and administrative leaders and the heads of central economic planning agencies.
It has been suggested that, for maximum effectiveness, it is better to use a combination of communication links, such as the hierarchical group, expert group, status group, or friendship group (FAO, 1985). The first two represent the pathway of most formal communications, while the next two help immensely in preparing the ground for formal communications. The presence of an enabling structural link is therefore critical for easy access to the administrative hierarchy and acceptance as one among equals.

Apex bodies use two kinds of formal link: *ex officio* membership in the body, and direct communication between the chief executive and senior political and administrative leaders. The latter mechanism also ensures accountability of the chief executive to government. Here again, the structural links did not appear full blown in the various apex bodies but evolved according to the needs of each agency over time. Similarities and differences between the formal communication links of the various apex bodies are discussed below.

Ex Officio Membership. In almost all the governing bodies of the NARS included in this review, the proportion of *ex officio* members ranges from 60 to 79 percent. The most prominent exception is in Japan where none of the council members has *ex officio* status. The inclusion of a majority of *ex officio* members has its advantages. Some are senior technical and administrative officials from other development ministries which may have their own research institution(s) servicing economically important commodities. Others are senior officials from ministries concerned with finance and planning.

Communication, through formal expert groups and informal friendship groups, is broadened and strengthened by the inclusion of senior and powerful *ex officio* members. They expedite the making of decisions and facilitate their implementation. Their presence also means that accountability is spread among a large number of government officials, thereby enhancing the credibility of the apex body in the eyes of government. The representation of the ministry of finance in the governing body ensures further accountability.

Chief Executive's Position. Since apex bodies were first introduced, attempts have been made to strengthen the chief executive's position in relation to the government's administrative hierarchy. ICAR was the first to achieve this objective, which has since been emulated by PARC and BARC.

The chairman of the governing body of ICAR is the director general. He has a direct link upwards with the president and vice-president of ICAR who are the "Union Minister of Agriculture" and the "Union State Minister of Agriculture", respectively (Chart 2). Concurrently, ICAR's director general is also secretary of the Department of Agricultural Research and Education (DARE) and once again has a direct upward link to the political hierarchy. This structural feature allows communication to bypass the Department of Agriculture, thus expediting communication flows with the central and state governments. Thus, the chief executive of ICAR finds himself as one among equals, not only in the expert group but also in the hierarchical and status groups.

In PARC too, the federal minister of agriculture is president of the council. The chief executive is council chairman, who in 1981 was also made secretary of a newly created Division of

Agricultural Research under the Ministry of Agriculture and Food. This restructuring has followed India's example in that the chairman of PARC is made responsive to the policy concerns of the Ministry of Agriculture.

In Bangladesh, the position of executive vice-chairman of BARC was comparatively weak until recently. Although the chairman of BARC was the minister of agriculture, the secretary of the Agriculture and Forestry Division of the ministry was the first vice-chairman (Chart 7), which interrupts the direct vertical link between the chief executive and the political hierarchy, as well as the horizontal links to the secretaries of the other divisions. It appears that this weakness has been rectified with the recent elevation of the executive vice-chairman's status to that of a secretary of the ministry.

Sri Lanka's CARP elects its chairman from among its members. During the first year and a half of its functioning, the hierarchical political and administrative links were strengthened with the election of the former secretary of the Ministry of Agriculture, and later the incumbent secretary, as CARP chairman. Thus, all four councils of the South Asian group of countries have ensured a strong working relationship with government.

The head of Indonesia's AARD and that of South Korea's RDA report directly to their respective ministers. By virtue of their technical competence and positions as principal executives of large organizations, they maintain strong links with the central government.

PCARRD and MARDI relate to their respective government hierarchies via science and technology organizations. In that respect, they have a broader base than the other apex bodies. PCARRD is an organic unit of the Department of Science and Technology. Although communications flow, coalition building, and securing domain legitimacy are less direct, its association with the science and technology department gives it better credibility among scientists and policymakers. Malaysia's MARDI, within the Ministry of Agriculture, is one of five autonomous agricultural research organizations distributed among three development ministries (agriculture, primary industries, and science and technology). Moreover, a central monitoring role is exercised by the National Council for Scientific Research and Development (NCSRD), which is in the Ministry of Science and Technology. Thus, linkage to the government's political and administrative hierarchy is via the secretaries of the ministries -- which also used to be the case for the apex bodies of the four South Asian countries covered by this review. Many of them, including Malaysia and India, inherited the original system from their common colonial mentor, the British administrative hierarchical system.

Organizational Features of NARS Implementation Strategy

The previous sections describe the apex bodies of NARS in selected Asian and South Pacific nations and compare their structural features in relation to governance responsibilities. Although these bodies are relatively recent creations, there is great diversity among them with respect to their nature, governance, and structural features. This diversity reflects, in turn, the myriad perceptions that political, administrative, and agricultural research leaders have formed about the kind of apex body most suited to their country. Foreign donor organizations have also contributed to this diversity.

Because the various NARS developed over several decades prior to the formation of their apex organizations, one should expect a still greater diversity at the implementation level of research. Before characterizing this diversity, it is relevant to describe the types of research that are carried out at the institutional level, since they have a bearing on the structures required at the implementation level.

Agricultural research in Asia could be characterized into four distinct types -- namely, basic, strategic, applied and adaptive research (Table 12). These are defined by the Consultative Group on International Agricultural Research (CGIAR 1981) and described below.

Basic Research. Sometimes referred to as fundamental or frontier research, basic research is designed to generate new knowledge and understanding. It needs access to the world of knowledge, competent scientists with a thorough understanding of basic principles, and adequate investment in resources. It is usually done in universities and specialized research institutes, and is therefore concentrated in the richer countries which can afford the high investment costs. Nevertheless, universities and research institutions in developing countries can play a limited but important role in basic research, either on their own or in collaboration with external centers of excellence and international agricultural research centers (IARCs).

Strategic Research. This type of research is designed to solve specific research problems and is therefore highly mission-oriented. Strategic research is usually conducted by central research institutes in a NARS. Universities and IARCs, however, have sometimes been associated with strategic research in the last two decades due to the inadequacy of such research within the national system (caused by a lack of trained scientists and inadequate physical resources).

Applied Research. This type of research is designed to create new technologies appropriate to specified agro-ecological zones. The technologies have to be refined if their optimum conditions for usage are to be identified. Applied research is usually conducted in central research institutes and regional experiment stations.

Adaptive Research. This type of research is designed to adjust technology to the specific needs of a particular set of environmental conditions. Component technologies and technology packages developed by applied researchers in an experimental station are fine-tuned based on farmers' needs and circumstances. Researcher-farmer cooperation is vital at this stage if the technology is to be adjusted to levels the farmers can use and afford. Besides serving to adjust and validate the technology, collaboration between scientist and farmer has the added benefit of promoting end-user acceptance of the technology and its early transfer to a wider audience.

The four stages of research are not expected to be done in isolation. Cooperation among the various players can improve the overall process (Table 12). In particular, networking between foreign scientists and in-country scientists usually between the first two stages of research, and among in-country scientists mainly between stages two and three, enhances the research effort. Likewise, networking of researcher-farmer communication between stages three and four can accelerate the dissemination of technology (Table 12).

The extent to which these four types of research are conducted in the NARS of Asian countries varies, as does the proportion of resources allocated to each type. An economically advanced country like Japan places more emphasis on the first three types, while a poorer country like Nepal emphasizes the applied and adaptive phases of research. In the South Pacific, where the agricultural research system is weakest, the need is for simple testing/verification-type trials, which were successfully adopted during a phase of the development of Nepal's agricultural research strategy in the late 1960s and early 1970s (Kayastha *et al*, 1989).

Dagg (1989) has also stressed that, in addition to the four types of research described above, testing/verification and demonstrations are parts of the continuum of research effort. Any NARS must consider all types of research and their contributions within the national system. Dagg argues that the minimum starting point for public service research in a NARS should be to keep up with world knowledge on commodity possibilities and then test the best opportunities among them. If these are promising, the farmer can proceed to verification and testing or to verification and demonstration. It is only if they are not satisfactory that there is a need to modify the technology components through adaptive research.

A clearer pattern of distribution of basic, strategic, applied, and adaptive research among the different organizations in the NARS structure is recognizable in Japan (Figure 2). A similar trend is emerging in China (Taiwan) and South Korea -- one which would be useful during the future reorganization of the other NARS.

The AFFRC of Japan uses 13 specialized national institutes, most of which are now based in the Tsukuba complex, to undertake basic research. In addition, it uses the resources and manpower in the universities for this phase of research by funding special research projects. Excluding the university researchers, 1936 agricultural scientists are associated with the institutes' research programs.

The six regional agricultural experimental stations distributed from Hokkaido in the north to Kyushu in the south conduct strategic and applied research. Researchers working in the stations total 1633.

Adaptive research is concentrated at the prefectural level where some 405 research organizations employ about 8000 researchers to adjust and validate the technology that has reached them (Tanaka, 1983; AFFRC, 1986). High school graduates are used extensively as investigators in this adaptive research.

The Japanese example cannot be ignored by virtue of the fact that it is a developed country with a strong economy. Many of the specialized institutes have been functioning since the turn of this century. Initially, the central government played a strong role, compared with the prefectural governments, to establish the research infrastructure. From the beginning of this century, 60 to 75 percent of expenditure on agricultural research has been at the prefectural level and the evolution of the NARS has passed through four stages (Ruttan, 1986).

At the beginning of the Meiji period in 1868, the transfer of Western mechanical technology was dominant. This was followed by the rationalization and extension of indigenous technology beginning in the 1880s. From the 1920s to the 1940s, the emphasis was on building its own scientific research capacity and on nationally coordinated crop development programs. After the Second World War, the system was reorganized to give branch stations and prefectural stations greater autonomy. Good linkages were developed for coordination at the different levels, and the AFFRC was established as the apex body for coordinating agricultural research. To meet the future challenges of high technology research, AFFRC has linkages with other apex bodies, universities, and private sector research institutions to make agricultural research more comprehensive and efficient (Tanaka, 1983).

Much of the organizational and structural evolution of Japan's NARS occurred when the country was in an economically less developed stage. Thus, the Japanese experience holds a number of lessons for other NARS:

- The central government took the initiative in developing the agricultural research infrastructure in the form of specialized national research institutes, regional experimental stations, and prefectural research organizations.

- Prefectural research was decentralized and the prefectures were given autonomy to conduct their research.

- An apex body, the AFFRC, was established in the Ministry of Agriculture to coordinate and support research on agriculture, forestry, and fisheries and to assist prefectural research organizations.

- A strong secretariat was formed at AFFRC to be responsible for planning, investigating, coordinating, developing, and supervising facilities and equipment at the research institutes, as well as for monitoring progress (Chart 6).

- The AFFRC developed good linkages to cooperate with universities and private institutions and, at the prefecture level, to develop and execute research of national importance. It also developed effective linkage mechanisms between administrative, research, and extension organizations (Chart 6).

- Research results have been disseminated through computer data bases, periodicals, radio, TV, newspapers and -- most important to administrators, farmers and their organizations -- through lectures, meetings, and expositions. These last three have also provided audience feedback useful in the formulation of future research projects (AFFRC, 1986).

- Remuneration, perks, and other benefits have been sufficient to keep scientists contented.

- Almost 70 percent of the agricultural researchers are in the prefectural research organizations. This reinforces the adaptive research capability of the system (Figure 2) and illustrates the closeness of researchers to farmers.

- The use of in-country facilities and resources for training scientists has contributed much to the success of Japan's NARS throughout its history. Thus, self-reliance was built into the system from the early years.

Primary Organizations for Implementation

Even before national agricultural research systems were conceived and apex bodies established, agricultural research was carried out in the Asian countries by networks of research institutes and experimental stations. Single-commodity research institutes or research stations were common. These focused on export-oriented commodities such as tea, rubber, coconut or sugar, or on an economically important food crop, usually rice, and were located in one of the crop's major production regions.

A variant was the multicommodity institute/station. This was either located centrally, with a national focus and usually called the Central Agricultural Research Institute or Station, or based regionally within a provincial, state or agro-ecological boundary. Purely disciplinary research institutes were uncommon and universities that had agricultural scientists conducting or supervising research were rarely associated with the national agricultural research effort. It was against this background that the apex bodies had to organize the NARS to carry out their implementation strategies.

Since the establishment of apex bodies in Asia, the NARS primary structures for implementation have expanded, particularly in India and Pakistan in South Asia and Indonesia and the Philippines in Southeast Asia. Each structure is in fact a network composed of a mix of institutions -- national research centers, national institutes, central research institutes (or research centers), regional research (or experimental) stations, and even university-based research complexes. This expansion has been assisted substantially by the infusion of foreign aid fpr agricultural research.

The mix of implementing structures varies from country to country according to the size of the NARS. In turn, NARS size is determined by country size, availability of agricultural scientists, resource endowment, and provincial, state and agro-ecological considerations. The situation found in the mid-1980s is summarized in Table 13.

Central research institutes (including single-commodity institutes) and regional research stations are the two key structures in all countries. They form the principal arteries of a NARS. India and the Philippines have fewer regional stations than Bangladesh, Pakistan, Indonesia and even the small country of Sri Lanka. This is because agricultural universities, distributed statewide in India and regionally in Philippines, are important sites of regional research, not found in the other

countries included in this review.

The primary structures in Table 13 were not examined in relation to the types of research defined earlier. But we can expect strategic research to be undertaken by national institutes, some universities, and most central research institutes. A large share of applied researchis tributed among central research institutes and regional stations. Adaptive research is confined to regional stations. The capacity for adaptive research in a few countries has been expanded by a network of low-profile structures such as testing stations in Bangladesh, provincial substations in Pakistan, experimental farms and ponds in Indonesia, and cooperating stations in the Philippines.

The research organizations can be classified into eight subgroups according to: the nature of their research (multicommodity or single-commodity, multidisciplinary or monodisciplinary); the scope of their mandate (national or regional focus); and the source of their support (central/federal government or provincial/state administrations). Examples of the eight types of primary structures are given in Table 14.

Type A. This type of research institution is funded by the central government through an apex body or ministry. It conducts multicommodity and multidisciplinary research focused on national needs. Most central agricultural research institutes and national research centers in a NARS fall into this category.

Type B. This type of research institution is also supported by the central government. Research is focussed on national priorities but limited to either a single commodity or a single discipline. The central rice research institutes and the plantation crop research institutes (for coconut, rubber, sugar, and tea) that are found in many Asian countries are the best known examples of single-commodity institutes in this category. Here the research program is multidisciplinary and departments are set up along disciplinary or program lines. Examples of type B monodisciplinary institutes include the Plant Breeding Institute of the University of the Philippines at Los Baños, Soil Survey of Pakistan, the Soil Research Institute of India, and the National Institute of Agro-Environmental Sciences in Japan.

Type C. Funds for this type of research institution are provided by an apex body. ICAR in India, for example, funds the Research Complex for the North Eastern Region, and Sri Lanka's Department of Agriculture funds its agricultural research centers. The former is regionally based and the latter are provincially or agro-ecologically based -- in both cases established to cater to the particular province's or region's research needs in the areas of crops, livestock, and natural resources. The expansion of Type C research institutions after the apex bodies were established in Indonesia, Pakistan, and the Philippines was significant. This development has occurred in the past in some countries even under the ministry model, as in Sri Lanka, which led to the establishment of agricultural research centers in the major agro-ecological zones.

Type D. This differs from type C research institution in that the institution concentrates its research efforts either on one commodity or one discipline but is limited in scope due to its regional focus. The regional focus may be determined by agro-climatic or agro-ecological limitations, as in the case of rubber in Sri Lanka, which is confined to the southwest quadrant of the country. It may also flow from policy directives, such as the recent emphasis on developing sugarcane as a rainfed crop in the southeast quadrant of Sri Lanka which gives the Sugar Research Institute a regional focus.

Type E. In institutions of this type, the provincial or state government is responsible for administration and financial support. However, it is not uncommon for the basic and strategic

research they conduct to be of national importance. Invariably, much research funding would be derived from the center, either from the apex body (as in India) or from direct government grants or foreign donor grants. The better state universities, which have good research resources and competent scientists, as well as provincial, state or regional research centers, come under this category.

Type F. These research institutions are located in a region under the auspices of a provincial government. Research is in a single discipline or on a single commodity, but the results are of national relevance. The Soil Testing Institute and the Livestock Production Research Institute of Pakistan are examples of institutions concentrating on a single discipline or commodity group.

Type G. Multicommodity/discipline research institutions of this type are becoming increasingly important due to the pressures for devolution of political power and administration to regions and provinces within a country. Decentralization of a NARS will contribute to the growth in the number of type G research institutions and improvements in their capabilities. The state agricultural universities of India, the provincial university-based agricultural research complexes of the Philippines, and the regional agricultural experimental stations of Japan can be included in this category.

Type H. Focused on a narrow research area and funded by a provincial or state administration, this type of institution is the rarest and its numbers are unlikely to grow due to its limited scope. It is costly to maintain these institutions unless the region covered is vast and the commodity or disciplinary research under provincial auspices is critical to the development of that region.

A number of patterns can be discerned among the eight types of primary institution discussed above:

- Types A and B are most common, followed by types E and G.
- Since the establishment of the apex bodies, there has been a rapid expansion of the numbers of type A, E, and G institutions. In the future, types C, E, and G could increase in number and a greater resource endowment would therefore be needed for their creation and for the expansion of existing ones.
- Although agricultural universities, faculties of agriculture, and specialized institutes of other universities should contribute to the NARS output in all eight categories, their role has been limited and should be addressed in the future.

Faculties and Universities of Agriculture

Higher education in agriculture has traditionally been the responsibility of a separate ministry of education or an equivalent ministry. It is so even today in the majority of countries reviewed in this study. Faculties or colleges of agriculture and related science faculties of the traditional universities provided the scientists needed for research. Yet, in the past, and even now, most of these are not identified as structural elements in the NARS of Asian countries.

Following the establishment of apex organizations, some governing bodies soon realized that the expansion and improvements envisaged would not be effective without adequate human resources. Different countries adopted different mechanisms to achieve this goal. In Japan, South Korea and China (Taiwan), the traditional universities were expanded and their capacity for training and research has been strengthened to meet the needs of their NARS. Collaboration between the university scientists and system scientists is high, and the apex bodies have linked the university

personnel into the NARS by supporting their research and including them in different committees.

In 1986, four of the seven members of Japan's apex body, AFFRC, were university scholars. Likewise, the National Institutional Cooperation Committee in Agriculture (NICCA) of South Korea, responsible for programming and evaluation, has had university professors among its members.

A significant departure from the traditional concept of training was introduced in India in 1960, following the recommendations of different committees, the last being those of the joint Indo-American Committee in the mid-1950s. The first agricultural university was established in 1960 at Patnagar (Uttar Pradesh State). Since then, 22 more have been added nationwide in the different states (Jain, 1988; Randhawa, 1987). Modeled on the U.S. concept of the Land Grant University system, they integrate support for research, education, and extension education in agriculture and related sectors in their respective states. Enabling legislation referred to as the Model Act provided for the creation of authorities, namely, the board of management, the academic council, the board of studies of each faculty including postgraduate studies, and other bodies as may be declared by statute.

These universities had several distinctive features (Randhawa, 1987):

- responsibility for teaching, research, and extension education, and their integration at all levels of the administration;
- complementarity of colleges and departments and multidisciplinary teamwork under a unified administration;
- acceptance of the responsibility of service to agriculture in rural communities to solve their economic and social problems;
- communication of new knowledge to students, extension staff, and end users;
- corporate boards of management with adequate powers;
- organizational and operational autonomy.

In most of these universities, research coordination is the responsibility of a director of research. While the agricultural university is a primary organization in the NARS of India, its substructures consist of statewide experimental stations and substations. Their importance can be gauged from the extensive network of research found in the country (Table 15). In the mid-1980s, there were 313 research stations, 129 centers under the National Agricultural Research Project (NARP), 793 centers under the All-India Coordinated Projects, and 339 Ad-Hoc Research Schemes distributed among the 23 agricultural universities.

Linkages between ICAR, which funds the bulk of the research, and the agricultural universities are maintained in several ways (see Chart 1):

- At ICAR the office of the deputy director general for agricultural education is responsible for the state agricultural universities. Like ICAR itself, this office has changed over the years. In the late 1940s, it was the Indian Council of Agricultural Education under the former ICAR. In the mid-1960s, it became the Division of Agricultural Education in ICAR, assisted by a standing Committee on Agricultural Education. And in the mid-1970s, these formed a combined Scientific Panel in Agricultural Education in the Division.

- The All-India Coordinated Projects link the deputy directors general, vice-chancellors and collaborating scientists of the universities, through the national project coordinator.

- The Norms and Accreditation Committee, chaired by the director general of ICAR, has five vice-chancellors nominated by the Union Minister of Agriculture. The committee examines norms for financial assistance to agricultural universities and ensures standards of education in agriculture and animal sciences.

- The eight regional committees that represent broad agro-ecological regions have technical representatives from agricultural universities. These committees, also chaired by the ICAR director general, review the status of research and education in their respective regions and makes recommendations to the governing body.

Inasmuch as the universities are represented in the policy-making and executive bodies of ICAR and the Council nominees serve on the Boards of Management of the agricultural universities, there is reciprocity. This is a good example of an interactive linkage in a NARS.

Of the 12 Asian countries reviewed, seven have agricultural universities, most of them established after their apex bodies were created. Other than in India, they are in Bangladesh and Pakistan in South Asia, and in Malaysia, Indonesia, and Thailand in Southeast Asia (Table 13). Pakistan is following on the Indian experience. In the other countries, though the agricultural universities have been under the ministry of education, attempts have been made with varying degrees of success to link them into the NARS.

In the Philippines, agricultural universities and state colleges are represented within PCARRD at various levels. At the policy level, the chancellor of the University of the Philippines at Los Baños (UPLB) represents the state colleges and universities in the Governing Council. At the management level, they are represented in the Technical Advisory Committee, and at the implementing level, in the National Commodity R&D Teams.

In addition, PCARRD has created a number of university clusters. Four universities -- the University of Philippines in Los Baños, Central Luzon State University, Visayas State College of Agriculture, and the University of Southern Mindanao -- have been grouped into four National Multi-Commodity R&D Centers of the national R&D Network (NRDN). Six state agricultural colleges have been grouped into regional R&D centers of NRDN, and 18 other strategically located state colleges and universities are grouped as cooperating stations. Thus, NRDN has 28 universities and state colleges (PCARRD, 1986).

Besides organizing the agricultural higher educational infrastructure as a component of the NARS in the Philippines, the council has provided funds for staff and graduate student research and has improved the research infrastructure of both established and newer state agricultural universities. These measures have helped the Philippines to increase the output of trained scientists needed to service an expanding NARS. Thus, PCARRD, like ICAR, has been instrumental in increasing agricultural research output with the help of the institutions of higher education.

Sri Lanka represents a different model. It has three faculties of agriculture, two of which are less than 10 years old. Their undergraduate programs provide the BSc graduates for the agricultural sector. To meet the increasingly greater training needs at the postgraduate level (which were foreseen in the early 1970s) due to the expansion of the research sector, a Postgraduate Institute of Agriculture (PGIA) was established in 1976 outside the conventional faculty model. Responsibility for postgraduate training in the country was transferred to this institute from the faculties of agriculture. The enabling legislation, an ordinance under the Universities Act, provided for the following features:

- Formation of a Board of Management, with *ex officio* membership of secretaries (or their nominees) of those ministries concerned with agriculture, livestock, plantation industries, finance and planning, and higher education. It also included the directors of commodity research institutes and commodity departments, representatives of the Faculty of Agriculture of the university, and nominees of the University Grants Commission. For example, the executive secretary of CARP is a 1989 UGC nominee.

- Formation of Boards of Study with academics from the Faculty of Agriculture and senior scientists from the NARS.

- The institute is headed by a director rather than a conventional dean. The director is the chairman of the Board of Management and an *ex officio* member of each Board of Study.

- Greater administrative and financial autonomy is given to the director as compared with a dean of a faculty. Hence, development of linkages outside the university system is easier and the generation and use of funds are less influenced by restrictive bureaucratic procedures.

PGIA does not have its own academic staff, laboratories or experimental stations. However, it has been able to use the resources within the university and the agricultural research system for teaching and research due to the collaboration and cooperation extended by representatives of different ministries and departments on the Board of Management and the Boards of Study.

During its first 12 years, PGIA trained 275 graduates with postgraduate degrees. This contrasts markedly with the Faculty of Agriculture which had produced only a few postgraduates in the preceding 30 years. Thus, institutional restructuring, coupled with enabling legislation and a different type of academic management (a departure from the conventional faculty administration approach), have catalyzed postgraduate agricultural training and research in Sri Lanka. Since the Council of Agricultural Research Policy provides for a university representative to serve on its board, the interactive linkage (as with the case of ICAR referred to earlier) would enable the PGIA to be associated more closely with Sri Lanka's NARS.

The number of primary organizations in Asia increased rapidly after the apex bodies were formed (see Table 13). Even in countries following the ministry model, a similar trend had occurred in the late 1960s and 1970s. To staff these facilities, an increased number of scientists was required. Table 17 shows the expansion that took place in eight countries.

The structural readjustments in agricultural higher education occurred not only in India, the Philippines, and Sri Lanka as described above, but also undoubtedly in the other countries reviewed. Without these changes, the NARS would not have been able to meet their societal obligations. As a result, the political and administrative hierarchies would have lost confidence in the systems. The changes were a watershed in the development of Asia's agricultural research and higher education. The integration of the two systems has made it possible to:

- produce a critical mass of trained manpower for research;
- increase in-country capacities and capabilities in agricultural research;
- increase self-reliance in post-graduate research;
- increase research output;
- foster a sense of urgency in solving problems relevant to socioeconomic issues; and
- impart a collegial approach to the conduct of research in Asian developing countries.

The NARS must now address the question of how this important resource can be developed further for the challenging tasks of the future.

Mechanisms for Inter-Institutional Collaboration

To foster inter-institutional collaboration among the components of a NARS requires the apex body to be appropriately structured. Table 18 summarizes the means by which collaboration can ensure overall research management, the conduct of inter-institutional research, research program and project coordination, technical and service support, and the conduct of research with IARCs and foreign organizations. As the information has been extracted from secondary sources, mainly publications identified in this report, there could be gaps due to possible recent structural changes. Nevertheless, the table shows how the apex organizations have attempted to construct a management bridge between the national and implementation levels of research.

Overall Research Collaboration. Structuring to implement commodity and disciplinary research initiatives is common to the majority of apex bodies (see charts). This is understandable because

the primary structures described in the previous section were either commodity- or discipline-based.

Two councils, BARC and PARC, have their full-time member directors or members, respectively, assigned to commodities or disciplines. Each member director of BARC is assisted by a principal scientific officer and senior scientific officer, while the council members of PARC are assisted by the research management staff and technical services staff. In Japan, two research councilors, with the support of the research counsellors and research coordinators, assist in this role.

In other large apex bodies, the offices of the deputy director general (DDG) in charge of commodity or disciplinary groups effect collaboration. In Indonesia, this activity is carried out in Research Coordinating Centers for commodities, disciplines, and services (Chart 10). For estate crop research and the Sugarcane Research Institute, collaboration is ensured by the director general of AARD who serves as the chairman of the boards of the these two research institutes.

In Thailand, the office of the deputy director general (Research) of the Department of Agriculture ensures collaboration, while in Nepal the "additional secretary" or "joint secretary" (Research), who heads the Research Coordinating Committee, performs this task. Sri Lanka's CARP does not have a formal mechanism as yet; at present the role is executed by the executive secretary of the council.

Inter-Institutional Research. The mechanisms used by apex bodies for inter-institutional research collaboration are not very clear in some countries. Weaknesses in such collaboration, as well as in research program and project coordination, have been stressed in reports by ISNAR and others. Although some apex organizations have provided for such coordination, it does not seem to be very effective.

BARC has designated one of its member directors for research liaison, while PARC has Specialist Technical Panels that advise the Executive Committee. Malaysia, the Philippines, and South Korea use the committee system: respectively, the Research Advisory Committee of Malaysia (the working arm of the Scientific Council), the Technical Advisory Committee of PCARRD, and the National Institutional Cooperating Committee in Agriculture of South Korea.

In the Philippines, the Regional R&D Consortia are an important structure for inter-institutional collaboration at the regional level. The consortia have been established as a mechanism for regionalizing R&D management tasks such as setting priorities, planning, monitoring and evaluating projects, sharing resources, and exchanging information for mutual benefits (Gapasin and Lorica, 1989). Activities are coordinated by a regional coordinator.

Japan's AFFRC has research counsellors and research coordinators who advise the director general and councilors. Indonesia has the Research Coordinating Centers whose heads ensure collaboration between the research institutes vertically under each center, as well as horizontally between centers. The National Research Commodity Groups of AARD are another structural feature for assisting the coordinating centers. In India, the deputy directors general are available to initiate collaboration. For the highly successful All India Coordinated Projects there are national coordinators who report directly to the deputy directors generals. The national coordinators provide leadership for inter-institutional collaboration between the apex body, its research institutes, and the state research organizations.

In Thailand, which follows the ministry model, inter-institutional research collaboration takes place between the directorates of the different departments (agriculture, fisheries, livestock, land development, irrigation, forestry) of the ministry of agriculture. Within the Department of Agriculture, the deputy director general (Research) is the common focus of collaboration between research institutes under his auspices. In Sri Lanka, the executive secretary of CARP has taken the initiative, under a foreign aid project, to implement intercropping research and farming systems research between research institutions of different ministries. Until CARP's support staff increases,

the executive secretary will be burdened with this task.

Research Program/Project Coordination. As noted earlier, weaknesses in inter-institutional collaboration in the NARS have been identified. Although structural features appear to be present, they need improvement. As for the coordination of research programs and projects, the situation seems even worse, judged by the critical statements made by various review missions. The repetition of features of collaboration given in the columns for inter-institutional research and program coordination in Table 18 reflects a structural deficiency in the systems that appears to exacerbate the problem.

The All India Coordinated Projects of ICAR is one of the oldest and best examples of how a coordinated project functions due to its built-in structural features. The scheme began in 1957 with a coordinated project on maize. Due to its success, it was soon expanded to other commodities and disciplines. In the past two decades, some of the coordinated projects that fulfilled their objectives have been closed down, others elevated to programs, and still others elevated to Project Directorates. During the 1980-85 period, 5056 scientists were working in five project directorates and 71 coordinated projects (Randhawa, 1987).

A Coordinated Research Project is headed by a full-time national project coordinator (a competent scientist) who has direct access to a deputy director general of ICAR. This person has to ensure timely implementation of trials and experiments, provide guidance, and remove any constraints. Constant monitoring and frequent visits to research centers help to maintain cohesion. The project coordinator has a Coordination Unit or Cell, assisted by a small group of scientists and technical and support staff and located in one of the central institutes or agricultural universities. In addition, there are a number of coordinating or cooperating centers located in agricultural universities, in central institutes, and in some cases in traditional universities and public institutions. Each cooperating center is provided with a team of scientists drawn from various disciplines to ensure an integrated, interdisciplinary approach to solving problems. In addition to the project scientists, others from among the regular complement of scientific staff in a center are sometimes integrated into a functional unit for the purpose of coordination (Randhawa, 1987).

The Coordinated Projects form a major component of the ICAR Program Plan -- conceived, formulated, and implemented at the project centers by the concerned subject-matter divisions. The deputy director general at the head and the assistant director general in charge of the program are linked to the directors and vice-chancellors of cooperating centers via the project coordinator. Thus, the coordinator deals directly with the leadership in the center (ICAR) and the periphery (cooperating institutions). He also acts as the common link between the cooperating centers of the project and the other research institutes.

The concept of the All India Coordinated Projects has been adopted by NARS in the Asian region with varying degrees of success. For example, in neighboring Pakistan, PARC had 30 national coordinated projects in 1986 which involved three or more cooperating institutions (Muhammed, 1986). Following ICAR's example, PARC-supported programs bring together scientists from national and provincial research institutes as well as universities. Although some projects were successful, the absence of focus in national priorities, inadequate administrative and financial autonomy to national coordination, deficiencies in the chain of command, and the absence of periodic reviews have been concerns (York, 1987). These difficulties are inevitable in countries where such national coordinated programs are young (compared with ICAR's 30 years of experience), but could be reduced through structural adjustments acceptable to the NARS of a country. It must be stressed, however, that organizational and structural features alone do not ensure success of such programs. Other characteristics, mainly cooperation and trust, are also needed during the implementation phase.

Technical and Service Support. Implementing research programs at the institutional level without

undue delay requires certain common technical and service facilities. Technical literature, data analysis, equipment maintenance, and central analytical facilities are among them. Under the older ministry model of research administration, this responsibility was devolved to the institutes and research centers. However, due to the expansion of NARS and recognizing the need for centralized facilities, some apex bodies have attempted to fill this gap by introducing a structural mechanism within their management structure.

BARC has one of its council members, a member director, designated for technical support services. Three other apex bodies (PARC, MARDI, and PCARRD) also have positions of director or deputy director who have responsibility for technical services. AARD of Indonesia has service centers for library and documentation plus statistical and data processing under the director general. In Japan, the Tsukuba office administers the facilities for common use of the Tsukuba Institutional Complex which contains most of the national agricultural research institutes plus the computer and information center. Nepal, though having the smallest agricultural system among the Asian countries reviewed, also recently set up a National Agricultural Research and Services Center, which operates under the "additional secretary" (Research) of the Ministry of Agriculture. However, its mandate covers only Department of Agriculture crops research.

Although apex bodies have attempted to provide some services, in practice the institutes at the implementing level often have to fend for themselves when it comes to obtaining the required technical and support services. It is not feasible for each component organization of a NARS to have to be self-reliant for these services. The apex organizations will therefore need more effective mechanisms to relieve the institutions of this costly burden.

Collaboration with Foreign Research Institutions and IARCs. Concurrent with the growth of the NARS in Asia and the increase of apex bodies to manage them, the number of international agricultural research centers (IARCs) around the world also increased. Of the 13 IARCs now operating, the research of 10 centers directly relates to research in the Asian region. In addition, the agricultural research conducted by regional centers -- such as AVRDC in China (Taiwan), TARC in Japan, BIOTROP in Indonesia, SEAFDEC in the Philippines -- as well as in many universities and research institutes within and outside the region has created the need for mechanisms of international collaboration. Such collaboration is known to expand research capacities, improve competence of researchers, widen program horizons, and foster a collegiate approach to research management.

Although collaboration with IARCs takes place in all the countries reviewed in this report, a structural feature is not evident in most apex bodies. The position of deputy director for international liaison in PARC (Pakistan), counsellor for international research cooperation in AFFRC (Japan), and the Research Support Services Division of the NARSC (Nepal) are the only three that show a collaborative structural feature in their organizational charts. In Indonesia, the Division of Agricultural Research Cooperation is placed under the Secretary of AARD. This has subdivisions responsible for cooperative arrangements, cooperative networks, and cooperative administration (AARD, 1987). It is assumed therefore that, structurally speaking, the linkage is not a formal one in some apex bodies but operates through the office of the chief executive of the organization. Since research collaboration does occur informally among scientists, it may be argued that a formal collaborating mechanism is an unnecessary evil. While such collaboration does occur between individual scientists in specific, narrowly defined research projects, the scope of collaboration is becoming increasingly larger and more complex. Sometimes it even involves a consortium of institutions requiring its management to be formalized through structural changes.

Organization and Structures for Operational Aspects of NARS Functions at National and Institutional Levels

Priority setting, planning, programming and budgeting, coordination, monitoring, review, and

evaluation are some essential elements of research management at the national, institutional, and implementation levels. Organizations in the Asian NARS have attempted to address these functions through structural features. However, as one would expect, they are not uniform; a variety of approaches has been taken in these countries to address identical management issues. Four countries with more organized structures in their NARS are compared in this report (Table 19).

Priority Setting. The economic and social development goals common to most developing countries, which are often articulated by the political leaders, are well known. Each country has it own national plan which is reviewed and revised periodically. This is available to sectoral and subsectoral organizations so that they can set their own priorities in keeping with national developmental goals. The agricultural research plan and priorities must be set in consonance with the agricultural sectoral plan or sectoral strategy of the overall national plan.

ICAR conforms to India's Seven Year Plan preparation sequence. Randhawa (1987) describes the process in his recent review. During the final year of the cycle of the present plan, the Steering Group for Agriculture and Allied Sectors was constituted under the minister for planning and the deputy chairman of the Planning Commission. It identified specific working groups/task forces to develop guidelines on approach, strategy, objectives, and targets of agricultural development. The Working Group on Agricultural Research and Education identified thrust areas and proposed research priorities. Three categories were prioritized: schemes implemented in the current plan to be strengthened; some current schemes to be reorganized; and new schemes to fill in critical gaps.

In the Philippines, PCARRD's initiative to prepare a national agricultural research plan commenced soon after the apex body was formed in 1972. Approved by the Technical Program Planning Review Board (TPPRB) and planned by the secretariat, the First National Agricultural Research Systems Congress was held in 1973. Based on the input of 18 commodity research teams and 500 Filipino researchers, the National Research Programme was synthesized into "the research agenda of the seventies" (Valmayor, 1985).

Improvements in priority setting have occurred since then -- via consultations at periodic regional congresses, the Second National Congress, and input from 31 commodity group teams. All this culminated in the Corporate Plan, which sets out, among others, the Directional Research Plans. Priority setting has continued in PCARRD under the Technical Advisory Committee which assists PCARRD's executive director (Chart 9). The completion of the establishment of the 14 regional research consortia in 1988 is another structural feature that can set priorities at the regional level.

Priority setting in Japan, carried out by AFFRC, is based on fixing 'basic objectives of research activities'. These indicate research guidelines for the comprehensive and effective promotion of research related to agriculture, forestry, and fisheries activities and to the livelihood of Japan's rural communities and fishermen (AFFRC, 1986). Objectives of research activities that were first stated in 1961 have been revised periodically, six times since then. The basic objectives stated in 1983 (see Annex) were fixed by the council with assistance from its secretariat.

In South Korea, priority setting is done by the Research Bureau which is under the administrator and deputy administrator of the Rural Development Agency (RDA). The bureau collects information that flows into the Ministry of Agriculture from several sources: researchers, the Agricultural Institutional Cooperation Committee, Provincial RDA offices, and extension channels. It uses this information to prepare its Guidelines for Research Projects (APO, 1983), which are then sent to the research institutes and the provincial offices.

Research Planning. In ICAR institutes, research program planning begins with individual scientists at the institutional level. Using a standard form, they propose new projects at the beginning of the year or request the continuation of ongoing projects. These are discussed at subject matter division level with the head of the division serving as chairman. The revised proposal is examined by the

Staff Research Council of the institution and then approved finally by the director of the institute.

In India's state agricultural universities, a different route is followed. At the college level, a Research Review Committee evaluates research projects. At the university level, it is done by the director of research assisted by his associates. The approved research proposals are then forwarded to the state government, ICAR, or other central organizations for further appraisal and funding. If a state has more than one agricultural university, a Coordinating Committee also reviews proposals to avoid duplication of research.

In the Philippines, researchers are required to submit proposals through the Regional Research Consortia during a specific period and initially in capsule form. These are reviewed by National Commodity R&D Teams in relation to commodity priorities previously defined. If a proposal is approved, it is evaluated by a Technical Review Panel for technical soundness. These panels may operate out of PCARRD or at the regional consortia. Final approval of the research projects is given by PCARRD, which endorses these projects to the Department of Science and Technology and the Department of Budget and Management for funding allocation. In addition, the Research Coordinating Committee within the Department of Agriculture streamlines program planning of the research conducted in the Bureaus and the Regional Integrated Agricultural Research Systems. The latter generate the agricultural research programs of the regions, integrating all activities in crops, livestock, soils, and socioeconomics, particularly the testing of small farm systems technologies generated within the national research and development network (ISNAR, 1985).

In Japan, the research program consists of ordinary studies and project-type studies. With ordinary studies, each research institute decides on themes in line with research objectives defined by the Research Council and corresponding to the predetermined allocations of the budget per researcher for different categories of research groups. The budgets per researcher for 1986 are given in Table 20. The project-type studies are carried out at various institutes in an integrated and systematic way, with the themes being selected by the Research Council. They are separated into groups according to the duration of the studies (three to five, five, or ten years) and cost per year. They are classified as special research projects, large projects, integrated projects and biotechnology/advanced research. The Research and Development Division of AFFRC is responsible for project-type research (Chart 6).

In South Korea, based on guidelines provided by the Research Bureau of RDA, researchers draw up their own proposals. These are discussed and examined by their co-workers, supervisors, and directors of institutes. Next they are examined by designated Research Planning Committees consisting of researchers, extension workers, professors, administrators, and leading farmers. The main criteria used are research objectives, methods, appropriateness, and cost. Committees meet twice a year: once to review research proposals dealing with summer crops, perennials, and livestock, among other subjects, and again to review proposals on winter crops. After examination, improvement, and coordination, the research plans are finally approved by RDA's administrator. The research stations and institutes are required to submit printed research plans of approved proposals to the Research Bureau.

The pathways of research program planning in the other Asian countries are not as well defined as those cited. It is likely that they follow systems similar to the four examples just described (see Table 19). Dagg and Haworth (1988) have described the interaction of the top-down and bottom-up pathways in agricultural research planning and review. A detailed study of individual countries would identify gaps in need of correction.

Implementation and Coordination. In all countries, research is implemented by the primary structures of the NARS: research centers, central institutes, project directorates, regional stations, and universities. At the institutional level, the chain of command for implementation and coordination begins at the top with the director of the institute, director of research, or dean of a college or faculty in a university. It proceeds through to the heads of divisions, the program

leaders, and the specific scientists charged with execution of the research. The linkage between the directors/deans and the apex body is through the director or assistant director of the commodity/discipline division of the apex organization -- except for national institutes which are linked directly to the director general, as in the case of ICAR. In most developing countries funding is a constraint on systematic and full implementation of research programs as approved. This is particularly true if governments make mid-year budget revisions and cuts due to fluctuations in the economy or to competing claims of different commodities and sectors of the economy.

Some countries have built-in mechanisms for coordination. South Korea's Research Bureau of RDA has a Research Management Division which, among other functions, is concerned with implementation and evaluation of research projects and oversees the research management of provincial RDAs (APO, 1983). In Japan, the research carried out by various institutes is coordinated at the council by the Liaison and Coordination Division. To fulfill this objective, a system of Coordination Units has been set up, giving the director general of a key institute the responsibility for coordination of the research activities classified by specialized field or region (AFFRC, 1986). In conformity with this system, the directors general of the respective institutes cooperate with the Research Council in the coordination of research activities. Examples of Coordination Units for a commodity group, a discipline, and international agriculture are given in Table 21.

PCARRD's coordinating mechanisms include the approval of all agricultural research proposals submitted by the various institutions of the country for government funding. In effect, this serves as an effective coordination mechanism through the control of the research budget. In planning its national R&D network, PCARRD did well to identify the national and regional R&D centers, their national and regional responsibilities, and the responsibility of each center as a cooperating station (PCARRD, 1986).

The research divisions of PCARRD coordinate the activities of the national R&D programs under its sector. The national commodity teams provide technical advice to PCARRD research divisions. In addition, the Department of Agriculture has a Research Coordinating Committee. It serves as an internal structure of the Bureau of Agricultural Research (BAR) to coordinate and integrate the research programs at the bureau and regional offices in order to streamline program planning, assure effective allocation of financial resources within the department, and optimal use of limited research facilities. At the regional level, a Regional Research Committee (RRC) enables regional directors to monitor research activities in the various stations and on-farm sites of the Regional Integrated Agricultural Research Systems (RIARS).

The Ad Hoc Task Force. The ad hoc task force is a structural element that becomes necessary for implementation and coordination of special research. Its life cycle can be short or long depending on its task. A sudden and catastrophic pest or disease problem that could have serious national economic and social consequences will demand immediate attention, outside the normal implementing and coordinating mechanisms. For example, a serious caterpillar outbreak threatened the coconut industry in Sri Lanka in the early 1970s. The rapid spread of the pest necessitated the formation of a task force of entomologists drawn from various institutions in the country to assist the entomologist of the Coconut Research Institute. Headed by a leading entomologist of the Department of Agriculture, the task force examined possible alternatives. With the assistance of cooperating agencies, it was able to introduce a predator from abroad that proved effective in controlling the pest. Thus, a cheap, clean, biological control method saved Sri Lanka's coconut industry. The work of the task force was completed within a few months.

The Bangladesh Rice Research Institute (BRRI) introduced seven task forces in the early 1980s. BRRI, unlike BARI, is modeled after IRRI, that is, on the basis of programs instead of disciplinary divisions. The task forces were established to provide interaction among disciplines because the institute places much emphasis on multidisciplinary, problem-solving research. The task forces meet three times a year to discuss problems needing more attention and how these should be approached,

and to assign projects or parts of projects to individuals for implementation. They deal with variety improvement, cropping systems, cultural practices, pest management, agricultural engineering, adaptive research, and training (Pray & Anderson, 1985). This type of task force has a longer life cycle and personnel can change with time. It is an effective coordinating and implementing sub-unit of the institute.

Monitoring, Review, and Evaluation. These three activities are *sine qua non* of effective research management. The adoption of mechanisms to keep research managers informed of the progress of project implementation has been necessitated by a number of factors, including: the expansion of the NARS of most countries at considerable cost, the increasingly tighter economic situations faced by research managers, and the threat of impersonal relationships developing between the center and the periphery in larger NARS.

Conventional mechanisms are still very useful in helping a director of a station or institute working on the periphery, or the secretariat and its relevant personnel in the apex body, to monitor and review progress. Some of the mechanisms used include in-house seminars, sub-annual and annual progress reports requested by granting authorities, annual station reports, papers presented at scientific meetings, and visits to field sites by supervisory staff. These are indispensable to judging quality, relevance, and progress of the research program. Yet, in terms of national priorities and accountability to policy planners and budget directors, additional mechanisms are needed and have been used in the region. Some of these are described below.

In India, ICAR's monitoring mechanisms consist of the following (Randhawa, 1987):

Annual Workshops: These have been used extensively in the All-India Coordinated Research Projects of the council. They are organized at different cooperating sites and bring the researchers and research managers together to review progress and make plans for the following year. They allow for judgment on quality and relevance of the work and avoid duplication. The workshops also provide for the informal interaction of scientists working on a common program, which further strengthens the program.

Annual Conferences: The annual conferences of the directors of ICAR institutes and the vice-chancellors of agricultural universities, which are held separately, help to review different facets of the research programs. They also provide a forum to discuss research management issues and national issues concerning agricultural research.

Annual Action Plan: This was prepared by DARE recently under a government directive. Its purpose is to separate activities within a time/target framework, including budget and action points of all activities and managerial functions.

Scientific Panel Meetings: The ad hoc research schemes financed by cess funds and managed by ICAR are reviewed and evaluated by 24 Scientific Panels constituted by the council. In addition to reviewing progress on current programs, these panels advise the council on issues of national interest relevant to the panel.

Management Committees: These function within each institute and review all aspects including research progress. The director highlights the work done and the evaluation is an in-house mechanism of assessment to provide mid-course correction if necessary.

Regional Committee Meetings: The eight regional committees, referred to in an earlier section, meet to review research and education and to identify critical gaps.

Quinquennial Review Teams: In addition to annual/biennial review of every project, the research of all institutes is reviewed by a special team every five years. For Coordinated Projects, the reviews are every 10 years. Their teams' reports have far-reaching

recommendations which are subsequently reviewed and approved by ICAR's Governing Body.

Visits to the institutes, centers, and coordinated projects by senior research managers of ICAR, plus participation at workshops and conferences, help to familiarize headquarters staff with the progress of research at different locations. ICAR thus has a most comprehensive, structured system to monitor, review, and evaluate research.

PCARRD's research divisions in the secretariat review progress of research funded by the government through researchers' progress reports and annual reviews of on-going and completed projects. Based on these, and assisted by the reviews of the 32 National Commodity R&D Teams, the secretariat assists the Technical Advisory Committee to recommend new programs for the approval of the Governing Board for the following year. In the Department of Agriculture, however, the Regional Research Committees and the Research Coordinating Committee monitor and review the research done in the department as an internal mechanism.

In Japan, after AFFRC was established, the council's secretariat set up a system of review teams that periodically review and evaluate the research activities of research institutes. Since 1965 four series of reviews have been held, each covering a period of five years. Factors covered by the reviews vary from series to series and are prestated. The number of institutes reviewed during any one period also varies. AFFRC's statement on the fourth series of research reviews for 1982-86 stressed efficient management and performance of research. The areas specifically considered were methods of evaluating research requests; methods of selection of themes; supervision; utilization of results; utilization of facilities and equipment; enhancing ability of researchers; cooperation with other organizations; and specific aspects requiring investigation in future.

In South Korea, research projects are evaluated more than twice a year. The timing varies for summer crops and winter crops. The Research Management Division is concerned with evaluation too. For this purpose Research Evaluation Committees consisting of researchers, extension workers, professors administrators, and leading farmers are formed (APO, 1983). They evaluate all the research projects carried out at the research institutes, stations, and RDA provincial offices (APO, 1983). The members of the evaluation committees are generally the same as those of the planning committees. Agricultural economists also participate in the economic analysis of research results.

In Indonesia, within the office of the secretary of AARD, there is a separate Division of Agricultural Research Programming with three subdivisions: data processing, program formulation, and evaluation/reports. The program formulation section assists the director general with R&D management. It coordinates the formulation of research activities, monitors and evaluates the research, and prepares reports on progress and project implementation (Nestel, 1985). For these activities the Division of Agricultural Research Programming depends on the outputs of the planning and monitoring divisions of the Research Coordinating Centers. In the latter and in the Research Centers, the organizational charts show a Division of Programming with three subdivisions: data processing, planning, and monitoring. However, these divisional and subdivisional structures are not represented in the research institutes.

Reports from the NARS of the remaining countries in Asia and the South Pacific, with the exception of China (Taiwan), suggest that research planning is generally poor. This is not due to a lack of definition of priorities -- most of them do have national development plans -- but perhaps due to research managers' lack of experience in program planning and the absence of structural mechanisms. As a consequence, they also have not developed effective systems of monitoring, review, and evaluation with a professional approach to them.

The conflicting interests of separate ministries with their own agricultural research thrusts and lack of authority of a designated body sometimes exacerbate the issue. BARC is a case in point. It took the initiative in priority setting by preparing two agricultural research plans within six years, but had its own built-in drawbacks that prevented effective planning, coordination, monitoring, and review processes. The drawbacks were caused by the location of some research organizations in

ministries other than agriculture, the lack of status of the holder of the post of executive vice-chairman, inherent defects in the composition of the council membership, and the lack of adequate funds disbursed by the council in order to have influence on the implementation of the country's research agenda.

Communication to Farmers and Feedback to Management

The expansion of the Asian NARS during the last 30 years has not only increased the variety of institutions and swelled the ranks of scientists but also contributed to the information explosion. In most countries, efforts were initially concentrated on establishing apex bodies, and later on improving the capabilities of some and stabilizing the viability of others. In the process, countries lost sight of the growing need to develop effective systems for communicating research results in a usable form to farmers and ensuring feedback to top management.

Thus, a majority of reviews of the Asian and South Pacific NARS, some of which have been cited in this report, highlight the weaknesses in research-extension linkages -- weaknesses that impede communications. In Japan, which has a long tradition of decentralized agricultural communication, the problem appears to be less serious. In India, where the apex body evolved over a long period and stabilization was relatively swift after its reorganization in the 1960s, the council was able to innovate with structural features and mechanisms to improve communication. In most other Asian countries, however, downstream communication to farmers and other end users of agricultural technology is cause for concern.

Various structural features and mechanisms have been adopted in the NARS for upstream and downstream communication. The mechanisms for programming and priority setting, implementation and coordination, monitoring, review, and evaluation, described in the previous section, give research managers feedback in order to refine and revise the research agenda. Despite NARS weaknesses in downstream communication, certain mechanisms, described in the remainder of this section, do give additional feedback to higher management. Three country cases are discussed.

Japan. The Law for Agricultural Improvement Promotion was passed in 1948. Its purpose is to ensure that farmers have access to accurate and practical information in order to develop efficient farming practices, increase production, improve home living, and contribute ultimately to public welfare. The law is composed of three chapters: general provisions, promotion of agricultural research, and promotion of extension. Under this enabling legislation, Japan established the AFFRC for agricultural research and the Agricultural Production Bureau (with its Department of Extension) for agricultural extension.

The law has been amended periodically to allow structural changes aimed at improving the transfer of technologies that have emerged during the last four decades of agricultural development in Japan. Four phases are recognizable. During the initial phase (1948-50), the bureau and the department were formed at the national level. At the prefectural level, its own Department of Agriculture also established a new Division of Extension which was the structural link to the Department of Extension in the Ministry of Agriculture. The two are linked via the prefectural administration.

The extension organizations of the prefectural administrations have direct links with Prefectural Agricultural Experiment Stations where the adaptive research is concentrated (Chart 16). The large number of agricultural researchers (Figure 2) at these stations are mostly high school graduates and work closely with farmers. Thus, the transfer of technology occurs through common bonds strengthened by the cultural and social milieu of rural Japan. The subject matter specialists of the prefectural government interact closely with the researchers at the experiment station.

In order to strengthen technology transfer, the extension arms of the Agricultural Production Bureau at the national level, as well at the prefectural level, have an educational side to them. At the

ministry, the National Farmers Academy is concerned with grooming farmers for agricultural development. At the prefectural level, extension workers are trained on the job. An Extension Information Center established in 1975 supplies technical and farm management information from the ministry to the prefectural extension arms; at the same time, it collects, classifies, and stores information obtained from the prefectural extension offices which is used for planning purposes.

An important structure in the Japanese research-extension linkage is the Committee for the Promotion of Agricultural Research in the Regions. It has representatives from the regional and prefectural research organizations and the regional and prefectural offices servicing agriculture (Chart 16). Farmers' perceptions of the technology that is generated are fed back to the committee. The information is used to plan research at the prefectural- and regional-level organizations.

India. It was noted earlier that agricultural research in India is the responsibility of ICAR. Extension, however, is primarily the responsibility of the departments of agriculture of the state governments. In order to integrate research and extension, several linkages have been developed at the national, zonal, state, and institutional levels (Randhawa, 1987).

National-level linkages: There are three structures with linkages at the national level in India, namely the ICAR Society, ICAR Governing Body, and Research Development Coordination Committee. The ICAR Society, being an autonomous organization under the Societies Act, has provision for farmer representatives. They represent different regions of the country, provide feedback on field problems and production constraints, and contribute to the conceptualization of the council's policies. The interaction of farmer representatives, high-level research managers, and scientists is an asset in the council's work. The ICAR Governing Body, too, has farmer representatives. Thus, there is a second line of interaction which the council can use to judge the relevance and effectiveness of its research mandate.

The Research and Development Coordinating Committee, at the management level, consists of senior management personnel from the Ministry of Agriculture, Department of Agriculture, and ICAR. It meets monthly to review the progress of joint projects and examine problems of coordination between research and extension at different levels.

Zonal-level linkages: Linkages at this level have been established through the National Agricultural Research Projects (NARP) which are executed by the state agricultural universities. These projects handle need-based research relating to common agro-climatic conditions. A close linkage between research and extension at the grass roots is an essential factor in the success of this program. The workshops of each agro-climatic zone are a meeting point for reviewing programs of regional research, the transfer of technology, and the extension programs of the state Department of Agriculture in the zone. The linkage of the NARP to ICAR is effected by the office of the deputy director general of Agricultural Education (Chart 1).

State-level linkages: The state agricultural universities and ICAR institutes are the organizations involved in research within the states of India. Although the ICAR institutes have a national mandate, they also respond to the research needs of the states in which they are located. Communication flows are established through several mechanisms: the adaptive trials conducted jointly by the state Departments of Agriculture and the agricultural universities; joint field visits by the extension staff of the departments and researchers of the universities and ICAR institutes; conferences; and workshops. The extension department of the agricultural universities, in the course of their training activities, also serve as a conduit for information both upstream and downstream. Additionally, the ICAR institutes and the agricultural universities assist in the training of subject matter specialists in the states' extension areas.

Institutional-level linkages: The ICAR institutes also have their own technology transfer

and extension programs which are the responsibility of the deputy director general, Agricultural extension, at headquarters. In addition to the zonal coordinating units under the NARP, three ICAR-initiated projects are implemented under him. These are the National Demonstrations Project (NDPs), Operational Research Projects (ORPs), and Lab to Land Projects (LLPs).

The National Demonstrations are multidisciplinary in nature. They demonstrate production technologies and the genetic potential of newly evolved crop varieties throughout the country. There are joint consultations between scientists and extension specialists of the agricultural universities and the state Departments of Agriculture. Coordinating Committees of the university and district implement the program. The subject matter specialists hold the field demonstrations and thousands of farmers are trained through field days organized at the demonstration sites. Thus, the emphasis on transfer of technology and feedback is through national demonstrations. An NDP can be coordinated either by an individual or a lead institute. The latter is a better alternative because it has the potential to provide a wider range of expertise than one person processes. Additionally, it has the advantage of group planning.

The ORPs allow an interdisciplinary group of scientists to test new varieties and technologies on a large unit -- usually a watershed area or a whole village. They enable researchers to study operational problems in technology transfer and identify sociocultural, socioeconomic, technological, administrative, and institutional constraints in a compact area. As ORPs have to be implemented in close collaboration with state Departments of Agriculture and other departments and agencies, implementation is coordinated by four committees, namely the State Level Review Committee, District Coordinating Committee, Scientific Consortium, and Village Resource and Management Society. The horizontal links between the research and extension sections of the four bodies are seen in Table 22. In the mid-1980s, 152 ORP centers and 47 watershed projects in 16 states were functioning (Randhawa, 1987).

The Lab to Land Projects were begun in 1979 as a way of taking new agricultural technologies to socioeconomically backward farmers. They are another structural mechanism for transferring technology and obtaining valuable feedback from farmers to assist scientists. By 1984, 75,000 farm families had been approached through 117 technology transfer centers, covering 34 ICAR institutes, 23 agricultural universities, 13 agricultural colleges, and 47 voluntary organizations (Randhawa, 1987). The objective of technology transfer here is to increase farmers' net incomes. The researchers come into close contact with farm families and develop an understanding of the barriers to the rapid technology transfer. The projects have influenced the research, education, and training systems of the research institutes and universities.

Sri Lanka. Even though several institutes under different ministries undertake research in Sri Lanka, technology transfer and extension are best developed in the Department of Agriculture which has the largest agricultural research arm in the country. The department's research concentrates on staple food crops and is conducted by agro-climatically based Regional Research Centers (RRCs) and by many supporting substations distributed across the country.

The principal mechanism for two-way communication is the Regional Technical Working Groups (RTWGs). RTWG meetings are held at least five months before the start of each cultivation season. Each group discusses the research, extension, and training requirements of the region. The meetings are attended by all researchers, subject matter specialists, and training officers of the region. They are also attended by the director of agriculture and the deputy directors of all the major divisions of the Department of Agriculture.

At RTWG meetings, extension staff of the region identify the farmers' production difficulties as observed from field visits and discussions with farmers. Farmers' views on new varieties and technological packages are also communicated at those meetings. They also provide a forum to

discuss results of the previous season's research program carried out in the region. Any research findings that are at a stage of transfer to farmers are documented and given out as extension messages. It is the responsibility of the RRCs to train extension workers in the use of the new technologies before they are taken to farmers during the next season. The RRCs have an In-Service Training Center where the researchers and subject matter specialist assist in training groups of extension staff. Figure 3 illustrates the coordinating structure (RTWG) and the communication links between management, research, extension, and training.

The drawback in Sri Lanka and other countries such as Bangladesh, the Philippines, and Thailand is that agricultural research is divided among several ministries, bureaus, agencies, and universities, but without any coordinated system of technology transfer and extension. As a result, farmers receive different messages from as many extension groups as there are research agencies, all of which causes great confusion. The situation is exacerbated under small farmers' conditions where the enterprise is oriented toward cropping systems or farming systems (as is commonly found in most countries). The problem is that extension advice from systems-based research and single-commodity research sometimes confuses not only the farmer who is the focus of attention, but also the extensionist. Even though the Indian model of a council or large agency has been used to manage research in many Asian countries, the links between research and extension have been a matter of great concern. Every country has strived to improve the situation, but coordination remains weak, resource utilization is wasteful, and the potentially higher returns to research are not being realized. Unless better systems are evolved, the situation could worsen due to growing pressures within the national economies of the region.

The Role of the International Agricultural Research Centers (IARCs)

Of the 13 international agricultural research centers (IARCs) under the CGIAR system, two are in the Asian region included in this review: IRRI in the Philippines and ICRISAT in India. AVRDC, a regional center, is located in China (Taiwan). Some IARCs have established regional offices to focus more intensively on regional problems. Among them are the regional offices of CIMMYT and CIAT in Bangkok, Thailand; CIP at PCARRD in the Philippines; and IFPRI at IRRI, also in the Philippines. Although the remaining IARCs of the CGIAR are found outside the region, their work also has a significant influence on the research of the NARS of Asia and the South Pacific.

In some instances, the IARCs have a strong regional impact and the spin-off benefits to some host countries are also quite high. Although their research and technological products are well known, their contributions to the organization and structure of the NARS are often overlooked. A few are noted below.

Strengthening NARS. The single-commodity research institute, well endowed with funds generated by a cess on production or exports (as in the case of tea, rubber, and sugar) and having a highly focussed mission, is well known in Asia. However, in the case of important staple food crops, research has been less well organized and has received less support from governments.

IRRI's success with rice and CIMMYT's with wheat occurred within a decade of the creation of these two centers. The impact of the new varieties in Asia and the centers' technologies encouraged national planners and research managers to develop their own research capabilities in the principal staple crop(s) of the countries. IRRI in particular indirectly catalyzed the creation and/or expansion of central research stations and institutes for rice in Bangladesh, Sri Lanka, Thailand, Indonesia, and the Philippines. The interaction of IRRI research managers and scientists with ministers, administrators, and planners of key development-oriented ministries, reinforced by visits to IRRI by the latter, helped to accelerate the process.

The establishment of the Bangladesh Rice Research Institute (BRRI) is attributed in part to the influence IRRI had on the policy-makers. In its structure, BRRI has adopted IRRI's patterns of

setting up departments based on programs rather than disciplines.

Supply of Research Resources. Germ plasm and scientific knowledge are essential to agricultural research. Conscious of deficiencies of these two ingredients, the IARCs developed their capacity for collecting and conserving germ plasm of the crops under their research mandate and built up their information resources. By sharing both with scientists in the NARS of the region, national research capacity was increased. The demonstrated importance of germ plasm conservation and the necessity of having facilities for their long-term storage have prompted many countries in the region to develop their own germ plasm conservation centers as an additional structural element of their systems. These are intended to meet the needs of research not only on the limited range of crops of interest to the IARCs, but also on all the commercially important crops and potentially important species for the future. Additionally, they help to conserve endangered species.

Restructuring of NARS. While association with the IARCs served to strengthen the NARS, it also resulted in a certain amount of restructuring, by direct intervention in some cases, indirectly in others. Connecting the IARCs' outreach programs with the national programs necessitated the establishment of coordinating committees with a national coordinator linked to the IARC coordinator. Thus, coordinated rice research programs or rice-based cropping systems programs needed a separate structural entity located within the responsible ministry or lead department. Networking on common research thrusts was another mechanism introduced by the IARCs to link scientists of different countries. The Asian Rice Farming Systems Network (ARFSN) of IRRI and the Southeast Asian Program for Potato Research and Development (SAPPRAD) of CIP are two examples. Both concepts -- outreach research programs and networking -- have become established features of national research management even for other areas of research.

Another type of restructuring was the establishment of specialized centers to train subject matter officers and extensionists. The IARCs had strong training divisions which were instrumental in providing hands-on experience in the use of improved technologies related to the crops they dealt with. Large numbers of young researchers and trainers were initially trained at the international centers. This provided the impetus to establish similar training programs in new or redesigned training centers within the NARS.

Since the establishment of ISNAR, the subjects of NARS restructuring and improvement of management skills have received greater attention. The various country reviews carried out by ISNAR in Asia and South Pacific (some referred to in this report) and the improvements that have occurred are ample evidence of the significant contributions of an IARC to the region as a whole.

Manpower Training. All the IARCs have trained large numbers of Asian researchers and subject matter specialists. Training has included long-term postgraduate work, short-term field production training, or specialized training within individual disciplines. For example, up to 1984 Bangladesh used the IARCs to train 89 people at degree level, 195 at production level, and 136 on specialized subject areas (Pray and Anderson, 1985). Other countries in the region have also sent large numbers of their staff on relevant and specific training programs offered by the IARCs. This contribution has been of major significance to the organization and structure of NARS given the substantial increase in the number of institutions in the systems (Table 13). Without the training and deployment of researchers, trainers, and support staff, the institutions would not have been able to function. Upon their return home, the trained personnel were also a good source of feedback to upper management. Indirectly, they induced minor structural adjustments and helped to develop management skills in their own institutions for improved effectiveness.

5. THE FUTURE OUTLOOK

THE reorganization and restructuring of the NARS over the last 25 years were prompted by a desire to respond to the challenges faced by the agricultural research managers of the day. The changes have proved to be effective. The NARS have responded to the needs of the period and the benefits derived from the changes will last into the future. However, the NARS will continue to be saddled with some of the older problems and there will always be new challenges.

Continued population and income growth and urbanization will demand additional technological improvements and breakthroughs to produce affordable food for the poorer segments of the population who constitute the major group in most countries. In addition to the availability and cost of food, nutritional imbalances are a subject of sociopolitical concern. Research focussed on this issue would complement the work on increasing production. The expansion of agriculture into diverse agro-ecological environments, and the resulting use and degradation of marginal land, demand new initiatives in systems research (cropping, farming, agroforestry). These will require good coordination with inter-disciplinary groups of researchers. The expanding fields of biotechnology and information and communication technology will add to the research agenda demanded of a NARS. The expansion of NARS organizations and structures have also brought home the need for research to refine the existing systems of management and to improve managerial skills.

Recent reviews of NARS have stressed that increasingly complex and diversified technologies will be required, national policies will be needed, institutional supporting facilities for agricultural research, among others, will have to be strengthened, and balanced institutional development must be achieved in order to respond effectively to future issues (ADB 1988; TAC,1985). What changes in organization and structure of NARS might be needed to face these issues?

Jain (1989) discusses in detail the probable reorganizational issues during the next phase of NARS growth in the developing countries. Most of the issues are highly relevant for Asia. Specific suggestions relate to the earlier discussion in this report and are advanced to complement the suggestions of previous studies. They are formulated on the assumption that the developing countries of Asia and the South Pacific will be confronted with much harsher economic realities in future, leaving their NARS managers to face a task much less enviable than that of their predecessors of two decades ago.

Apex Bodies

By itself, the creation of apex organizations did not resolve all the governance and research functions expected of them. Some, like ICAR in India, AFFRC in Japan, RDA in South Korea, and COA in China (Taiwan), proved successful in a short period. Others, like AARD in Indonesia and PARC in Pakistan required a longer gestation period. Still others such as BARC in Bangladesh, continue to lag behind, probably due to inherent structural and organizational deficiencies. A review of the development of apex bodies reveals that most countries have had to amend their enabling legislation -- in order to change the constitution of their governing bodies (PCARRD), or the principal areas of research coverage (PCARRD, BARC, and AARD), or the status of the chief executive (BARC, IARC, PARC, PCARRD), to name a few. Thus, for the future one would also expect continuing change for various reasons: in the managing councils and agencies, to make them more effective and efficient in management; and in the coordinating councils, to provide better support structures for more effective functioning.

In future, the apex bodies will have to extend their research mandate to include development. The names of four bodies (AARD, MARDI, PCARRD, and RDA) emphasize development. In all the developing countries of Asia and the South Pacific islands, the emphasis on development will have

to be institutionalized through enabling legislation and by organizing the apex bodies to perform this role.

The possibility of other types of apex bodies evolving into the managing type is not unlikely, provided they have developed credibility in the minds of researchers, policymakers, and the clients of research. But the forces that originally brought about the diversity in apex organizations will continue to operate in future. Therefore, providing the apex bodies with the prerequisites to perform the functions for which they were originally created would be an easier goal than changing their mission altogether. For example, the provision of a good technical secretariat to organizations such as BARC in Bangladesh and CARP in Sri Lanka would improve planning, programming, coordination, monitoring, and review -- functions expected of them.

Donor support for inter-institutional research programs (e.g., rainfed farming and ecological conservation), as well as inter-disciplinary ones (e.g., farming systems and biotechnology), should be channeled through these councils. This would build their competence in coordination and related functions. At the same time, the donors could use the opportunity to provide input to the restructuring efforts in order to build stronger coordinating councils.

The tendency of apex bodies to be too administrative in outlook, a trait inherited from the highly bureaucratic ministry model, has been raised by their critics. Ruttan (1986) refers to excessive administrative burdens that stifle both research investigations and research entrepreneurship in Asian NARS. While this was understandable during the formative period when the hangover of bureaucratic internship under the ministries was common among research managers, the need now is to be more management oriented.

It should be emphasized that there is a need to do more research on research management in the Asian context to develop a pool of knowledge, methodologies, and skills for improving the systems. The role of IARCs, such as ISNAR, and other international and regional aid agencies and development banks is to provide this input to improve management.

In future, formal mechanisms will be needed to link agricultural apex bodies to comparable ones in other sectors concerned with S&T, such as engineering, health, and social sciences. These will ensure a symbiotic working relationship between agriculture and other sectors to generate mutually beneficial research outputs. Shared manpower, infrastructure, and capital would be cost-effective and more affordable to the partners. New research thrusts in state-of-the-art technologies (biotech, commtech, and infotech) will drive apex organizations to 'share and search' through the formation of new alliances. The structural links required to make these possible will have to be examined. In the Philippines, such linkages have already been formed. PCARRD and planning councils in four other sectors -- health, industry and energy, aquatic resources, and advanced sciences -- are operating under the secretary of the Department of Science and Technology.

Apex organizations will also have to be more active in generating funds for agricultural research. For too long, national governments, donor agencies, and development banks pampered organizations because funds were freely available and some countries' economies were stronger. However, a changing economic climate, debt burden, natural disasters, and social militancy arising out of unemployment and poverty in Asia will put pressure on politicians and planners to divert funds to more pressing needs than research. Apex bodies will have to organize themselves to secure resources from hitherto uncanvassed sources, such as the corporate sector, in their own countries and outside. For this purpose, even legal enactments may need revision and management structures will have to be modified to ensure a professional approach to obtaining, investing, and utilizing funds so generated.

Primary Structures

All the Asian NARS included in this review have increased the types, numbers, and sizes of their primary structures (Table 13). The division of labor between the four kinds of research (basic,

strategic, applied, and adaptive) is also evident, with most countries directing their efforts to applied and adaptive research. The primary structures have diversified further into single- or multi-commodity/disciplinary forms. Research program emphasis on national or regional priorities and the nature of the support (derived from the central governments and/or provincial or state administrations) have broadened this scenario (Table 14). Growth in agricultural research in Asia has been impressive and obviously it cannot continue much longer. A critical survey might reveal too much investment of research infrastructure in relation to scientific staff, which would be a burden to the system rather than a source of productivity (Ruttan, 1986).

What structural realignments or organizational changes would be needed to get the maximum returns from the large investments in building the infrastructure and training the manpower in the NARS that contributed to the above scenario? Where should the basic and strategic research be done and what degree of restructuring would be needed to make the NARS more effective? What organizational changes will be needed to ensure that the peripheral structures that were established or enlarged, mainly with foreign aid, will continue to be effective when aid dries up? These and other questions will have to be addressed by the NARS manager.

It could be surmised that future overall growth of the Asian NARS will be less than growth in the last two decades. The need will be to identify lead institutions to take primary responsibility for one or a few commodities and secondary responsibility for a few others. During the definition of national priorities, identification of regional research complexes, and prioritization of programs, PCARRD clarified the national R&D network (PCARRD, 1986). It provides a good lead which could be useful to the other countries of the region. Thus, a nation-wide distribution of research mandates among the primary structures and efficient division of labor between them can be expected in future. In this respect, the possible increase in Type E and, more important, Type G institutions described previously (see Table 14) would require the attention of NARS managers as well as the location of new stations and resource allocations for them.

Centralization versus Decentralization

Two issues will likely be debated in future: decentralization of apex bodies and the level of autonomy of peripheral institutions.

There is concern that all apex bodies are becoming too centralized. Debate will center on just how centralized they should be and whether the form of centralization (and the incipient bureaucratization) nullifies the purpose for which the apex bodies were established. PCARRD has been actively decentralizing research managementfor a few years through the establishment of the 14 Regional R&D Consortia on Agriculture, Forestry and Natural Resources (Gapasin and Lorica, 1989). Other structural and organizational forms of decentralization can be expected to surface in different countries. Together with decentralization, the mechanisms for research priority setting, planning, programming, implementing, monitoring, evaluating, and funding will need to be critically studied. PCARRD's decentralized R&D system and its effectiveness merit examination by the NARS leaders of the region.

The second issue is the level of autonomy that should be enjoyed by provincial or peripheral research structures. Superimposed on this is the phenomenon of devolution of political power to provinces or regions, a trend now surfacing in most countries that have not already experienced it. In this context, then, the question is how to give more autonomy to the peripheral research stations while maintaining effective links with the central structure. The process of decentralization will demand a review of the structural entities in the primary structures within the provincial political boundaries that would enable them to take over some of the governance and research functions.

In addition to these two important issues, future systems will have to look critically at the viability of the different centers and their research programs.

Centralization may be unavoidable in some services that support research such as central libraries and data processing centers. The high costs of acquiring scientific literature in conventional form (journals and books) and of maintaining libraries mitigates against their multiplication around a country. Thus, centralized services, which could adopt emerging technologies to better assist researchers, will be unavoidable. Their location, structure, and linkages to the regional stations should be considered by the apex organizations.

Universities and Faculties of Agriculture

The involvement of universities in the functions and responsibilities of the Asian apex bodies has been limited. The exceptions are in India, the Philippines, and Japan. India uses a modified version of the U.S. Land Grant University model to expand research capability, university researchers to conduct need-based research in the states, and the institutions as bases for transfer of technology. But Ruttan (1986) feels that the mixed federal-state system has not yet reached the level of maturity that characterizes the U.S. federal-state or the Japanese national–prefectural systems. He further points out that this scheme performs better in some states and for some commodities than others.

In the Philippines, too, research capability has been expanded through university-based research, and the universities are members of the national R&D network. But sometimes they lack the focus on need-based research and teaching is often emphasized over the research function. Japan and, to some extent, South Korea and China (Taiwan) use the university contracted-research approach to undertake vital basic and strategic research. By and large, the universities and faculties of agriculture of the other Asian countries, though they expanded together with the other primary structures of the NARS, have been passive observers of the changing agricultural research scene.

In contrast to the expansion of university-level agricultural manpower training in the Asian countries, there has been no manpower development thrust in the countries of the South Pacific. They have only two institutions, the University of Papua New Guinea and the University of the South Pacific (USP), both servicing higher education needs in agriculture. The former has a Faculty of Agriculture that is barely 15 years old. USP, though located in Fiji, has its Faculty of Agriculture in Western Samoa. The deficiencies of both, in terms of academic programs, research training, facilities and academic staff have been highlighted in different reports (ADB, 1981; ISNAR, 1982, 1985). Thus, the primary goal in the South Pacific should be a strengthening of the existing institutions to tailor their teaching and research to the region's needs.

Asia's universities have a large pool of well trained scientists, mostly young and highly motivated, to do research. In order to harness this resource base, the NARS should think about possible enabling legislation, structural mechanisms, and formal linkages suited to their own countries. The NARS could also encourage collaboration between the universities and the private sector. Jointly they could undertake basic and strategic research in certain fields such as biotechnology, mechanization, and food science.

Some IARCs have already initiated biotechnology research. In order to transfer and implement such technologies generated by the IARCs and other institutions abroad, biotechnological laboratories with adequate capability should be available in the NARS. These could be developed through the university systems. Such a capability would ensure that commercialization of biotechnologically derived agricultural requirements, (such as varieties, propagules, and vaccines) does not result in unrealistically high costs to farmers because of the profit motive. It would also hasten the transfer of technology and insulate the agriculture sector against a new type of exploitation by foreign private firms.

The role of the universities could also be strengthened by inviting technical personnel to serve on governing or management bodies, scientific panels, technical committees, coordinating units, and

the review and evaluation teams of apex bodies and institutions at the implementation level. To some extent this occurs formally as in the case of PCARRD's national commodity R&D teams. But often such participation occurs only because of informal personal relationships. Likewise, the universities could reciprocate by having senior research managers and researchers from the NARS on their academic bodies.

Operational Aspects of NARS Function

The discussion on operational aspects in section 4 revealed that the NARS of some countries are weak in one or more areas of management. On the whole, the most serious deficiencies are in the areas of policy, planning, programming, priority setting, reviewing, and evaluation. Difficulties in coordination are also of concern in a few countries. The deficiencies seem to permeate the system -- from the apex bodies at the national level to the implementing organizations at the field level.

If the systems are to become more efficient and effective, each NARS has to diagnose the root causes at all levels and make suitable modifications in the organizations concerned. Since the larger NARS in particular have numerous units at the institutional and implementation levels, the creation of committees, groups, and teams and the work expected from them could themselves be very time-consuming and adversely affect the conduct of individual members' own research. The cycles of expansion and contraction of capable manpower that characterizes NARS also mitigate against developing effective groups to service these management functions.

In the haste to expand the NARS through infrastructural development, such as setting up new regional and experimental stations, some countries made questionable choices regarding the location of facilities. The interests of research can be damaged if, in order to meet a donor's target date for project completion, stations are established without adequate technical information and resources and without consideration of community factors. Proper evaluation of such facilities has the advantage of revealing their lack of potential and can assist in future decisions on resource allocations to them.

The creation of monitoring, review, and evaluation structures, however, may be viewed with suspicion by young NARS scientists and their research managers. Credibility can be established if the apex organization sets an example by subjecting itself to the same review requirements and takes corrective action on diagnosed weaknesses.

Strengthening the Ministry Model

For some countries, the ministry model will continue to prevail. Even in Thailand, with its large NARS and large Ministry of Agriculture (comprising departments of agriculture, livestock, forestry, fisheries, irrigation, and land development, and having several production and processing organizations under its authority), there has been continued resistance to having one apex organization. In those countries with small research systems, the ministry model is the only viable option. Strengthening the NARS in each type would require the gradual introduction of appropriate structures to improve the operational aspects of planning, programming, priority setting, monitoring, review, and evaluation.

The development of a strong secretariat to service agricultural research and having an effective coordinating group would be indispensable. In larger countries like Thailand, ways of according regional research organizations greater autonomy to develop their capabilities should be considered. Other options are open to the South Pacific islands, by virtue of their setting and the small size of their NARS. A Regional Research Support System, for example, has been proposed as a way for these countries to develop a coordinated program for the region and to strengthen linkages among themselves and with CGIAR centers and other external research centers (ADB, 1981).

The behavior of international donor agencies has an important bearing on the potential for strengthening the ministry model. Often the lack of coordination among these agencies and the pressures some of them exert in pushing their own programs or management styles undermines the evolution of strong capabilities within a ministry.

Linkages

Strengthening existing linkages and forging new ones will continue to expand the research horizons of NARS. Both internal and external linkages are indispensable.

Internal Linkages. The need to link in-country peak agencies and their institutions to undertake joint research on the emerging technologies was stated earlier. Such linkages were poor in the past and the creation of different apex agencies to service other parts of the economy has even led to unnecessary competition for scarce resources and a certain degree of isolation in scientific endeavors. Developing countries can ill afford to do so in future.

Linkages between research, training, and extension are still weak in many countries despite the significant advances each has made in its own right. Specific initiatives in individual countries in the region suggest a need to synthesize the approaches so far tried in order to develop better ones. Innovations in organization and structure are needed to realize the most effective means of transfer, to derive the maximum potential from researchers' output.

Another internal linkage that should be fostered is private sector cooperation in the financing of research -- through contract research, institutional support, commodity support, endowments for university research, and so on. The region has private sector support for research in the form of a cess on commodities produced for export or internal consumption. Though they were created through the passage of enabling legislation and at times were even opposed by producers, the beginnings of private sector support were institutionalized. Subsequent events such as the nationalization of plantations and the expansion of production under government corporations have transformed private sector support into a public sector function. Countries like China (Taiwan), however, have continued to foster the private sector support for research. Today, several agricultural research institutions in that country are supported by enterprises or foundations:

- Taiwan Sugar Research Institute, with three branches;
- TSC Animal Industry Research Institute;
- Taiwan Food Industry Research and Development Institute;
- Agricultural Engineering Research Center;
- Taiwan Banana Research Institute;
- Pig Research Institute, Taiwan.

Likewise, Malaysia has several private companies that undertake research on the processing of rubber and palm oil.

In the process of restructuring the economies of developing countries, public sector corporations that were previously importing, producing, and marketing agricultural inputs (such as seeds, fertilizer, and agro-chemicals) or commodities (such as rice and sugar) are being privatized. The new generation of private sector upper management is normally conscious of the social dimensions of their commercial enterprises. Therefore, the environment is improving to harness the potential of private sector cooperation in agricultural research. In support of this statement, a recent initiative is cited. In Sri Lanka, the import of sugar, which had been a government function for a long time, was opened to the private sector in 1987. The Sugar Research Institute (SRI) derives a cess on the production of sugar in the country from the public and private sector organizations, but there is no cess on imports. On the recommendation of the Board of Governors of SRI to the Sugar Importers Association, a recently created private sector organization, the Association granted one million rupees in 1988 to the SRI to support its research. The grant represented 25 percent of the

recurrent funds for 1988. It is an encouraging start which could be emulated in other Asian countries.

External Linkages. It was fortunate that with the creation and expansion of the NARS in Asia, the CGIAR-supported IARCs and other regional centers were also expanded. In addition to the 13 CGIAR centers, the region's NARS interact with seven international organizations, 18 regional organizations, 31 agricultural research networks, and 13 foundations and bilateral assistance organizations (ADB, 1988). These linkages have no doubt strengthened the capacities and capabilities of the national systems.

This formidable array of linkages suggests that the apex organizations each need a separate structural unit to coordinate and follow up, even if not all the linkages are operative in a country in any one year. Except for a few organizations like PARC and AFFRC, there is no indication in the organizational structures of the apex bodies as to how these linkages are coordinated. As the NARS expand further and new research initiatives are explored, the external linkages may continue to expand with university-based research institutes and consortia also linking with the system. Management of linkages to ensure benefits to as many institutions and researchers in a NARS as possible is, therefore, an area in need of greater attention than it has been given.

In conclusion, what each country does will have to be determined by their own leaders in the areas of agricultural R&D, planning, and financing. Unlike the past two and a half decades, when the NARS of the region were small, today the national systems have the capacity and capability to respond to even greater challenges. The local research leaders and the foreign ones they interact with are also now better informed of the objectives of R&D, conscious of the political, social, and economic environments under which research operates, and less likely to adopt hasty and ill-conceived strategies. The excellent pool of trained scientific personnel, many of whom are conscious of the need for a solid management approach, is the greatest asset of the NARS. The Asian region, therefore, can place even greater hopes on them than it did on their mentors who guided the transformation of agricultural research into the coherent national agricultural research systems of today.

Recommendations for Future Studies

This review has identified gaps in organization and structure that need to be researched in order to improve the efficiency and effectiveness of NARS in Asia and the South Pacific islands. .A summary of studies that require attention is given below. It is not exhaustive, but should serve as a guide to NARS managers and to the directorates of the international centers.

Restructuring Apex Organizations.
a) Continuous changes in organization and structure suggest that the ICAR prototype, which dominated the conceptualization of other apex bodies, was not the ideally suited to other countries. Indigenous sociopolitical situations, competing scientific hierarchies, pressure groups, and other forces have modified powers, responsibilities, and mandates to the point of making some apex bodies less effective than others. Detailed analyses are needed to answer various questions:

- What further changes are required in large apex bodies such as ICAR, PCARRD, AARD?
- What improvements are necessary in relatively weaker ones such as BARC?
- What adjustments are essential for new ones such as CARP?
- What modifications are anticipated for apex bodies to be functionally'development-oriented' as R&D bodies?

- What types of organizational and structural adjustments should be introduced to the ministry system which is still predominant in some countries?

b) What is the optimum composition of a council's Governing Board? During the formation of apex bodies there has been undue pressure to give representation to numerous groups. For example, PARC has 35 members of which 25 are *ex officio*. At the other extreme, AFFRC has only seven members with no *ex officio* representation. Moreover, with the need for decentralization being voiced in many circles, now is an opportune moment to examine this question critically.

c) What essential organizational structures are needed at the apex? What composition would transform them from top-heavy scientific bureaucracies with large secretariats (the current trend) into smaller, effective management organizations that provide leadership and direction to policy making, priority setting, resource allocation, programming, and evaluation?

d) The 1960s and 1970s were marked by an urgent need for self-reliance in food crop production. The emphasis was placed mainly on rice and wheat and major successes were subsequently registered. Even now the focus at the management level is research based on specific crops and disciplines. In future, however, the research agenda will have to focus more on interdisciplinary R&D involving many disciplines, commodities, and systems. Added to this complexity will be the need to do research on production under more difficult environments -- such as dryland farming which would open up more land for agriculture. What changes would be needed in structure and organization to shift management from its focus on commodity- and discipline-oriented research to interdisciplinary management?

e) In countries with no Ministry of Science and Technology and with various apex bodies dispersed among several ministries, what structural mechanism(s) and enabling enactments are needed to formalize interdisciplinary, cooperative R&D that would have an impact on development?

Decentralization of Research Management If decentralization is necessary for improving the efficiency and effectiveness of agricultural research management, the structures required for different countries will vary. Moreover, the need to guard against the replication of bureaucratic central structures at the state/provincial/regional level should be evident. What modifications in organization and structure would be required at the apex body? To what degree should it be scaled down? What should be the functions and responsibilities of the center and decentralized units? What type of linkage mechanisms are best? And what form of enabling legal provisions are required to bring about the changes? A study of the decentralized R&D system of the Philippines and other countries should serve as a starting point.

Restructuring Primary Structures. Let us assume that decentralization of the apex functions and consolidation of the R&D of primary structures will occur. What criteria would be needed by NARS managers to organize and restructure the existing features, while keeping in mind both the necessity for new research initiatives and the constraints on the current expanded network of primary structures? What form of restructuring could make productive use of a large pool of agricultural scientists who are available in the university system?

Improving Operational Aspects. Shortcomings in planning, priority setting, programming, monitoring, and evaluation and the resulting deficiencies in resource allocation have become evident. These will be exacerbated as the NARS take on new research thrusts requiring interdisciplinary and inter-institutional cooperation. How the operational functions are actually taking place in different countries merits critical study so that organizational and structural changes within each system can be proposed.

Linking the University System. Except in a few countries, university scientists are not fully participating in their national agricultural research systems. This is an obvious gap that needs to be corrected. Since the research agenda will expand and become more inter-disciplinary and inter-institutional, university researchers will be able to make a substantial contribution to the basic

and strategic components of the research. Organizational and structural features have to be introduced to link NARS researchers with the scientists of the best universities and centers of excellence in the Asian region. These mechanisms will also have to link them with similar institutions in the developed countries and to the international research centers. The linkages would also promote better training of the next generation of NARS researchers. A detailed study of existing systems and recommendations for the future merits support.

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ANNEX

OBJECTIVES OF AGRICULTURAL RESEARCH ACTIVITIES IN JAPAN

The Agriculture, Forestry and Fisheries Research Council fixes the basic objectives of research, indicating the research guidelines in order to promote in a comprehensive and effective manner research relating to agricultural, forestry, and fisheries activities and to the livelihood of the rural communities and fishermen of Japan.

Accordingly, on November 29, 1983, the "Basic Objectives for Research in Agriculture, Forestry and Fisheries" for the development of advanced technology to meet the needs of the 21st century and the "Research Objectives Relating to Agriculture" were defined.

The basic guidelines for research were drafted in the respective research organizations in 1983. The "Basic Objectives for Research in Agriculture, Forestry and Fisheries" include six main aspects:

(1) Increase of productivity and output in the field of agriculture, forestry and fisheries.

(2) Efforts to meet the consumers' demand for diversified and high-quality products.

(3) Enhancement of the value and careful utilization of the natural resources as well as preservation of the environment.

(4) Promotion of the role and activities of the rural communities.

(5) Contribution to the development of agriculture from a global standpoint.

(6) Promotion of technical innovation in the field of agriculture, forestry, and fisheries to meet the needs of the 21st century.

In addition, "the Basic Objectives for the Promotion of Crop Breeding" were defined by the Research Council Secretariat in FY 1985.

Source: AFFRC (1986)

Table 1. Population data, GNP and energy consumption of review countries (1986)

Region and Country	Population* (millions)	Life Expectancy* at Birth (yrs)	Density /km² (people)	Urban* Population (%)	Literacy** Rate (%)	GNP* Per Capita ($)	Energy Consumption* Per Capita (kg of oil equivalent)
South Asia							
Bangladesh	103.2	50	721	18	26	160	46
India	781.4	57	234	25	36	290	208
Nepal	17.0	46	120	7	19	150	23
Pakistan	99.2	52	130	29	24	350	205
Sri Lanka	16.1	70	248	21	85	400	139
South East Asia							
Indonesia	166.4	57	89	25	62	490	213
Malaysia	16.1	69	49	38	60	1830	762
Philippines	57.3	63	190	39	75	650	180
Thailand	52.6	64	102	18	86	810	325
East Asia							
Japan	121.5	78	326	76	92	12,840	2196
South Korea	41.5	69	419	64	93	2370	1408
Taipei, China	19.5	72	540	70	90	6053	
South Pacific							
Fiji	0.7	68	42		1810		
Papua New Guinea	3.4	52	7	14		720	244
Solomon Islands	0.3	58	10			530	
Western Samoa	0.16	65	57			680	

* World Bank (1988)
\# ESCAP Population Data Year book
** ADB (1984)

Table 2. Total land area and its agricultural use and key production indices in agriculture in selected Asian countries (1986)

Region & Country	LAND (x 1000 Ha) Total Area	Arable	Perm. Crops	Perm. Pasture	Forest & Wood	TOTAL PRODUCTION INDICES 1979-81 = 100 Agricul.	Crops	Livestock Products	Cereals
South Asia									
Bangladesh	14400	8866	269	600	2143	116	115	115	123
India	328795	165400	3550	11850	67140	123	120	139	123
Nepal	14080	2290	29	1978	2308	111	119	112	112
Pakistan	79610	20100	400	5000	3060	127	133	131	120
Sri Lanka	6661	1080	1125	439	2383	102	97	96	125
South East Asia									
Indonesia	190457	15500	5380	11850	121494	133	132	152	134
Malaysia	32975	1040	3330	27	20060	122	126	158	91
Philippines	30000	4500	3400	1160	11350	110	110	106	123
Thailand	51400	17600	2020	308	15000	120	115	133	116
East Asia									
Japan	37771	4194	538	626	25198	198	105	117	110
South Korea	9848	1996	148	80	6555	108	109	157	109
South Pacific									
Fiji	1827	152	88	60	1185	112	111	116	138
Papua New Guinea	46199	30	355	86	38270	106	111	126	91
Soloman Islands	2845	40	15	39	2560	108	106	108	17
Western Samoa	284	55	67	1	134				

Source: FAO Production Yearbook 41 (1987)

Table 3. Agricultural research indicators in selected countries in Asia

Region	Country	Importance of Agriculture		Expenditure on Ag. Research: 1980-1985 averages					
		%AgGDP of GDP 1984	% Economically Active Ag. Pop. of Ec. Ac. Pop. 1988	Total US$ 1980 (million)	US$ per Scientist 1980 (000)	as a % of GDP	as a % of AgGDP	Per Economically Active Ag. Pop 1980-84 average (1980 US$)	Per Hectare Agricultural Land 1980 only (1980 US$)
South Asia	Bangladesh	48.39	69.81	71.45	64	0.14	0.30	3.65	8.52
	India	33.28	67.14	449.89	54	0.11	0.30	2.36	2.63
	Nepal	61.75	91.97	11.12	26	0.13	0.21	1.87	4.93
	Pakistan	24.68	50.64	48.53 **	16	0.05	0.19	3.34	2.40
	Sri Lanka	24.42	52.02	21.03	69	0.10	0.38	7.03	9.08
Southeast Asia	Indonesia	23.55	50.17	132.83	98	0.08	0.32	4.06	6.30
	Malaysia	20.14	33.86	100.62	124	0.20	0.97	44.96	20.99
	Philippines	25.86	47.72	28.70 *	15	0.04	0.16	3.07	2.46
	Thailand	19.51	65.61	74.89	n.a.	0.08	0.38	4.34	3.49
East Asia	Japan	3.24	7.17	1011.28	69	0.10	2.84	173.49	196.99
	South Korea	13.33	26.67	46.75	35	0.04	0.26	8.93	13.96
	Taiwan	6.33	13.71	68.63	45	0.11	1.55	9.15	n.a.
South Pacific	Fiji	17.25	40.16	5.05	136	0.26	1.34	52.55	18.46
	Papua New Guinea	33.67	68.90	19.66	184	0.40	1.18	16.70	49.30
	W. Somoa	n.a.	14.55	0.43	48	n.a.	n.a.	45.65	1.90

Sources:
1. Personnel and agricultural research expenditure: Pardey, P.G. and J. Roseboom. "Agricultural Research Indicator Series: A global data vase on national agircultural research systems". ISNAR: The Hague (unpublished draft version, 1988).
2. AgGDP, GDP and other agricultural indicators: Pardey, P.G., et. al. "Agricultural Research Indicator Series: Supplementary files. Staff Note No. 88-2, ISNAR: The Hague.

Definitions:
1. Agricultural Research Expenditures (in millions of 1980 US$). Agicultural research expenditures were first deflated into constant 1980 local currency units using an implicit GDP deflator (UN, 1988) and then converted into 1980 US$ using PPP over GDP indices from SUmmers & Beston (1988).
2. Agricultural research expenditures per scientist = Ag. Res. Expds./Personnel (in 1000's 1980 US$).

* PCARRD only ** PARC only

Table 4. Expenditure on agricultural research in three subregions of Asia during three periods

	Expenditure (constant 1980 US$ thousands)		
	1959	1970	1980
South Asia	32 024	72 573	190 931
Southeast Asia	9 028	37 405	103 249
East Asia	141 469	521 971	734 694

	Expenditure as % Value of Agricultural Product		
	1959	1970	1980
South Asia	.12	.19	.43
Southeast Asia	.10	.28	.52
East Asia	.692	.012	.44

	Expenditure per Scientist Person Year (SPY) (constant 1980 US$ thousands)		
	1959	1970	1980
South Asia	22	28	34
Southeast Asia	20	32	25
East Asia	18	38	43

Source: Ann Judd et al (1987)

Table 5. Twelve critical factors in building effective NARS

POLICY CONTEXT OF AGRICULTURAL RESEARCH
• Interactions between national development policy and agricultural research
• Formulation of agricultural research policy: priority setting, resource allocation, and long-term planning
STRUCTURE AND ORGANIZATION OF AGRICULTURAL RESEARCH
• Structure and organization of research systems
• Linkages between NARS and policymakers
• Linkages between NARS, the technology transfer system, and users
• Linkages between NARS and external sources of knowledge
MANAGEMENT OF AGRICULTURAL RESEARCH
• Program formulation and budgeting
• Monitoring and evaluation
• Information management
• Development and management of human resources
• Development and management of physical resources
• Acquisition and management of financial resources

Source: ISNAR (1987)

Table 6. Levels of management functions, their methodological means and organizational options

Where	What	How	By Whom
Level	Management Functions	Methodological Means	Organizational Options
National	Securing political, financial, and human resources	• Information exchange • Coalition building • Ensuring external accountability for use of funds	• Apex body: board/council, national committee, ministry • Semi-autonomous institution • Some combination of above • Each institution independently
	Determining policy and strategy, and approving long-term research plan	• Political processes • Socioeconomic studies • Analysis of technical potential • Assessment of availability of research resources	• Apex body • Technical committee(s) • Ad hoc task forces
	Organizing for implementing policy, strategy, and long-term research plan	• Assigning responsibility • Inter-institutional coordination • Ensuring accountability of research institutions	• Apex body • Committee • Task force
	Supervising implementation	• Reporting mechanisms for monitoring and evaluation, and annual programming • Periodic review of organizational performance	• Ministry dept. • Secretariat to apex body • Standing committees • Planning unit

(table 6 continued)

Where Level	What Management Functions	How Methodological means	By Whom Organizational options
Institution	Research programming	• Identification of production problems • Setting objectives • Assessing scientific potential, resource availability, and researchability • Setting priorities • Approving annual programs	• Institution management • Research managers • Research committee
	Organizing research and supervising implementation	• Assigning responsibilities to implementing level units • Coordinating between implementing units • Reporting mechanisms for monitoring and evaluation, and annual programming	• Institution management • Research managers • Program leaders • Multi-disciplinary teams
Implementation units	Formulation of annual programs	• Assessment of scientific potential, resource availability and researchability • Setting priorities • Preparing study proposals and experiments	• Unit management • Researchers • Multi-disciplinary teams
	Implementation of studies and proposed experiments	• Experimental design • Conducting research • Data collection • Analysis • Interpretation of results • Dissemination of results • Reporting to higher management	• Researchers • Technical and support staff • Extension staff

* Source: Hariri & Sachdeva (1988): Personal communication

Table 7. Types of apex bodies in the NARS of selected Asian countries

Subregion & Country	Type of National Apex Organization			
	Managing Council	Coordinating Council	Ministry of Agriculture or Primary Industries	Autonomous Agency/ Institute
South Asia				
Bangladesh		√ (1973/76)*		
India	√ (1947/65/74)			
Nepal			√	
Pakistan		√ (1964/79/81)		
Sri Lanka		√ (1987)		
Southeast Asia				
Malaysia				√ (1967)
Indonesia				√(1974/84)
Philippines		√ (1971/82/86)		
Thailand			√	
East Asia				
Japan	√ (1961/79)			
South Korea				√ (1962/85)
China (Taiwan)		√ (1979/84)**		
South Pacific				
Fiji			√	
Papua New Guinea			√	
Solomon Islands			√	
Western Samoa			√	

* In parenthesis: year of establishment followed by year(s) of re-organization

** Prior organization was Joint Commission on Rural Reconstruction (JCRR), 1949-79

Source: APO (1983); Jain (1988); Trigo (1986)

Table 8. Types of governance, size and nature of membership of apex organizations

Subregions & Country	Apex Organizations	Number of Members	Type of Governance	Chairman at Meetings
South Asia				
Bangladesh	BARC	22 (14)*	Council Members	Minister of Agriculture
India	ICAR	21 (12)	Governing Body	Director General, ICAR
Pakistan	PARC	39 (25)	Board of Governors	Minister of Agriculture
Nepal	Ministry of Agriculture	18 (7)	Committee[1]	Secretary of Ministry
Sri Lanka	CARP	14 (11)	Council Members	Elected from members
South East Asia				
Malaysia	MARDI	11 (?)	Governing Board	Director General
Indonesia	AARD	-	Director General	Director General
Philippines	PCARRD	9 (6)	Governing Council	Secretary, Dept. of S&T
Thailand	Ministry/Department	-	Undersecretary/Director	Secretary/Director
East Asia				
Japan	AFFRC	7 (0)	Council of Members	Elected from members
South Korea	RDA	-	Director General	-
China (Taiwan)	COA		Head	-
South Pacific				
Fiji	Ministry/Dept.	-	Secretary/Director	Secretary/Director
Papua New Guinea	" "	-	" "	" "
Soloman Islands	" "	-	" "	" "
Western Samoa	" "	-	" "	" "

* Numbers in parenthesis are ex officio members.
[1] National Agricultural Research Coordination Committee (NARCC) formed in 1983.

Source: ADB (1988); APD (1983); FAO (1986): Yadev (1987)
National Agricultural Research Plan (BARC, 1979)
Pakistan Agricultural Research Project II (FAO, 1987)

Table 9. Enabling legal authority of apex organizations

Organization	Enabling Enactment
BARC (Bangladesh)	Presidents' Order, 1973, and Ammendment, 1976
ICAR (India)	ICAR Society Act and Ammendments to Rules and Bylaws made periodically
PARC (Pakistan)	Ordinances of 1974 and 1981
CARP (Sri Lanka)	Act of Parliament, 1987
MARDI (Malaysia)	Act of Parliament, 1969
AARD (Indonesia)	Presidential Decrees, 1974, 1979 and 1983
PCARRD (Philippines)	Presidential Decrees, 1972 and 1975 Executive Order, 1986

Table 10. The research mandate of apex bodies in Asia

Region and Country	Crops	Livestock	Inland Fisheries	Forestry	Animal Health	Systems (Farming/ Cropping)	Land-Soil-Water Resources
South Asia							
Bangladesh (BARC)	√[a]	√	√	√	√	√	√
India (ICAR)	√	√			√	√	√
Nepal*	√		√			√	
Pakistan (PARC)	√[b]	√	√			√	
Sri Lanka (CARP)	√	√	√	√	√	√	√
Southeast Asia							
Malaysia (MARDI)	√[c]	√	√			√	√
Indonesia (AARD)	√	√	√		√	√	√
Philippines (PCARRD)	√	√		√	√	√	√
Thailand*	√[d]	√	√	√	√		√
East Asia							
Japan (AFFRC)	√	√	√	√	√	√	√
South Korea (RDA)	√[e]	√			√	√	√
China (Taiwan) (COA)	√	√	√	√	√	√	√
South Pacific*							
Fiji	√[f]						√
Papua-New Guinea	√						√
Solomon Islands	√						
Western Samoa	√						

* Ministry of Agriculture or related ministry serves as apex organization

√ Solid tick indicates research is good; dotted indicates weak research.

a Excludes sugarcane and tea

b Excludes cotton and tobacco

c Excludes rubber and oilpalm

d Excludes sugarcane and tea

e Excludes tobacco and gingseng

f Excludes sugarcane

Table 11. Functions and responsibilities of apex organizations as provided in enabling enactments

Functions & Responsibilities	South Asia					Southeast Asia				East Asia		
	Bangladesh (BARC)	India (ICAR)	Nepal*	Pakistan (PARC)	Sri Lanka (CARP)	Indonesia (AARD)	Malaysia (MARDI)	Philippines (PCARRD)	Thailand	Japan (AFRC)	Korea (RDA)	Taipei, China (COA)
Policy Formulation	✓	✔	—	✓	✓	✔	✔	✔	✓	✔	✔	✔
Research Coordination (L/C)**	✓L	✔	✓L	✔L	✓	✔C	✔C	✔	✓L	✔C	✔C	✔C
Priority Setting	✓	✔	—	✓	—	✔	✔	✔	✓	✔	✔	✔
Program Planning	✓	✔	—	✓	✓	✔	✔	✔	✓	✔	✔	✔
Funding	✓	✔	✓	✔	—	✔	✔	✔	✓	✓	✔	✔
Providing Support Grants	✔	✔	—	✓	✓	—	—	✔	✔	✔	✔	✔
Program Implementation	✓	✔	—	—	—	✔	✔	—	✔	—	✔	✔
Infrastructure Development	✓	✔	✓	✔	—	✔	✔	✔	✓	✔	✔	✔
Management of Research Institutions	—	✔	✓	✓	—	✔	✔	—	—	✔	✔	✔
Postgraduate Research	—	✔	—	—	—	—	—	✔	✓L	—	—	—
Interinstitutional Coordination (L/C)	✓L	✔C	✓L	✓L	✓L	✔C	✔C	✔	✓L	✔C	✔C	✔C
Interministry Coordination (L/C)	✓L	✔C	✓L	✓L	✔L	✓L	✓L	✔	—	✔C	✔C	✔C
Provision of Service Facilities	✔	✔	✓	✔	—	✔	✔	✔	✓	✔	✔	✔
Development of External Linkages	✔	✔	✓	✔	✓	✔	✔	✔	✓	✔	✔	✔
Career Development	✔	✔	—	✔	—	✔	✔	✔	✓	✔	✔	✔
Monitoring, Review, & Evaluation (L/C)	✔L	✔C	✓	✓	✓	✔C	✔L	✔C	✓	✔C	✔C	✔C
Dissemination	—	✔	✓	✓	—	✓	✔	✔	✔	—	✔	✔
Facilitation of Technology Transfer	—	✔	—	✓	—	✔	✔	✔	✔	—	✔	✔

NOTE: ✔ = Strong
✓ = Weak.

* Refers to the National Agricultural Research Services Centre set up in 1985.

** L = Loose
C = Clear

Table 12. Types of research done in NARS

TYPE OF RESEARCH	BASIC →	STRATEGIC →	APPLIED →	ADAPTIVE
Expected output	New knowledge New understanding	Technology generation Solving specific research problems	Technology refinement and application Indentifying optimum conditions	Technology adjustment and validation to specific farmer situation
Location	University Advanced research institutes	Principally experimental stations; some in IARC's and universities	Experimental stations Outreach experimental sites	On-farm sites with research-farmer extensionist interaction
Linkage	Research networking Mainly foreign and IARCs and local inter-institutional	Research networking Mainly in-country inter-institutional	Communication networking In-country inter-agency research-extension	

Table 14. Representative examples of multicommodity/discipline or single commodity/discipline research institutions under central or provincial auspices and having national or regional focus

	CENTRAL/FEDERAL RESPONSIBILITY	PROVINCIAL/STATE RESPONSIBILITY
M	**TYPE A** National Institutes (India) Fruit Research Station (Japan) Research Institute for Spices and Medicinal Crops (Indonesia) Universities (Japan, China-Taiwan, Philippines)	**TYPE E** Larger State Agricultural Universities (India) Ayub Agricultural Research Institute (Pakistan)
S	**TYPE B** Rice Research Institutes (India, Philippines, Sri Lanka) Plant Breeding Institute (Philippines) Soil Survey of Pakistan National Institute of Agro-Environmental Science (Japan)	**TYPE F** Soil Fertility Survey and Soil Testing Institute (Pakistan) Livestock Production Research Institute (Pakistan)
M	**TYPE C** Research Complex North-Eastern Region Hill Region (India) Agricultural Research Centers (Sri Lanka)	**TYPE G** Kyusha National Agricultural Experimental Station (Japan). Central Mindanao University (Philippines) State Agricultural Universities
S	**TYPE D** Sugar Research Institute (Sri Lanka)	**TYPE H** Provincial Research Institute for Animal Health (China-Taiwan)

M - Multiple commodity/discipline
S - Single commodity/discipline

Table 13. Types of NARS primary structures at the institutional level

Region & Country	Number of Agricultural Scientists (year)	National Research Centers	National Institutes	Central Research Institutes/ Research Centers (CRI/RC)	Regional Stations	Single Commodity Research Institutes (CRI/RC)	Higher Education	
							Agricultural University	Others with Faculty of Agriculture or Equivalent
South Asia								
Bangladesh	1600 (1987)			10	35[a]	5	1	4
India[b]	33357 (1987)	8	3	36	16	8	26	
Nepal	388 (1980)				8[c]		0	1
Pakistan	4500 (1987)	1	1	30[d]	73[e]	5	3	3
Sri Lanka	506 (1985)			17	29	4	0	3
South-East Asia								
Indonesia	2000 (1986)	2[f]		29[g]	51[h]	6	1	23
Malaysia	440 (1984)			4	16	4	1	
Philippines	3046 (1986)	4			8[i]	8	9	11
Thailand	7954 (1984)			38	82	15	4	1
East Asia								
Japan	11598 (1986)[j]			17	6			
S. Korea	2500 (1983)			14			0	22
China	3500 (1987)			2 ·	15	8	5	3
(Taiwan)								

a) Has in addition about 10 testing stations.
b) Has in addition 4 National Bureaux on Resource Conservation and one National Academy of Agricultural Research Management (NAARM).
c) Refers to adaptive research stations. In addition has some adaptive research farms.
d) Includes 15 Provincial Research Stations.
e) Includes 55 Provincial Research Sub-Stations.
f) Servicing centers - Library and Data Processing.
g) Has in addition 5 Research Coordinating Centers.
h) Has in addition 196 Experimental Farms and Ponds.
i) Has in addition 83 Cooperating Stations.
j) Includes Prefectural Level.

Sources: AARD(1987 a & b); ADB(1988); AFFRC(1986); FAO(1986;1987); PCARRD(1986); ISNAR (Country Reports)

Table 15. Number of research stations and ICAR-supported research projects in the agricultural universities of India

No. of Universities	No. Research Stations under Universities	No. Centers under NARP* (ICAR)	No. Centers under All-India Coordinated Projects (ICAR)	No. Ad Hoc Research Schemes (ICAR)
25	313	129	793	339

* NARP - National Agricultural Research Project

Source: Randhawa (1987)

Table 16. Agricultural universities/colleges in PCARRD's national R&D network

Types of Center/ Station	Scope of Research	No. of State Universities/ Colleges
National multicommodity R&D centers	Basic/strategic/ applied	4 universities
Regional R&D R&D centers	Applied/ verification	4 universities 2 colleges
Cooperating stations	Adaptive field trials	9 universities 9 colleges

Source: Gapasin and Magboo (1986)

Table 17. Increase of agricultural research scientists in selected countries in Asia

	1975*	Recent**
South Asia		
Bangladesh	635	1600 (1987)
India	5666***	33357 (1987)****
Sri Lanka	149 (1974)	506 (1985)
Southeast Asia		
Malaysia	367 (1977)	440 (1984)
Indonesia	463	2000 (1986)
Philippines	1128 (1974)	3046 (1986)
Thailand	5504	7219 (1984)
East Asia		
South Korea	992	2500 (1983)

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* . Source: ISNAR Data Bank; Thailand (Isarangkura, 1986)
** Sources: ADB (1988), FAO (1986)
** Excludes agricultural universities
**** Includes agricultural universities; otherwise about 8500 in ICAR institutes and centers.

Table 18. Mechanisms of inter-institutional collaboration of apex organizations in Asia

Region & Country	Overall Collaboration	Inter-Institutional Research	Research Program Coordination	Technical & Service Support	Foreign Insitutions and IARCs
South Asia					
Bangladesh (BARC)	Council's Member Directors for commodity groups and disciplinary groups PSO & SSO	Member Director Research Liaison	Member Directors for commodities and discipline	Member Director technical support services	Member Director, Research Liaison
India (ICAR)	DG for National Institutes and Research Centers DDG & ADG for commodity and disciplinary groups and education	DDG Commodity and disciplinary groups Coordinator-National	Coordinator National coordinated programs coordinated programs		
Nepal	Joint Secretary Research	none	Additional or Jt. Secretary Research Coordination Comm.	National Agriculture Research, & Services Center (NARSC)	Research Support Services Division of NARSC
Pakistan (PARC)	Council's Members for commodity and disciplinary groups	Specialist Technical Panels	Exec. Committee with Provincial Coordination	Director, Planning & Technical Services	Director Planning & DD International Liaison
Sri Lanka (CARP)	Not established yet Presently Executive Secretary	Executive Secretary	Not established in CARP	Not established in CARP	Executive Secretary

(table 18, continued)

South East Asia					
Malaysia (MARDI)	DDG Commodity research and for research support	Scientific Council Research Advisory Committee	Research Advisory Committee	DD Research Support	Office of DG &
Philippines (PCARRD)	DED for research and for development	Technical Advisory Committee (TAC)	TAC Commodity Research Teams	DD Institutional Development Financial Management	Office of Executive Director/Planning & Development Dept.
Indonesia (AARD)	Dir. research coordinating centers (RCC) for commodity, discipline and Services DG in Boards of Estate Crops and Sugar	Directors RCC National Research Commodity Groups	Directors RCC with National Research Commodity Groups	Service Centers of AARD	Secretary AARD Div. Agric. Research Cooperation
Thailand	DG of Department of Agriculture DDG Research	Directorates of Depts. & Deputy Directors (Research)	Office of Specialists with DD (Research)		Secretary Ministry
East Asia					
Japan International (AFFRC)	DG, Research Councillors and Research Councillors	Counsellors Research Coordinators	Counsellors	Tsukuba Office of AFFRC	Counsellor Research Cooperation
South Korea (RDA)	DDG and Heads of Research and Technical Services	National Institutional Cooperating Committee on Agriculture (NICCA)	Research Planning Committee		

Table 19. Structures and mechanisms available for managing essential research elements in four NARS

	India	Philippines	Japan	South Korea
PRIORITY SETTING	Working Group on Agricultural Research & Education Regional R&D Consortia	PCARRD-Governing Council Technical Advisory Committee National Commodity R&D Teams	AFFRC Secretariat	RDA Research Bureau
	(Plan Document)	(National R&D Program)	(Basic Objectives of Agricultural Research)	(Guidelines for Research Projects)
RESEARCH PLANNING	a) ICAR Researcher to Staff Research Council to Director of Institute to Funding Agency	a) Researcher to Regional R&D Consortia to PCARRD through its Nat'l Commodity R&D Teams and TAC	a) Researcher to Director of Institute	Researcher to Internal Review at Institute to Research Planning Committee to Research Bureau
	b) University Researcher to Research Review Committee to Director of Research to Funding Agency	b) Researcher of Department of Agriculture to BAR Research Coordinating Comm. (RCC) to PCARRD	b) Researchers to R & D Division of Council	
IMPLEMENTATION & COORDINATION	Directors of ICAR Institute and Director of Research at Universities	BAR/PCARRD Regional R&D Teams Director of Research of Institutes	Coordination Units	Research Management Division
MONITORING, REVIEW AND EVALUATION	Annual Workshops (Coordinated Programmes) National Conferences Annual Action Plan Annual Activity Milestone Scientific Panel Meetings Management Committee Meetings Regional Committee Meetings Quinquennial Review Teams	RRC and RCC of BAR National Commodity R&D Teams and Secretariat of PCARRD External Evaluation Panels	Research Review Teams of Secretariat	Research Evaluation Committee of Research Management Division

Table 20. Budget per researcher approved for 1986 by AFFRC for different groups of agricultural research institutes

Research Group	Institute	Amount (₦'000)
Group I	National Research Institute of Agricultural Engineering	1440
	National Research Institute of Fisheries Engineering	1440
Group II	Other Institutes	1260
Non Experimental Research	National Research Insitute of Agricultural Economics	910

Source: AFFRC (1986)

Table 21. Examples of coordination units in the Japanese NARS

Name of Coordination Unit	Person Responsible for Cooperation	Specialized Field
Fruit Trees	Director General of Fruit Tree Research Section	Research for the development of technology relating to fruit trees
Agricultural Economics	Director General of the National Institute of Agricultural Economics	Integrated research on the economic problems related to agriculture
Tropical Agriculture	Director General of the Tropical Agriculture Research Center	Research for the development of technology for agriculture, forestry and animal husbandry in the tropics and subtropics

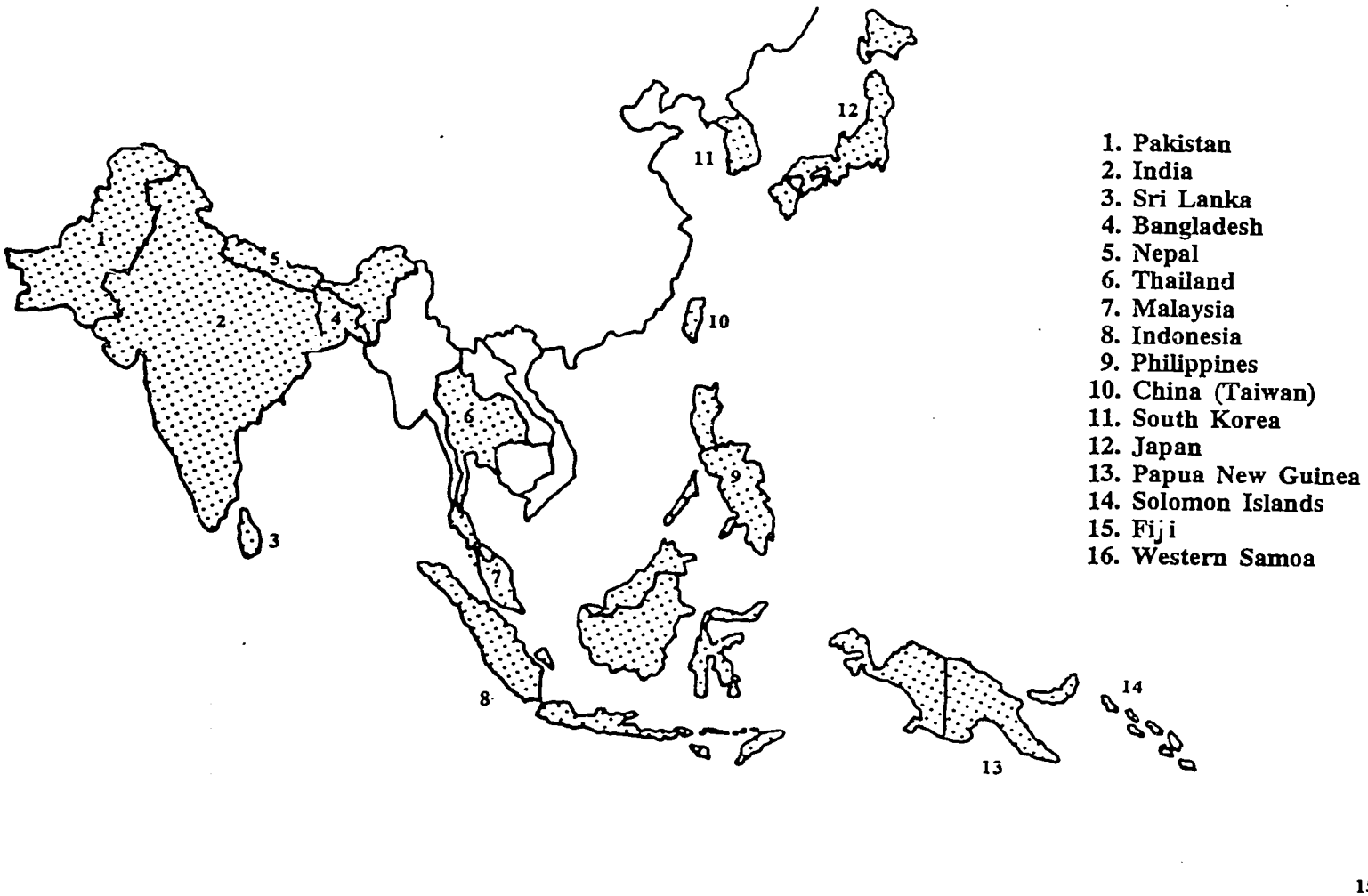
Source: AFFRC (1986)

Table 22. The research-extension links of implementation-level bodies of ICAR operational research projects

	State Level Review Committee	District Coordination Committee	Scientific Consortium	Village Resource and Management Society
Chairman	Agricultural Production Commissioner	District Collector	Director of Research or Extension*	Village Head
Research Link	Director of Research Nodal Scientists**	Nodal Scientists** ORP Scientists	University Scientists	ORP Staff
Extension Link	Director of Extension	Extensionists	----------	IRO Staff
Production Link	Heads of Development Departments	Heads of Development Departments	----------	Progressive farmers Other beneficiaries

* Refers to State Agricultural University
** Refers to scientists associated with the watershed of the State

Fig. 1 Geographic location of countries of Asia and the South Pacific Islands considered in review



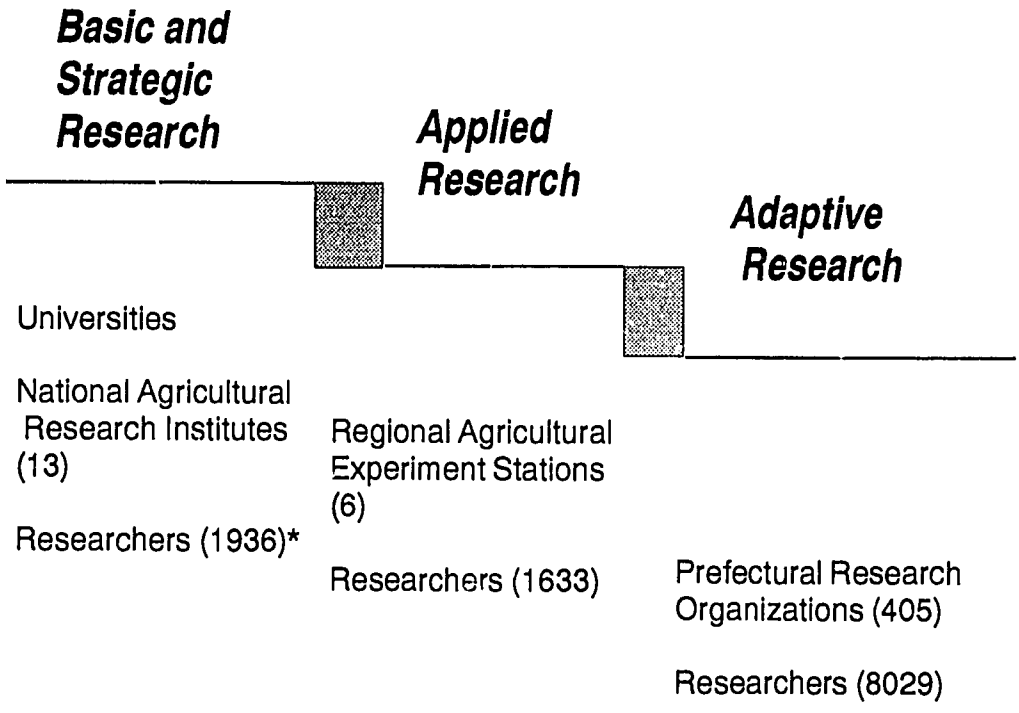


Fig. 2 Range of responsibility of different kinds of strucutures according to types of research in the NARS of Japan. Shading indicates overlapping responsibilities.

* Excludes university researchers

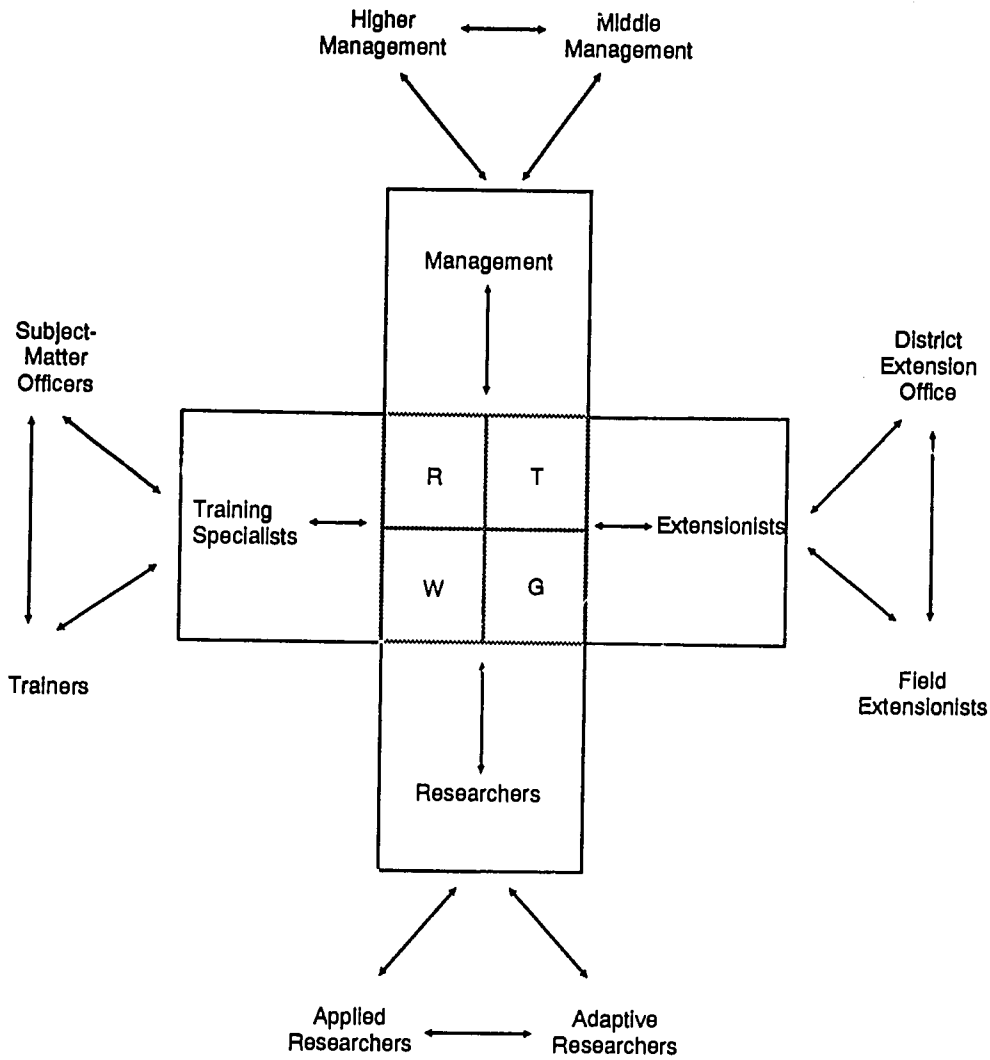


Fig. 3 The Regional Technical Working Group (RTWG) as a coordinating structure for communication and priority setting between management, research, extension, and training in Sri Lanka

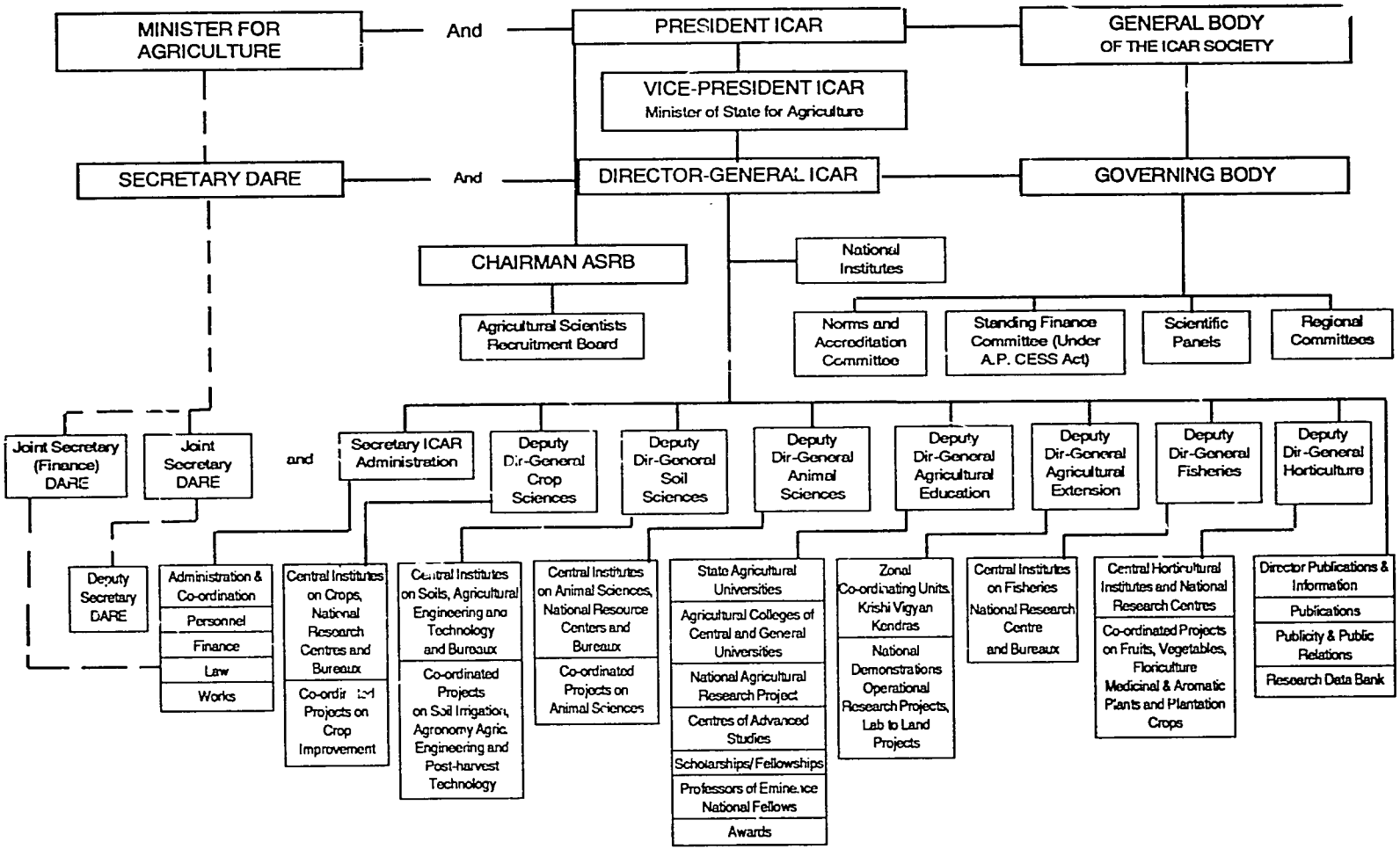


Chart 1. Organization of Department of Agricultural Research and Education and Indian Council of Agricultural Research, 1986

Source: Subba Rao.

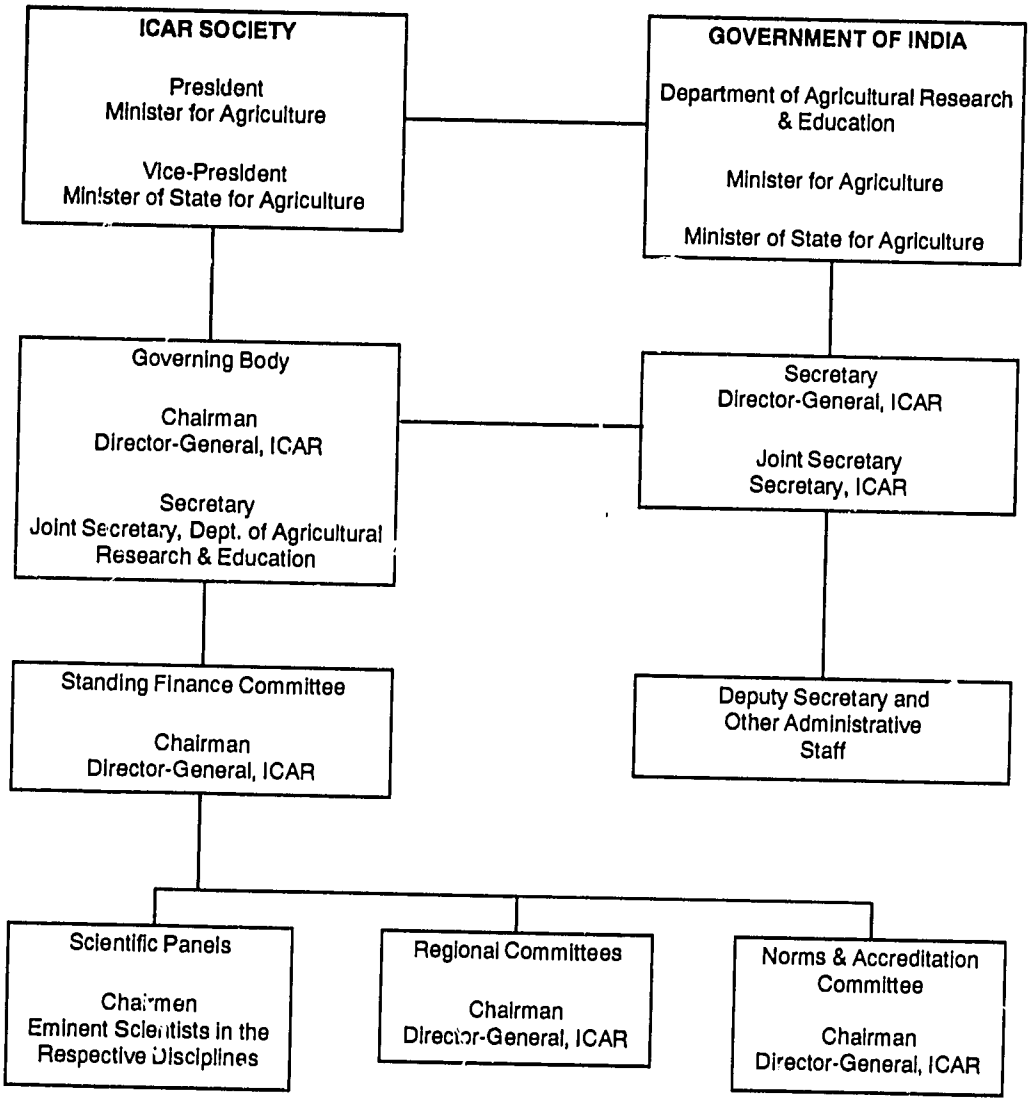


Chart 2. Present structure of ICAR with its linkage with the government of India

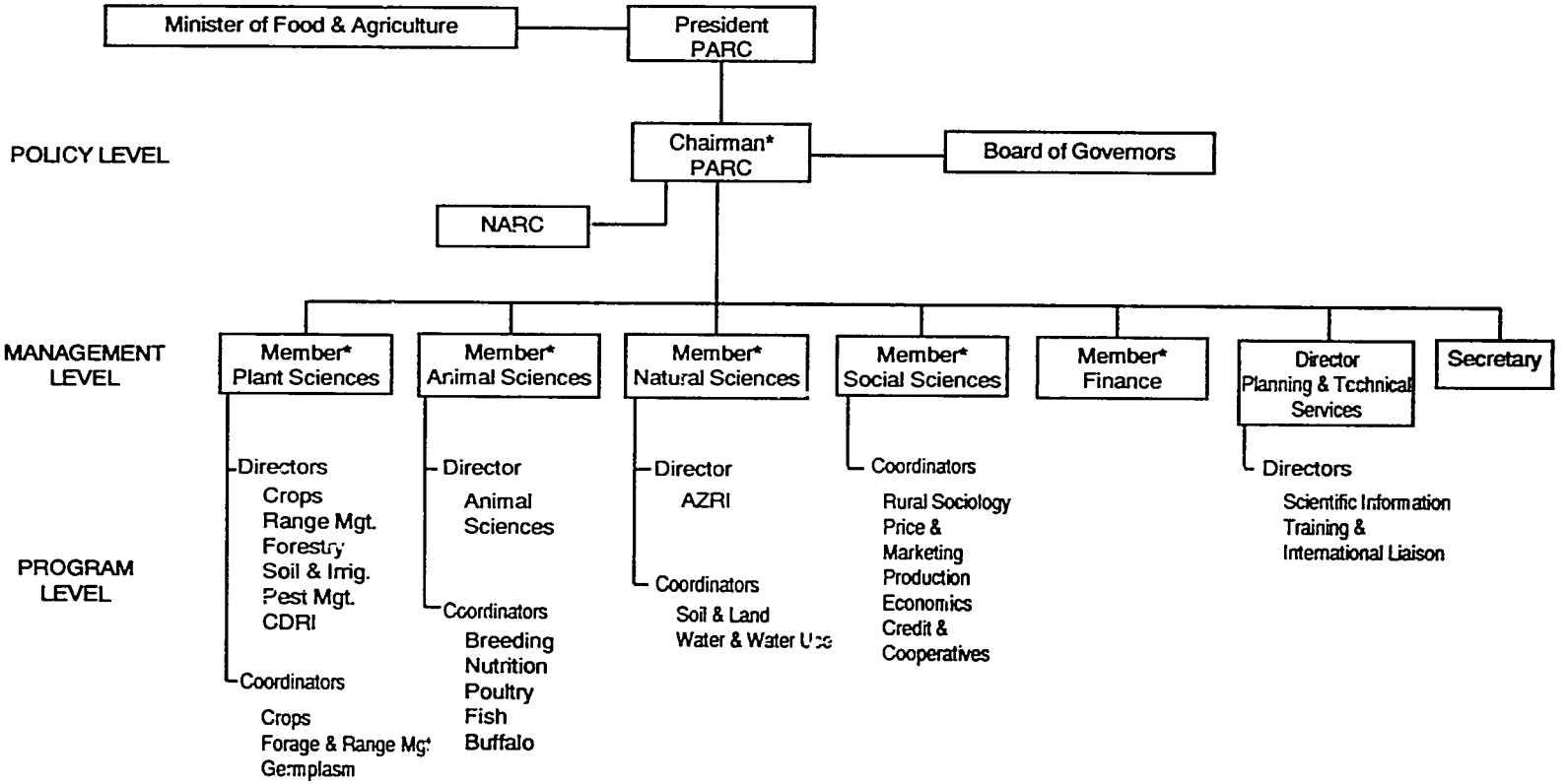
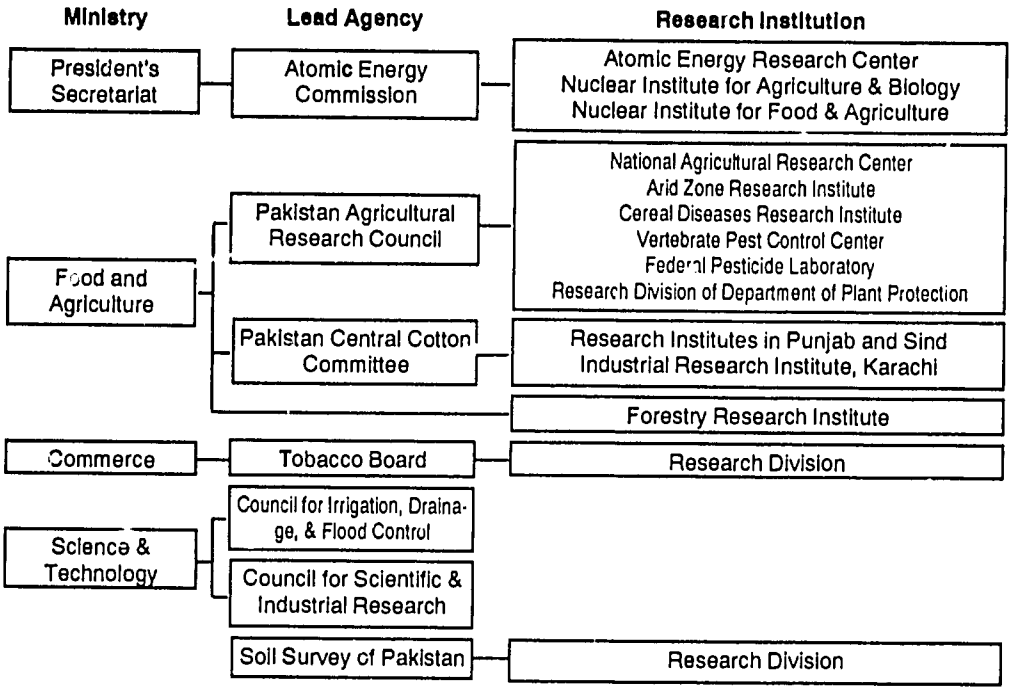


Chart 3. Organizational structure of the Pakistan Agricultural Research Council

SOURCE: Based on information in FAO (1987).
*Constitutes a six-member executive board
NARC = National Agricultural Research Center
CDRI = Cereal Disease Research Institute
AZRI = Arid Zone Research Institute

A. FEDERAL RESEARCH INSTITUTIONS



B. PROVINCIAL RESEARCH INSTITUTIONS

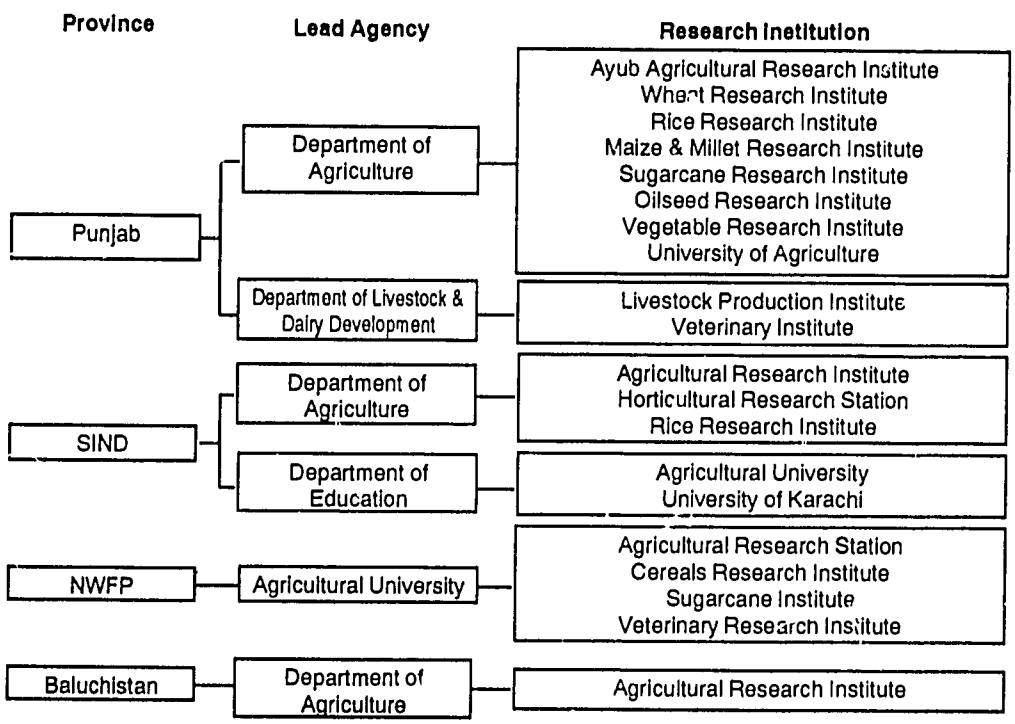


Chart 4. Fragmented distribution of principal agricultural research institutions in Pakistan

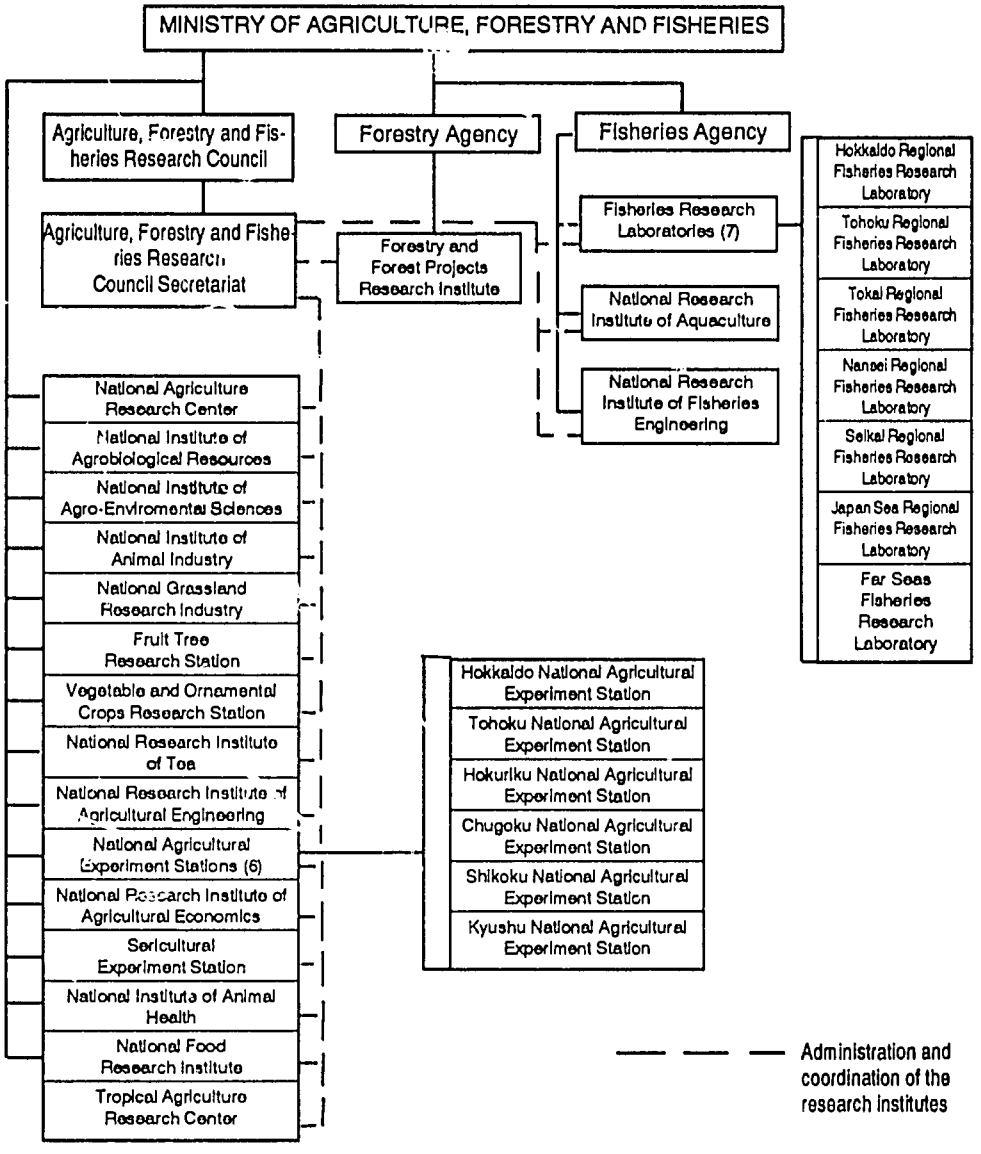


Chart 5. Organization of the research system affiliated with the Ministry of Agriculture, Forestry and Fisheries in Japan

FAO (1986) RAPA Pub. 1986/17.

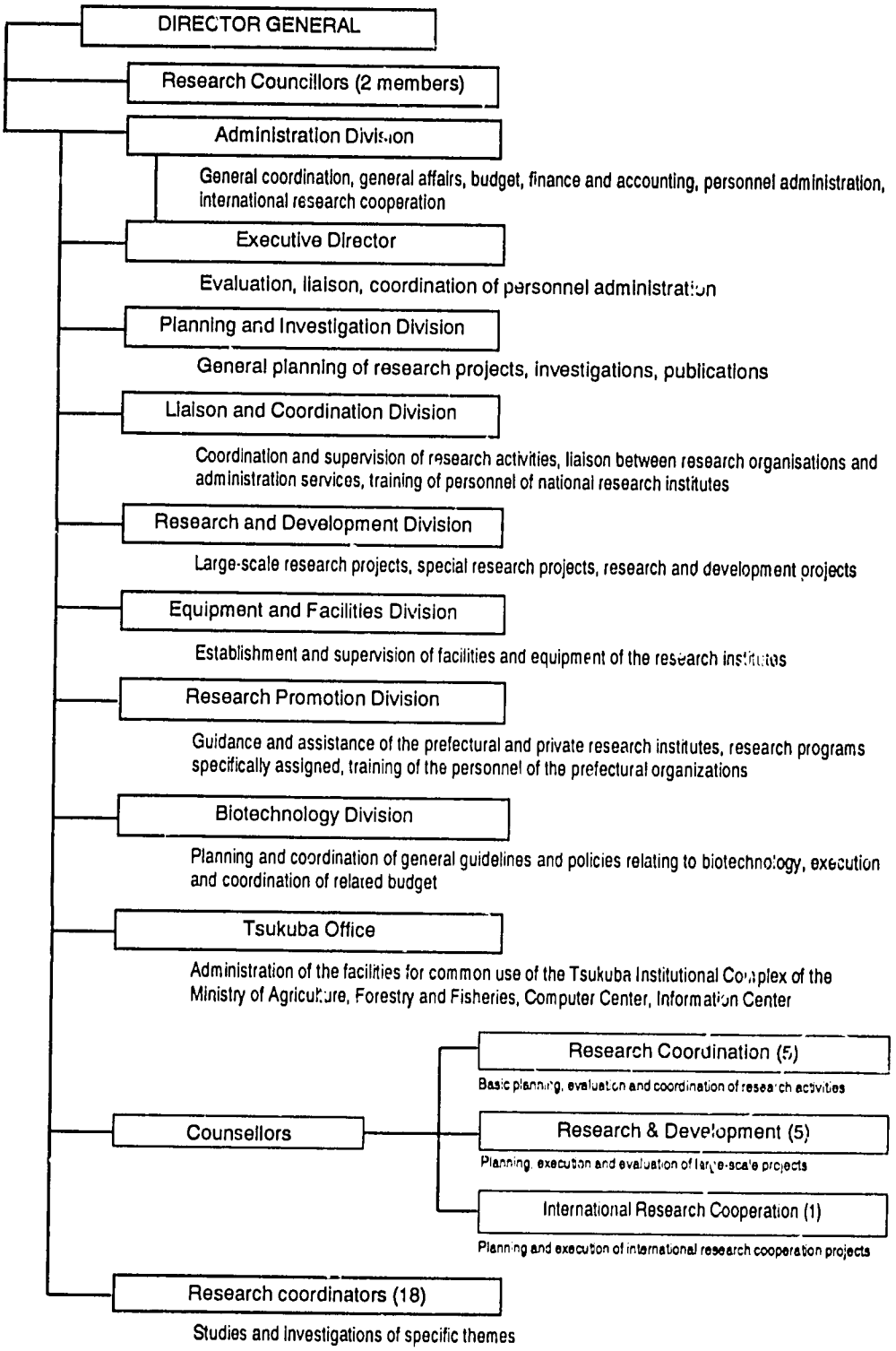


Chart 6. Organization and Functions of the Agriculture, Forestry and Fisheries Research Council Secretariat of Japan

Source: FAO (1986) RAPA Pub. 1986/17.

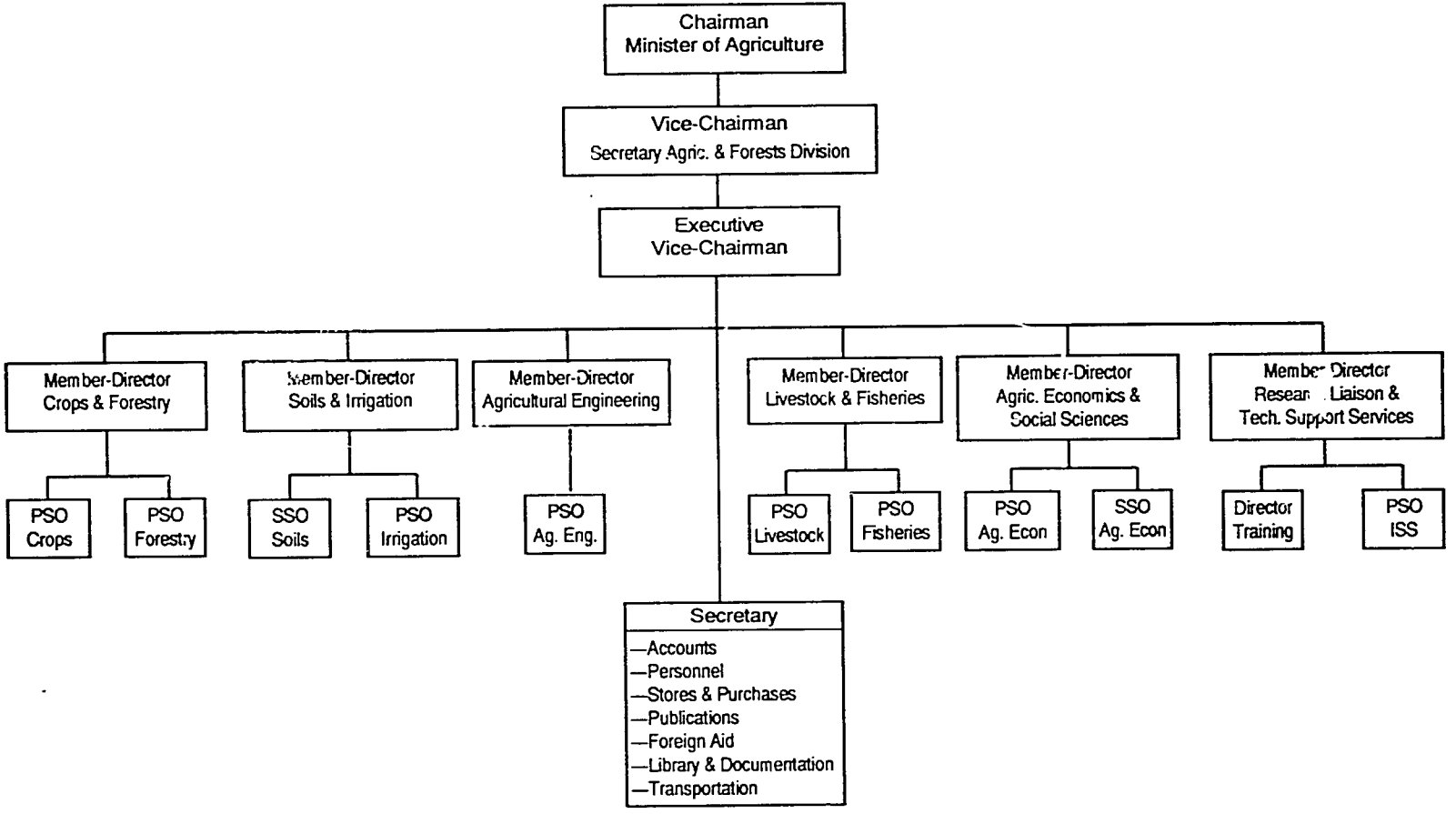


Chart 7. Organizational chart of the Bangladesh Agricultural Research Council

SOURCE: FAO (1986).
PSO = Principal Scientific Officer
SSO = Senior Scientific Officer

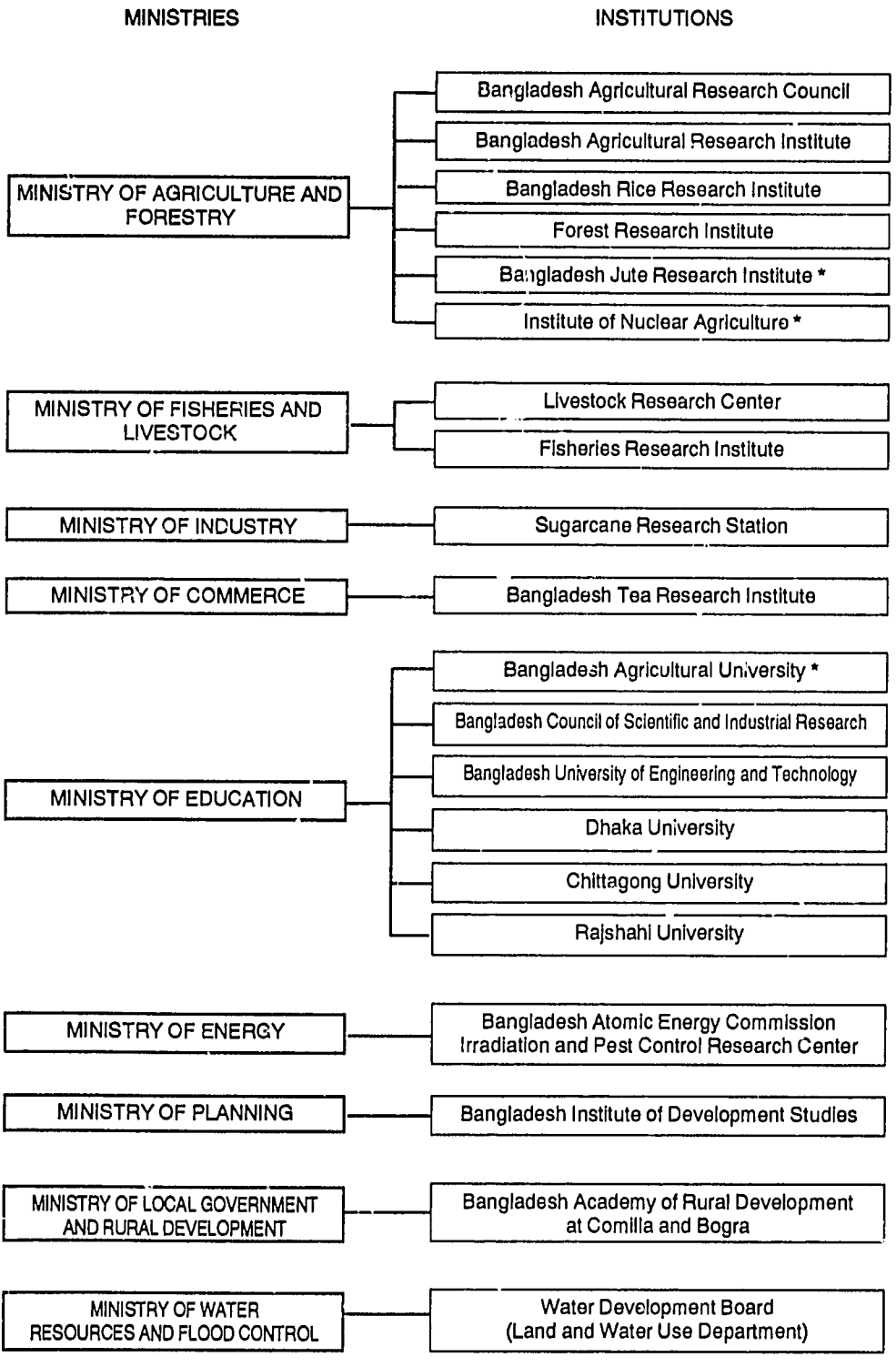


Chart 8. Institutions conducting agricultural research in Bangladesh in 1986

*Relocated from two other ministries since 1985.
Source: FAO (1986) Horticultural Research Project
Pray and Anderson (1985).

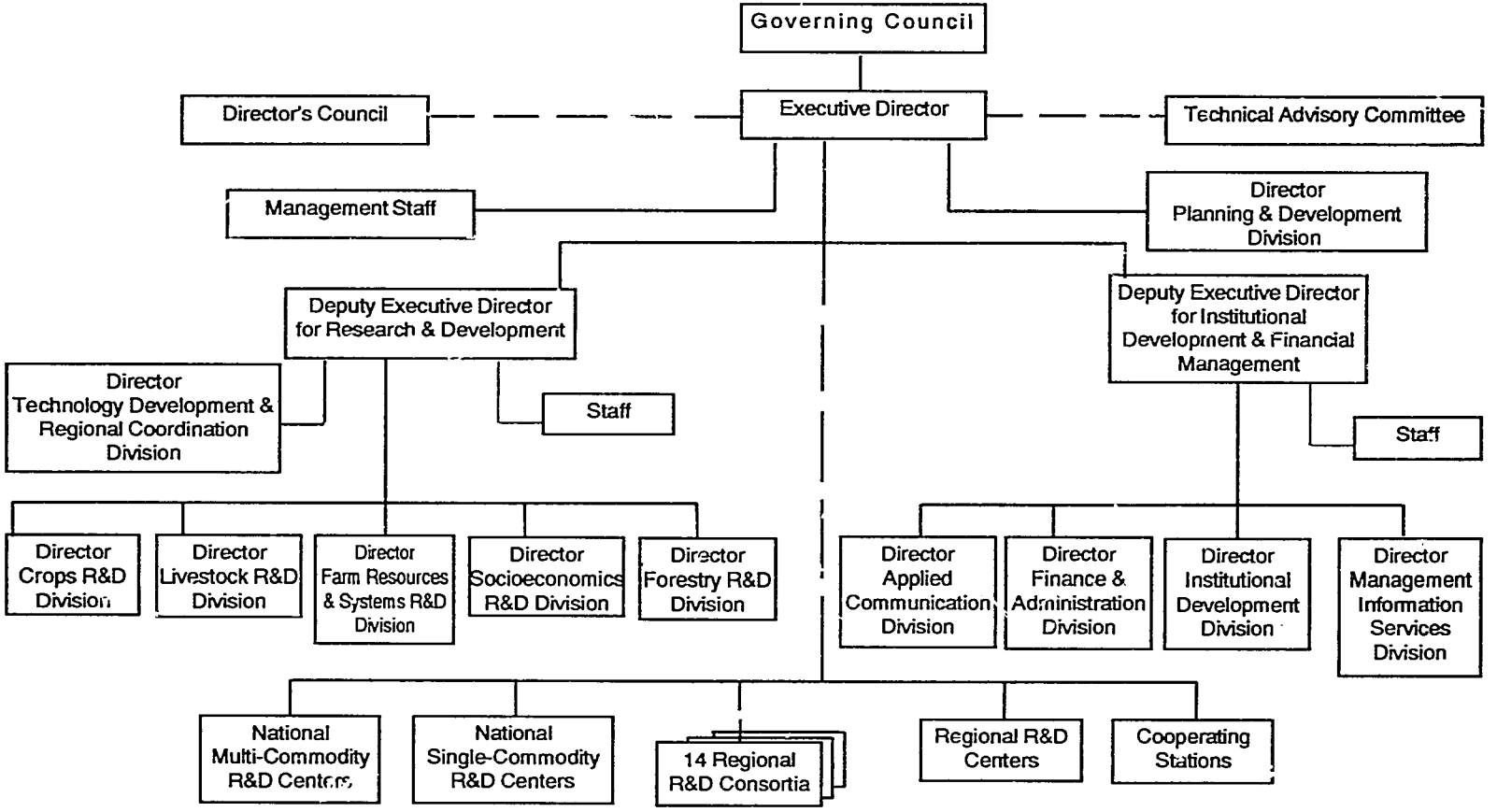


Chart 9. The organization of the Philippine Council of Agriculture, Forestry and Natural Resources Research and Development

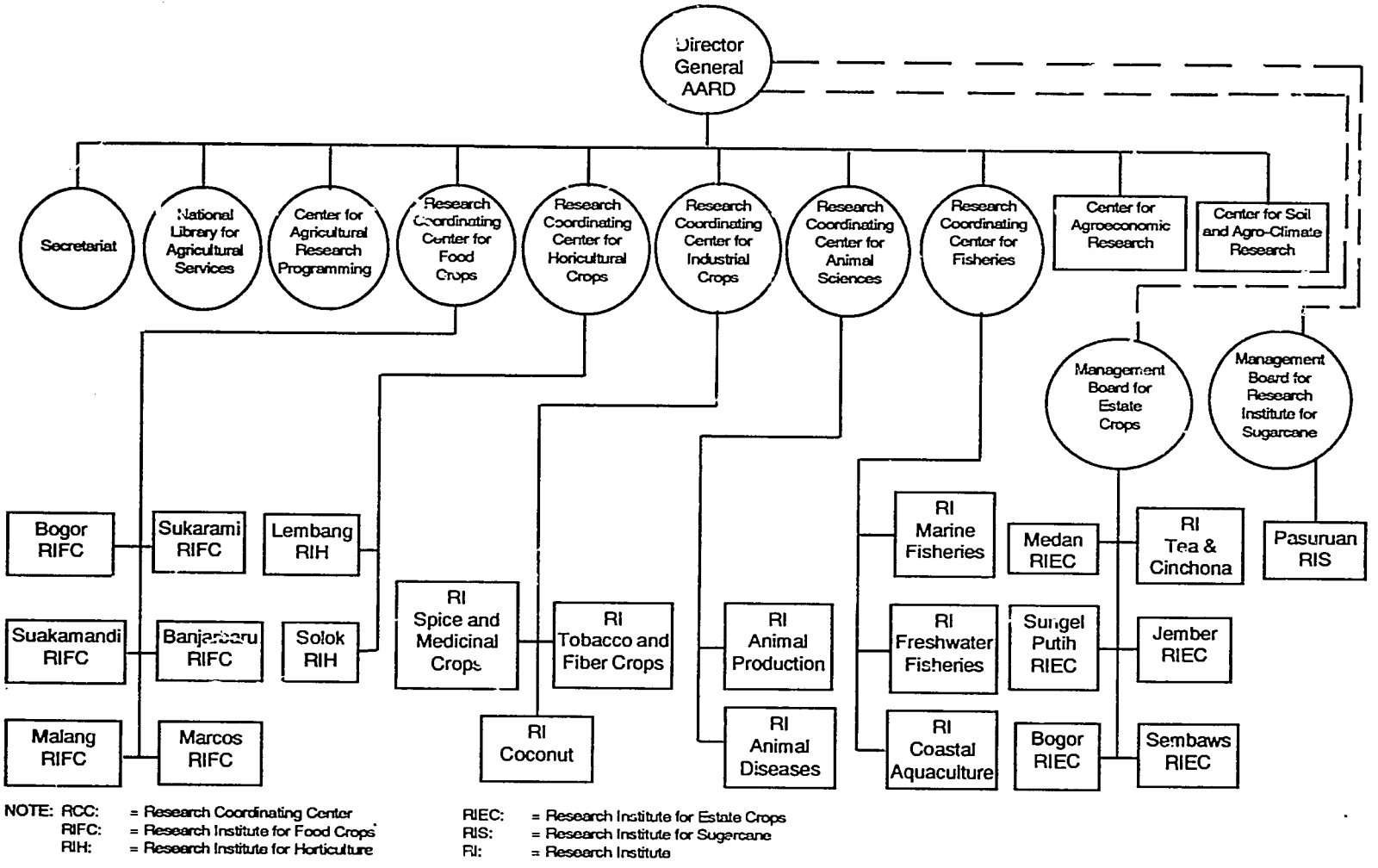


Chart 10. Organizational structure of the Agency for Agricultural Research and Development (AARD) in Indonesia

Source: AARD (1987).

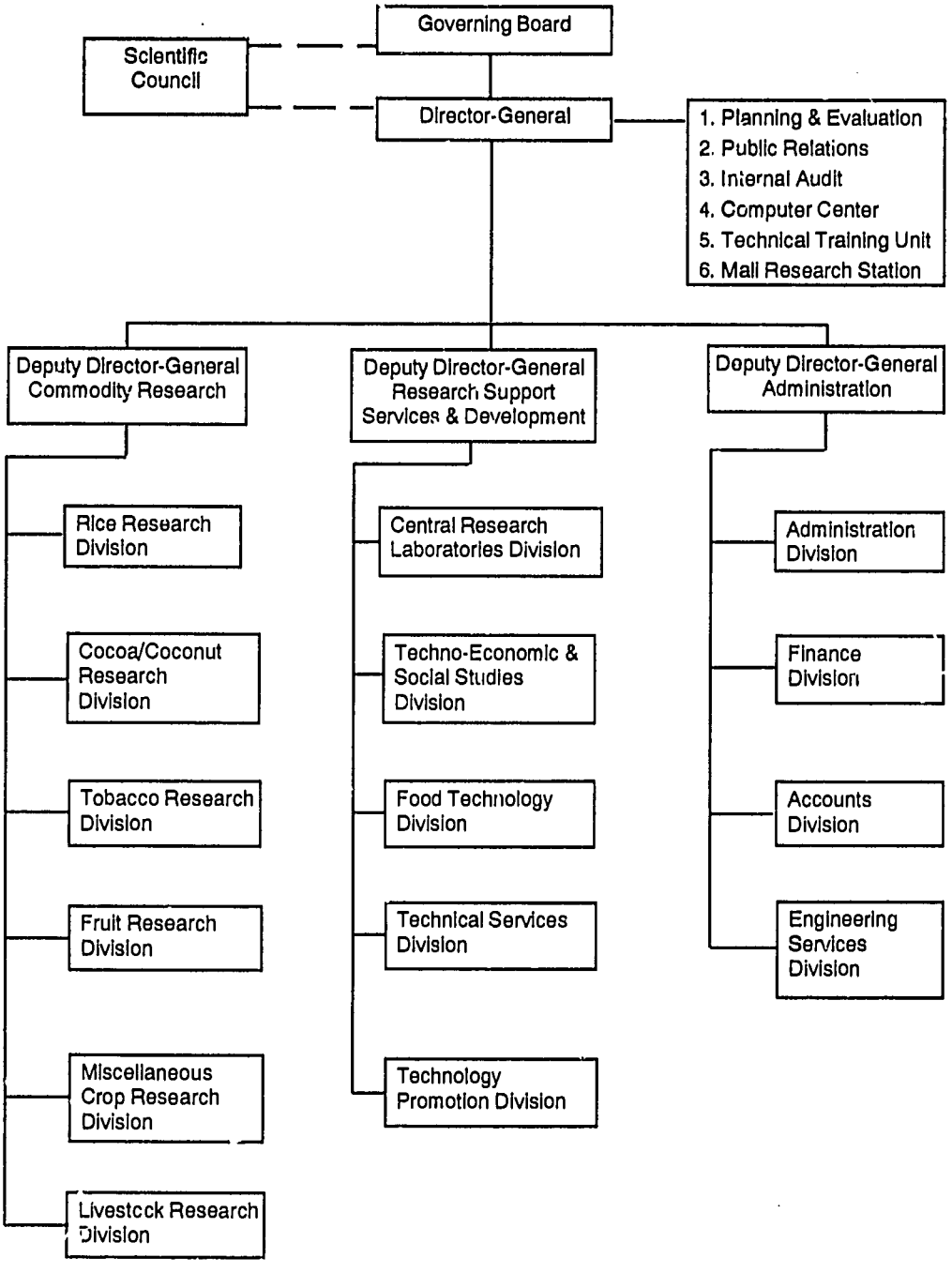


Chart 11. Organization of the Malaysian Agricultural Research & Development Institute

SOURCE: MARDI in Brief.

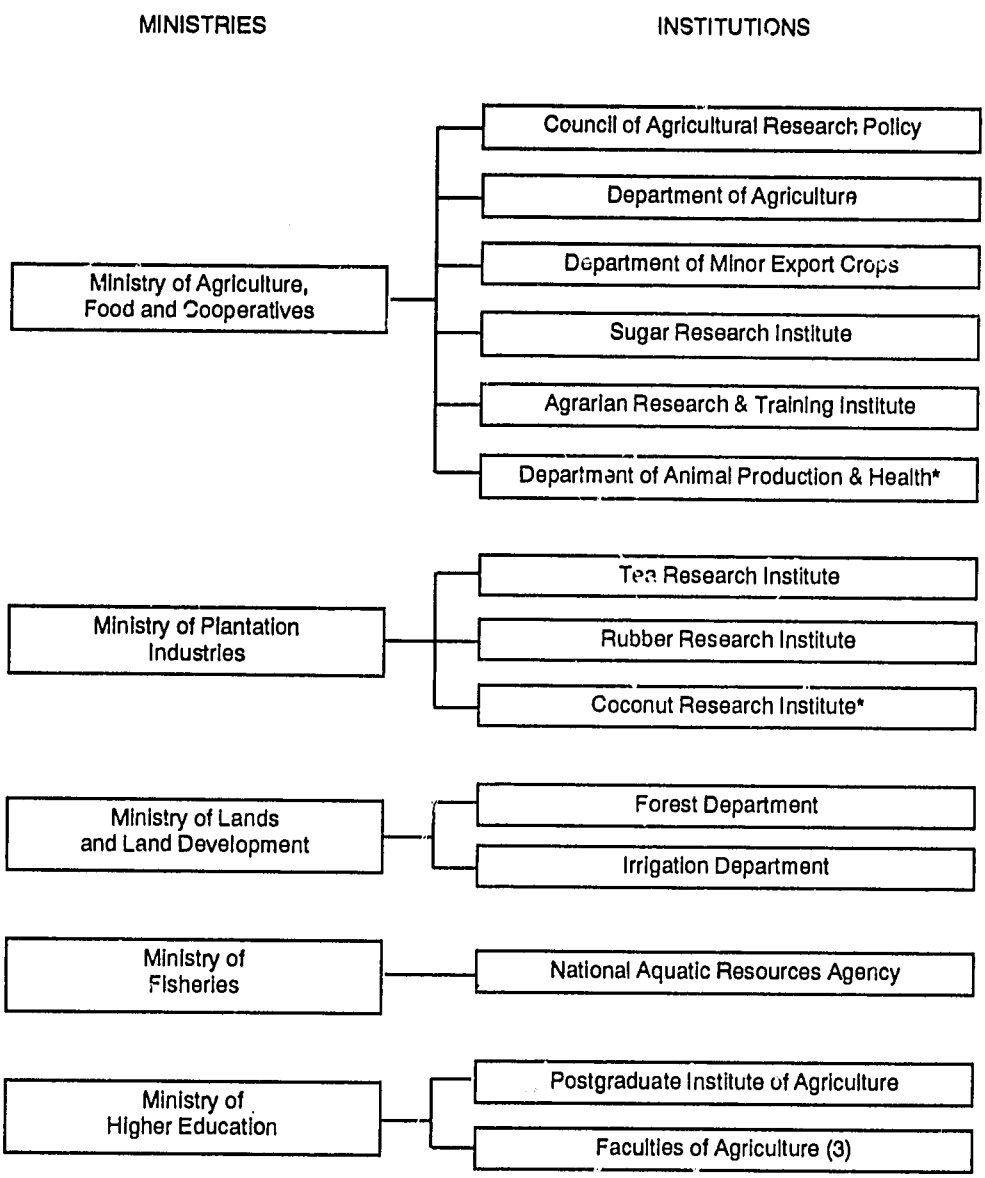


Chart 12. Institutions conducting agricultural research in Sri Lanka in 1989

*Relocated from another ministry since 1989.

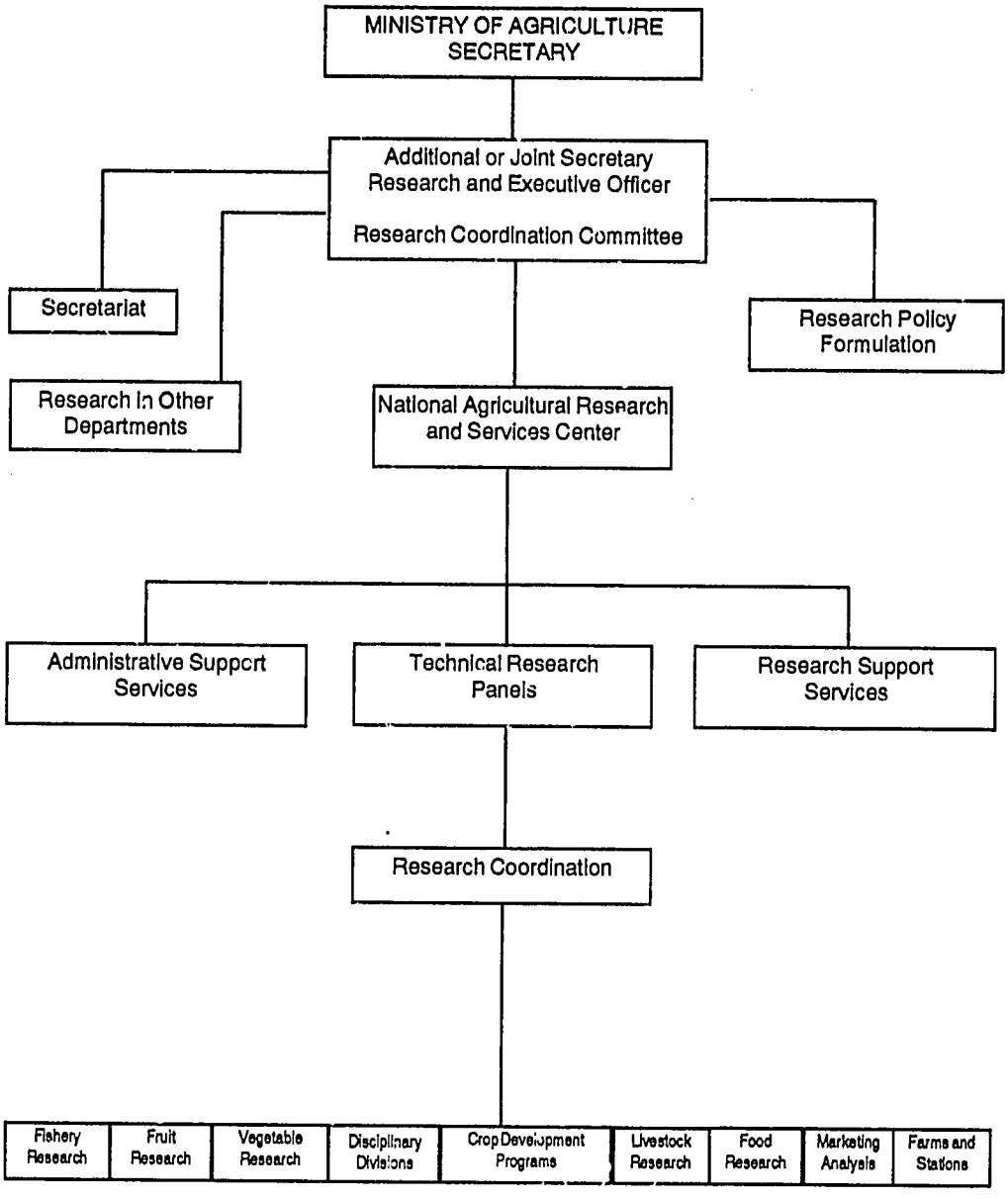


Chart 13. Functions and Roles of the Research Coordination Committee and National Agricultural Research and Services Center in Nepal in 1988

Source: Kayastha et al. (1989).

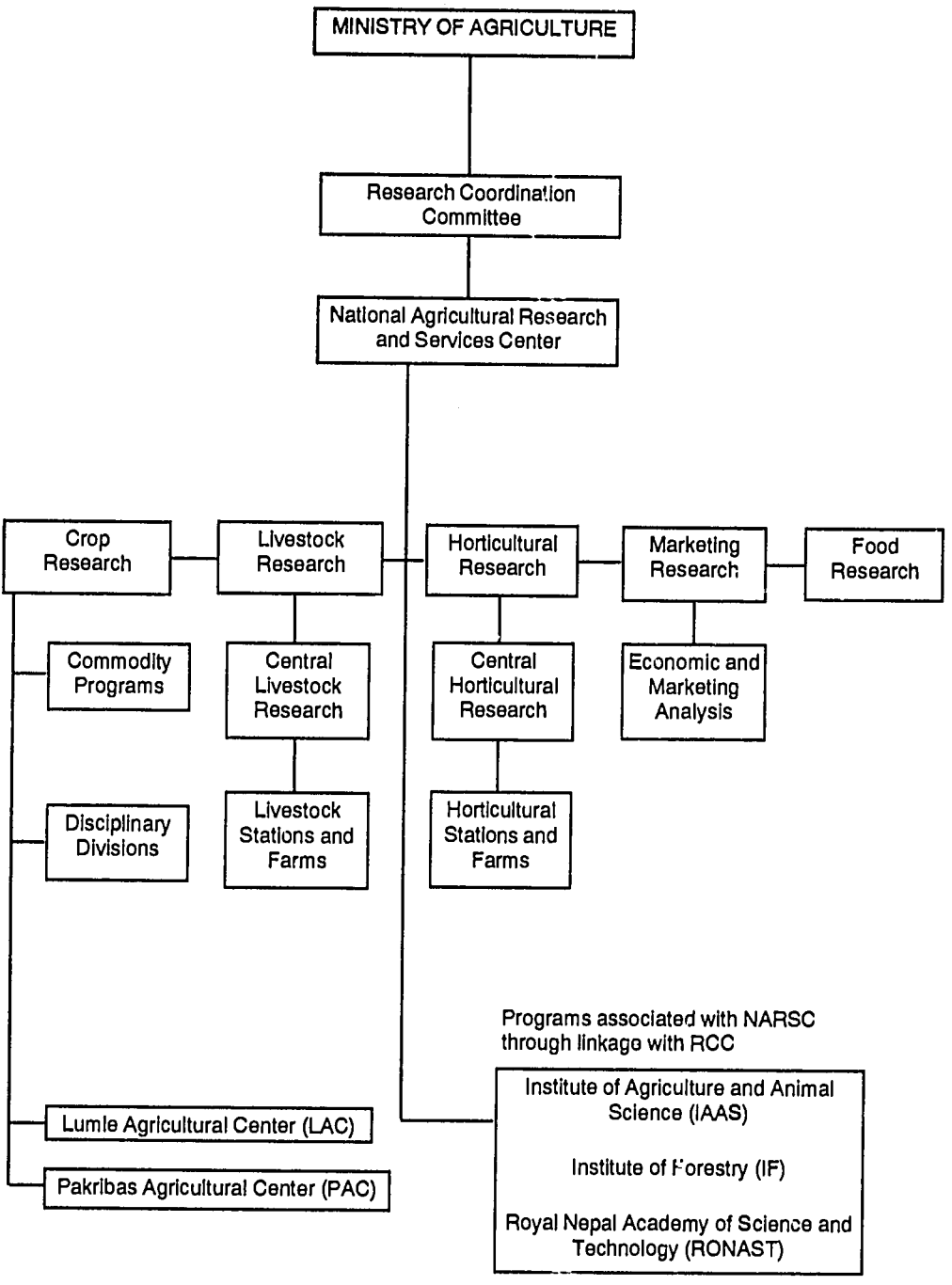


Chart 14. Organization and Structure of the National Agricultural Research and Services Center in Nepal in 1988

Source: Kayastha et al. (1989).

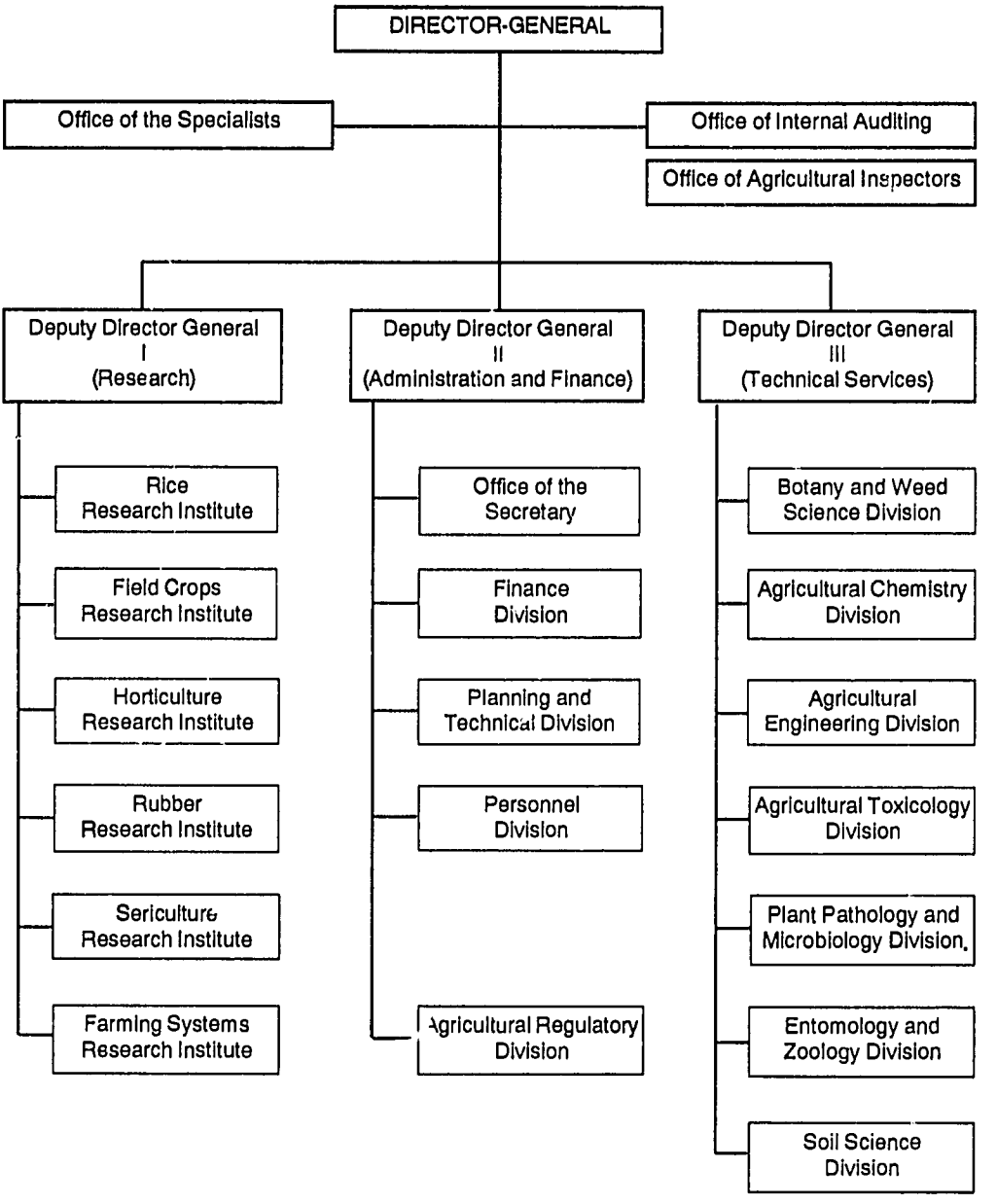


Chart 15. Organization of the Research System in the Department of Agriculture, Thailand

Source: FAO (1986).

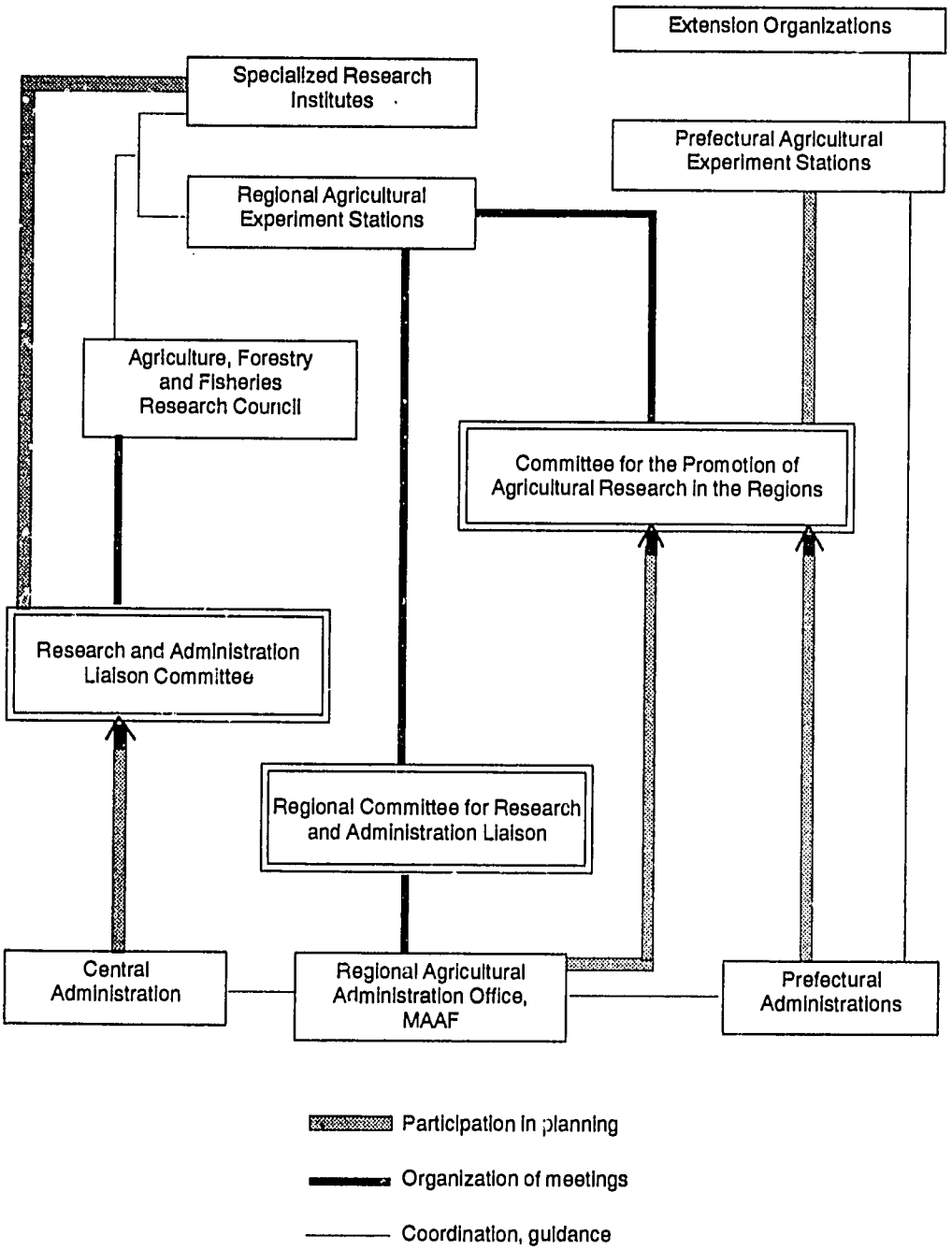


Chart 16. Linkage mechanism between the administration, research institutes and extension organizations in Japan

Source: AFFRC (1986).