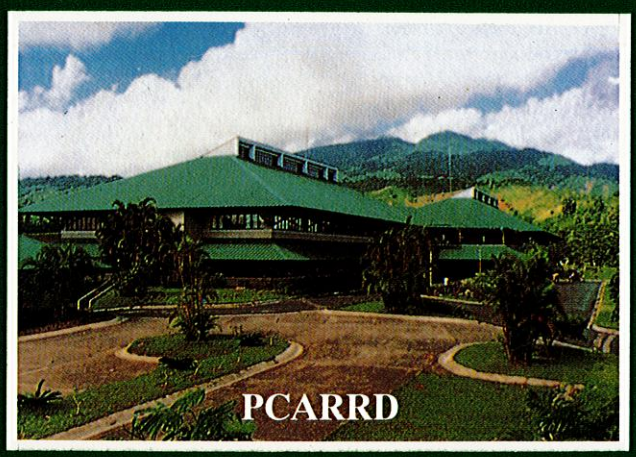
APAARI Publication: 1995/6

SUPPORT FOR AGRICULTURAL RESEARCH SYSTEM IN SOUTH-EAST ASIA

- IMPACTS ON GROWTH AND DEVELOPMENT

by

WILLIAM D. DAR



ASIA-PACIFIC ASSOCIATION OF AGRICULTURAL RESEARCH INSTITUTIONS
FAO REGIONAL OFFICE FOR ASIA & THE PACIFIC
BANGKOK - 1995

APAARI Publication: 1995/6

SUPPORT FOR AGRICULTURAL RESEARCH SYSTEM IN SOUTH-EAST ASIA

- IMPACTS ON GROWTH AND DEVELOPMENT

by

WILLIAM D. DAR

ASIA-PACIFIC ASSOCIATION OF AGRICULTURAL RESEARCH INSTITUTIONS
FAO REGIONAL OFFICE FOR ASIA & THE PACIFIC
BANGKOK - 1995

For Copies Write To: **The Executive Secretary**
Asia-Pacific Association of Agricultural Research Institutions (APAARI)
FAO Regional Office
Phra Atit Road, Bangkok 10200
Thailand

Typesetting and Lay out of Publication: Jiraporn Kruaval

Printed in September 1995

CONTENTS

LIST OF TABLES

FOREWORD

Research and technology are the cornerstones of sustainable agriculture and rural development. Having recognized this, the Asia-Pacific countries have been establishing or strengthening their national agricultural research systems (NARS). But there are great variations in the organizational pattern and effectiveness of the NARS, thus presenting an opportunity for sharing the successful experiences. Further, based on the premise that the problems faced by most of the countries in their agricultural production and development are fairly common, it is natural for the countries in the Region to establish strong and viable research infrastructure and systems and cross-fertilise their experiences.

In the fast changing world agricultural scenario, National Agricultural Research Systems (NARS) in developing countries are confronted invariably with major issues such as: conservation of biodiversity, improved food security especially in the Low Income Food Deficit Countries (LIFDC), increased Household Nutritional Security, Sustainable Agriculture and Rural Development (SARD), Post-GATT agreement and globalization of agriculture, and above all the Agricultural Human Resources Development (AHRD). Many developing nations in the Asia-Pacific Region are addressing these issues in all earnest. Strategies and national policies are also being put into operation in order to have effective remedial measures before it is too late.

In the process, it is becoming evident that no individual NARS has the capability to deal with most of the emerging challenges independently. Even vision of NARS towards well-established centres is changing and issues such as partnership role and devolution are being pursued vigorously. Also it is being convincingly felt that through Technical Co-operation among Developing Countries (TCDC), NARS could build their capabilities more effectively for technology generation, assessment and transfer. Unfortunately, many NARS in the different regions have not been able to yet devise suitable mechanisms/networks through which they could derive benefits from the strengths of one another. Even, information concerning strengths and weaknesses of different NARS in the region is not available at one place.

In view of the above, this publication of APAARI relating to Support for Agricultural Research Systems in South-East Asia by Dr. William D. Dar is a timely step in the desired direction. I congratulate Dr. R.S. Paroda, Executive Secretary, APAARI for his initiative and vision to bring out a number of such useful publications. I hope this publication would serve a useful purpose to all those concerned with research and development of agriculture in the region.

A.Z.M. Obaidullah Khan
Assistant Director General and
FAO Regional Representative for
Asia and the Pacific

SUMMARY

This paper provides a critical assessment of the agricultural research management system of eight countries in the Southeast Asian Region and two countries in the East Asian Region. The analysis is basically a comparison of these countries' agricultural research systems in terms of their evolution, the support system, the determination of agricultural R & D priorities, funding of agricultural R & D, linkage mechanisms, and impact of agricultural R & D.

An updated profile of the agricultural research system of these countries is included.

I. INTRODUCTION

The Southeast Asian Region is composed of countries that lie between the Tropic of Cancer and the Equator and spreads from Indonesia to the Philippines in the east and to Myanmar in the west. The Region has a total land area of 434 million hectares of which 18 percent is devoted to agriculture. The agriculture sector predominates the economy of these countries. However, the potential for economic takeoff particularly for some of the more economically advanced countries will likely change the region's economic structure to a more industrial orientation.

The Region is endowed with vast natural resources that make it one of the resources-rich area in the world. These resources have enabled the Region to become the major producer of rice, rubber, oil palm, coconut, spices, buffalo, finfishes, molluscs, seaweeds, and crustaceans (ADB, 1988).

Despite these, the Region's agriculture sector is characterized by the following (ADB, 1988):

1) consisting of small farms and farmers;
2) unfavorable land/farmer ratio;
3) deteriorating soil, water, and forest resources, lora and fauna, and the atmosphere due to pollution;
4) diverse farming systems;
5) decreasing farm lands due to the conversion of agricultural lands to non-agricultural uses;
6) limited farming capital; and
7) limited agricultural support services such as credit, marketing, research, extension, and post-harvest facilities.

The Region is heavily dependent on agriculture. This is evident in the large proportion of the labor force employed in the sector and in the structure of its exports which is dominated by agricultural crops and processed commodities. Thus, the economic development of the Region is dependent on improvements in its agriculture sector. This is vital since the demand for more food and export earnings from agriculture to support industrialization lies in the modernization of the agriculture sector. Even with the move of some of the countries in the Region to shift to industrialization, the agriculture sector will continue to play an important role in this process, for agricultural and economic growth are closely related in the economies of Southeast Asia.

The development of the agriculture sector will be influenced to a large extent by improvements in production efficiency. This must be achieved despite the increasingly limited area available for agriculture and the adverse weather condition. The task to improve agricultural productivity will depend on the development and use of appropriate technologies.

The conduct of research and development (R & D) in the agriculture sector is geared towards increasing productivity, enhancing sustainability through proper resource management, and in providing information for the improvement of the policy environment (ADB, 1988). Historically, a strong agricultural research capability is essential to sustain a dynamic agricultural and economic growth, for new technology provides the means to efficiently convert land and water endowments into products beneficial to the economy and in increasing food availability and improving the nutrition level, providing the raw materials for other sectors of the economy, and generating foreign exchange. Economically, this is evident in the high rates of return of agricultural research investments which often exceeds 25 percent (Pinstrup - Andersen, 1982).

Enhancing the contribution of agricultural R & D for economic development requires the establishment of a committed and strong research management system that is able to harness and utilize resources for effective management of R & D in agriculture supportive to national development goals. R & D must relate and contribute to the achievement of national development goals for it to become relevant and effective. Realizing this role, most countries in the region have established strong national agricultural research systems (NARS). These NARS have been able to promote the effective and efficient conduct of agricultural R & D, and have generated better technologies that consequently increased agricultural productivity. However, much remains to be done. The changing economic landscape of the region coupled with the complexity of agriculture necessitates that the NARS in the Region be able to face the challenges of producing more food in an increasingly limited area at the same time ensuring the sustainable use of the Region's agricultural production environment.

II. FOCUS OF THE RESEARCH

This paper aims to critically assess the research management systems in the region in the following areas:

a) Agricultural research management systems and their linkages with development agencies;

b) Existing apex system, other infrastructure and system support;

c) Funding support for agricultural research in the context of agricultural gross domestic product (GDP) and analysis of possible returns from expenditure on research;

d) Impact of investment on agricultural research on overall agricultural development;

e) Relative comparison of the agricultural research management scenario in the region; and

f) Suggestions for future improvements including policy issues and overall directions.

The research was based primarily on available literature on agricultural management system in the region. It covers 10 countries, eight of which are in Southeast Asia, namely: the Democratic Republic of Cambodia, the Republic of Indonesia, the Lao People's Democratic Republic, the Government of Malaysia, the Union of Myanmar, the Republic of the Philippines, the Government of Thailand, and the Socialist Republic of Vietnam. Two countries from East Asia, the People's Republic of China and the Republic of Korea, are also included in the research.

Analysis of the data gathered is based on a descriptive comparison of the agricultural research management systems of these countries, with due consideration to their unique characteristics and prevailing situation. Limited information were gathered from socialist countries included in the study. Focus was given to public sector involvement in agricultural R &D activities since data on private sector involvement is often unavailable.

The research expanded and updated, in some instances, previously available information on the agricultural research system of these countries (*Please see the Appendices*).

III. EVOLUTION OF THE NATIONAL AGRICULTURAL RESEARCH SYSTEM

A. History

Agricultural research in the Southeast Asian Region began at the turn of the twentieth century. This was initiated by the colonial administrations prevalent in the Region during that time. Early research

efforts were done through the establishment of botanical gardens. These gardens were involved in the acquisition, screening, and field testing of new plant materials that were needed to support the emerging plantation economies in the Region. Emphasis was placed on commercial crops for export such as rubber, tea, coconut, sugarcane, and palm oil, among others. Private estate companies which operated large plantations for these crops also invested on their own research activities for these crops. During this early part of research evolution, the private sector's involvement in research activities was quite significant and was often complemented by research agencies established by the colonial administration.

The growing importance of these export crops prompted the establishment of commodity-oriented research institutes. Among the early research institutes established dealt with sugarcane, tea, and coffee in Indonesia and rubber in Malaysia. In the other countries, the establishment of research facilities took place during the first 10 years of the twentieth century. Except for Thailand, which was not subjugated by any colonial power, a research station was established in 1915 when the Thai monarchy took full responsibility for agricultural modernization (APO, 1983).

After the Second World War, when most of the Southeast Asian countries regained their independence, interest in food production and achieving food self-sufficiency became high priority in the development plans of these countries. However, the transition to independence and the reconstruction from the ravages of war preoccupied much of the political priorities during that time (Senanayake, 1990). Little progress was made in pursuing the momentum gained from the research activities done previously. While this limited the growth of research in these countries, the situation was aggravated by the exodus of foreign manpower which manned the research institutes and the inadequacy of agricultural educational institutions to provide the needed manpower to undertake research activities.

The development of high yielding varieties (HYVs) and improved crop production management in the 1960s gave birth to the "Green Revolution". It made countries realize their capacity to break the bond of subsistence agriculture and increase farm productivity. Policy makers, likewise, became aware of the importance of agricultural research in averting food shortages and starvation. This event triggered an increase in resources committed to agricultural research and transformed the orientation and structure of most research institutes in the Region. Moreover, it prompted most of the governments in the Region to establish their respective networks of research facilities and linkages with International Agricultural Research Centers (IARCs), such as the International Rice Research Institute (IRRI), aimed at improving their capabilities to increase farm productivity and ensure food sufficiency. These later on transformed into coordinated systems each managed by an apex organization which became known as the National Agricultural Research Systems (NARS).

B. Organization

As early as 1957, a NARS was already established in China (**Table 1**). This was followed by Korea, Malaysia, the Philippines, and Indonesia which established their NARS in 1962, 1969, 1972, and 1974, respectively. Thailand established its NARS much later in 1981 when the Department of Agriculture (DOA) was founded, mandated to carry out various crop researchers. The National Agricultural Research Project (NARP) was instrumental in the institutionalization of the NARS. The Socialist Republic of Vietnam operates its NARS through the Scientific Council under the Department of Agricultural Science and Technology (ADB, 1988).

Both the Lao People's Democratic Republic and the Union of Myanmar have their respective network of research institutes but they are characterized as fragmented and limited in scope. They have no coordinating system to oversee and properly manage the research activities. It is believed that agricultural

research in these countries started only in the 1950s after they had regained their independence. The Democratic Republic of Cambodia has again recently established its agricultural research capability.

TABLE 1. ESTABLISHMENT OF THE NATIONAL AGRICULTURAL RESEARCH SYSTEM

Country	Intial Year of Research Activity	Year of NARS Establishment (Reorganization)
Cambodia		
China	1902	1957
Indonesia	1876	1974 (1979, 1984, 1990)
Korea	1905	1962 (1970, 1985)
Laos	1955	
Malaysia	1905	1969
Myanmar		
Phillipines	1910	1972 (1982, 1986)
Thailand	1915	1981
Vietnam		

Source: APO (1983), Pasandaran (1983), Senanayake (1990), ADB (1988), SEARCA (1977), BAR (1991), Pardey et al. (1991).

TABLE 2. NATURE AND GOVERNANCE OF NATIONAL AGRICULTURAL RESEARCH APEX ORGANIZATION

Country	Nature of Apex Organization	Type of Governance
Cambodia	Ministry Level	Minister
China	Ministry Level	Minister
Indonesia	Autonomous Agency	Director-General
Korea	Autonomous Agency	Director-General
Laos	Ministry Level	Minister
Malaysia	Autonomous Agency	Governing Board
Myanmar	Ministry Level	Minister
Phillipines	Coordinating Council	Governing Council
Thailand	Ministry Level	Minister
Vietnam	Coordinating Council	Scientific Council

Source: APO (1988), Senanayake (1990), Pardey et al. (1991).

There are three types[1] of agricultural research apex organizations in the Region. These are the ministry level, the autonomous agency, and the coordinating council. Majority of the apex organizations in the Region operates under the ministry type **(Table 2)**. Countries having this type of organization are Cambodia, China, Lao PDR, Myanmar, and Thailand. This type of organization represents the most basic NARS model from which the other types of apex organizations have evolved. This type provides for the direct governance of the NARS under the Ministry of Agriculture or its equivalent.

The autonomous agency type of organization is adopted by Indonesia, Korea, and Malaysia. This type allows for greater autonomy in the formulation and implementation of agricultural R & D activities. In Indonesia and Korea, the NARS is governed by the head of the apex organization itself. In Malaysia, however, governance is provided by a governing board, which is not necessarily headed by the lead of the apex organization.

The coordinating council set-up is used in the Philippines and Vietnam. This type is limited to the coordination of national agricultural R & D such as the formulation of R & D programs, and the monitoring and evaluation of these programs. Coordinating councils are not usually engaged in research implementation. The coordinating councils in the Philippines and Vietnam are multi-sectoral councils which provide policy direction to the NARS.

Regardless of the type of apex organization existing in a particular country, the NARS of these countries differ only in the way they are operationally managed. In terms of policy and program formulation, however, all the NARS of these countries are directly linked with the country's politico-economic system. This ensures that research priorities are in line with national development goals. Even for autonomous agency types in Indonesia, Korea, and Malaysia, the apex organization is administratively supervised by the Ministry of Agriculture or its equivalent.

Most NARS in the region are organized along three levels: the national, the regional, and the provincial or location-specific research facilities. The national level research facilities conduct basic and strategic researches of national or long-term importance. The regional level facilities conduct, in most cases, applied researches of regional significance. The provincial or location-specific facilities conduct verification researches and fine-tuning of technologies generated by the national and regional level research facilities. This allows a systematic flow of technology development that is able to suit the technologies developed to a specific production environment. Likewise, it enhances the utility of the technologies developed and establishes specialization of work in the technology development process.

The effective and efficient operation of the NARS in each country in the region greatly depends on a strong apex organization that is able to balance the development needs of a country with its R & D resources. Without this, the specialization of work in the NARS will become disorganized and inefficient.

C. Mandate

The functions of the NARS in the Region are basically classified into the governance function and the research function (Jain, 1989). The governance function includes budget allocation and management, resource management, determining personnel policies, and deciding on centralization. The research function involves the formulation of research policy, research programming, resource allocation, research coordination, program implementation, monitoring and evaluation, and research communication. In the Region, both functions are performed by the apex organizations operating under the autonomous

* [1] *Senanayake (1988) provides for a definition of these types of apex organizations.*

agency type. Coordinating councils perform either function or some of these functions are done by the apex organizations. The ministry type performs these functions in a variety of organizations within the Ministry of Agriculture or its equivalent.

Generally, each NARS is mandated to manage a country's research program and its resources particularly the research manpower and the research infrastructure. In most of the countries in the Region, this role is often limited to research coordination and program implementation **(Table 3)**. This indicates the limited operational capability and clout of most NARS in the Region.

There is, however, an emerging extension of the role of NARS as pioneered by Malaysia which recently added to its mandate the promotion of commercially viable technologies. While this goes beyond the realm of traditional NARS activity, it does promote the effectiveness of the research system by translating research results to technologies then to economic applications with immediate benefits. It adds on rather than undermines the existing system of technology transfer adopted by most NARS in the Region. Recent changes in the NARS activities in Indonesia and the Philippines suggests a move towards this innovation. Although this role is unfamiliar to most NARS in the Region, it does provide an option to accelerate the use of research results and enhance its effectiveness.

Most NARS in the Region function as program implementors and as research coordinators. The implementation of research programs is usually done through the agencies or research institutes comprising the NARS. In countries which have the ministry type of apex organization such as in Cambodia, Lao PDR, and Myanmar, research coordination is either loose or non-existent. This situation does not necessarily undermine the effectiveness of the NARS in those countries due to the simplicity of the research network set-up. Research activities are still conducted but are done by separate sectorally-oriented departments whose functions do not overlap.

Thailand, although operates under the ministry type of apex organization, it has developed a mechanism to enhance research coordination among agencies in the NARS through the NARP. This was done in response to a number of evaluations made of its research system and its growing complexity. In China, the situation is such that the Chinese Academy of Agricultural Sciences (CAAS), does the research coordination although it is also involved in the conduct of research activities.

IV. SUPPORT SYSTEM

The support systems of NARS consist of human resources, research infrastructure, and information resources. The human resources of a NARS are composed of the scientific or technical manpower and the support/administrative staff. The following discussion on the human resource development of NARS in the Region is limited only to its technical manpower. The research infrastructure refers to the research facilities/stations established to conduct R & D activities. The information resources refer to the gathering, dissemination, and communication of research literature relevant to the conduct of R & D as well as technology transfer.

A. Human Resource Development

The scientific or technical manpower of a country's NARS comes from the research institutes of the Ministry/Department of Agriculture and Fisheries or its equivalent, other government Ministry/Department or institutions engaged in agricultural R & D, agricultural colleges/universities, and the staff of the apex organization. Available data, in most cases, indicate only public-sector employed scientific workforce, although a number of agricultural scientific manpower is employed by the private sector in some countries of the Region.

TABLE 3. NARS MANDATE AND FUNCTION

Country	NARS Mandate	Functions of NARS										
		Research Policy for Formulation	Research Programming	Resource Allocation	Research Coordination	Program Implementation	Monitoring & Evaluation	Research Communication	Budget Allocation	Resource Management	Personnel Policies	Technology Commercialization
Cambodia						x						
China			x		x	x		x	x			
Indonesia	Conduct and coordinate agricultural research to support national development	x	x	x	x	x	x	x	x	x	x	x
Korea					x	x	x	x				
Laos						x						
Malaysia	Conduct scientific, technological, sociological, and economic research on the production, utilization, and processing of all crops Promote commercially viable technologies		x		x	x	x		x			x
Myanmar	Crop diversification and farming systems research					x						
Philippines	Conduct and coordinate agricultural research to support national development	x	x	x	x	x	x	x	x	x		x
Thailand	Develop the research insfrastructure and manpower	x	x		x	x	x	x				
Vietnam	Increase agricultural productivity to guarantee food supply at adequate nutritional level		x		x	x						

Source: ADB (1988), AARD(1992), Country Profiles (Appendices), Personal Communication (DOA, CARP-AARD, RCARRD).

TABLE 4. NUMBER OF AGRICULTURAL SCIENTISTS/RESEARCHERS

Country	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979 - 1970	1969 - 1960*
Cambodia																
China							61,000		33,454					20,790		
Indonesia	2,821	2,621	2,360	2,348	2,263	1,975	2,254	1,909	1,363			1,389			450	
Korea	**2,000						2,650		**1,004		2,500	1,758		1,296	856	539
Laos															29	
Malaysia	***1,647						1,003		440		708				295	152
Myanmar							267									20
Philippines							3,046	3,046	2,438						1,128	
Thailand							2,012								585	
Vietnam							1,800									

** Average number of those reported during the period.*

*** Includes only ROA researchers.*

**** Includes onlyMARDI researchers.*

Source: ADB (1988), APO (1983), Pardey and Roseboom (1989), Personal Communication (CARP-AARD).

Table 4 presents the number of agricultural scientific manpower in the Region. The largest number of scientific manpower in a NARS is found in the People's Republic of China with 61,000 personnel. Apparently, this is due to the size of the country and its establishment of an extensive network of provincial or location-specific research facilities. The least number of scientific manpower is found in the Lao PDR with some 29 researchers in the 1970s, and is estimated to remain the same until the present (ADB, 1988). The number of research personnel of the NARS is dependent on the magnitude of its research programs and the capacity to provide for its manpower needs. It is essential to determine the quality of research personnel in gauging the human resources of the NARS.

In 1987, the number of scientific manpower among the NARS in the Region ranges from 1,000 to 3,000 personnel. To date, it is estimated that the scientific manpower of most NARS in the Region has doubled this number. This is reflected in the tremendous increase of scientific manpower in the region between the 1960s and 1980s. This serves as an indication of the importance given by the national governments to agricultural R & D.

In Indonesia, Korea, and Malaysia, the bulk of the scientific manpower has advanced degrees. The massive investments in human resources by these countries were aimed to improve their agricultural research capability and make it at par with the world's best. Other countries in the Region have also invested in human resources but not in a sustained manner as was done in Indonesia, Korea, and Malaysia.

B. Infrastructure Development

The research infrastructures among the NARS in the Region consist of the national or central research facilities, regional facilities, and provincial or location-specific research stations. The national research facilities include single-commodity or multi-commodity research stations that cater to agricultural commodities of national importance as well as agricultural colleges and universities that are engaged in national R & D programs. Regional facilities are those that conduct applied research to address the research needs of a major geo-political area of a country and are often multi-disciplinary in orientation. Provincial or location-specific stations are involved in fine-tuning of technologies to suit the needs of a specific area.

These research facilities comprise the research implementing units of the NARS. These facilities conduct researches responsive to national and location-specific needs. Likewise, they operate in a complementary manner with the national and regional research facilities, providing new and adaptive technologies to the provincial stations which in turn provide feedback on the performance of these technologies and the research needs of their clientele.

Table 5 shows the number of agricultural research facilities in the Region. Overall, China has the largest network of national, regional, and provincial research facilities with 59, 359, and 671, respectively. Among the countries in Southeast Asia, the Philippines has the maximum number of national research facilities with 52. However, this number will be reduced further as an offshoot of the station rationalization program of the Department of Agriculture. In terms of regional facilities, Thailand has the maximum number with 132 stations. Indonesia registered the maximum number of provincial stations with 221.

In some countries, such as Korea, Thailand, and Vietnam, adaptive and verification researches are conducted by either the regional or provincial stations. Meanwhile, in Malaysia and Lao PDR, the national stations perform the whole spectrum of activities in the technology development process. Recently Cambodia, which has again established its research capability, is concentrating on the fine-tuning of available technologies provided, particularly by the IRRI.

TABLE 5. NUMBER OF AGRICULTURAL RESEARCH INFRASTRUCTURE IN THE REGION

Country	Type of Research Facility *		
	National	Regional	Provincial or Location Specific
Cambodia			
China	59	359	1,271
Indonesia	35	10**	316
Korea	15		9
Laos	3		
Malaysia	25		
Myanmar	4	16	54
Philippines	52	94	143
Thailand	36	132	
Vietnam	2	40	

* *Includes Agricultural Colleges and Universities.*

** *Still Finalizing the Establishment of an Additional 17 Regional Research Institutes.*

Source: ADB (1988), Personal Communication (CARP-AARD).

C. Information Resource Development

The increased investment in agricultural research during the last three decades has produced an explosion of new agricultural information and knowledge. This requires careful and deliberate management in order to enhance its utility to the research system. The rate in which new research results are generated increases the pressure of previous information becoming obsolete within a relatively short period of time. Likewise, the growing complexity of information transfer requires a system that would aid in the effective management of this increasingly important new resource information.

The research system, in order to become effective, must have sufficient manpower, infrastructure, and information resources. The interplay of these resources through the research process produces new technologies and information. Thus, information as a resource is both an input and an output of this process. Efforts to manage this resource have, until recently, been initiated by most research systems particularly the IARCs. This is due to the increasing complexity of acquiring and transferring information, and its rapid turnover.

Information resource support system is essential to a research system. The information support system is intended to provide the information needs of its scientific manpower and for improving the transfer of knowledge and research results (SEARCA, 1981). It must provide a systematic access to local and foreign scientific literature to keep scientists and researchers abreast with current developments in their fields of specialization. This is done through the strengthening of library facilities and provisions for documentation services. The system, likewise, must promote a two-way interaction in the information transfer process through the dissemination of research results and in providing rapid access to new

information and technologies among farmers and fishermen. This interaction develops empowered farmers and fishermen that are able to articulate their technology needs, thus, ensures that the disseminated technologies are relevant to their needs.

Among the countries in the Region, only China, Indonesia, Korea, and the Philippines have established a distinct unit within its NARS tasked to manage its information resources. The unit is basically responsible to make R & D activities more effective and productive. Effective R & D requires a continuous flow of information to enable scientists and researchers to follow progress and scientific advances in their fields of specialization. Productive research ensures that research results are communicated to its various users (AARD, 1993).

In China, the Library of the Chinese Academy of Agricultural Sciences (LCAAS) manages the information needs and resources of the Academy. In Indonesia, the Center for Agricultural Library and Research Communication (CALREC) is mandated to coordinate and strengthen the communication efforts of its NARS by expediting scientific communication, international information networking, and providing technical assistance to the library and to the information and communication units of AARD. In Korea, the Technical Information Center (TIC) of the Rural Development Administration (RDA) provides a central mechanism for the publication of all available data, the exchange and procurement of reference materials, and the operation of the library for the various units of RDA. In the Philippines, NARS information support is handled by the Scientific Literature Service (SLS) and the Applied Communication Division (ACD) of PCARRD. The SLS provides the library services and the exchange and procurement of scientific literature while the ACD is responsible for information transfer. In addition, most research units in the NARS operate their own specific information management system albeit smaller in scope. Moreover, the University of Philippines at Los Baños (UPLB) maintains a main library that is the repository of agricultural research information in the country and the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA).

Other countries in the Region have not established a formal or centralized system of information support. It is presumed that the management of its information resources is done loosely through the various units of its NARS. Perhaps some countries are now in the process of establishing such system. The establishment of a formal or centralized system promotes an efficient management of information resources in such a way that information transaction between the generators and users of agricultural research information becomes more systematic and rapid.

V. DETERMINATION OF AGRICULTURAL R & D PRIORITIES

Agriculture is a dominant factor in the economy of the Region. About 60 percent of its population is directly dependent on this sector and is the main employer of its labor force. Traditionally, the countries in the Region have adopted an economic development strategy anchored primarily on the development of the agriculture sector. It is envisioned that the path to industrialization is through the improvement of agricultural productivity as experienced by most developed countries. With the exception of some newly industrializing countries, agricultural development remains the foremost concern of the Region. As such, agricultural development goals should account for a significant aspect of the overall national development goals in the Region.

Appendix Table 1 presents the medium-term national, agricultural, and R & D goals, strategies, and priorities of individual countries. There exists, however, an overriding concern for restructuring a country's development goals in favor of industrialization. There is a prevailing optimism in the Region that economic development is influenced largely by rapid industrialization. Even among the centrally-planned economies,

there is a growing tendency to restructure the economy into a market-oriented one and join the bandwagon to rapid industrialization. It is widely believed that industrialization is a fast track means in raising the standard of living and welfare of the population, which is the main concern in the Region. Moreover, for some countries, such as Indonesia, Malaysia, and Thailand, which have achieved industrializing country status, sustaining the gains from past economic development efforts is given priority in overall medium-term development goals.

As the countries in the Region move into the path of industrialization, agricultural development goals have been relegated to a supporting role. This role still involves the traditional improvement of agricultural productivity towards food self-sufficiency as the primary sectoral concern, and generating foreign exchange from increased export of agricultural products with emphasis on processed products. In addition, some countries in the Region are promoting complementary growth in the agriculture sector through the establishment of agro-processing industries that provide for the integration of agriculture with the industrial sector.

Since the agriculture sector still predominates the economy, socioeconomic welfare goals are also given priority concern. This is done through improvements in the delivery of public sector services, and more efficient utilization and conservation of resources in the sector.

The establishment of the NARS in the Region has provided a mechanism to effectively align R & D efforts to the agricultural development needs. With this development, agricultural sector goals must articulate its R & D needs in order for the NARS to be properly tapped and to contribute its share in the national development effort.

The primary concern of agricultural R & D in the Region is the provision of appropriate technologies for increased agricultural productivity **(Tables 6)**. This is essential to the common strategic concern of food self-sufficiency, and to the improvement of the nutritional intake of the population. Increased agricultural productivity also contributes to the efficient utilization of resources. The gains in efficient agricultural production activities can free some resources such as labor and capital which can be used for other productive activities in the economy. Improving agricultural productivity affects the improvement of farm income and the country's agricultural trade competitiveness.

Aware of the threat to the environment and the increased pressure on agricultural resource use, agricultural R & D workers in the Region are also concerned with promoting resource sustainability. This concept holds that agricultural resources if utilized judiciously can still provide for the needs of future generations. In effect, the development of productivity-enhancing technologies is balanced with the concern for the sustainable use of the agricultural production environment of the Region.

For countries that are becoming less dependent on the agriculture sector for their development needs, such as Indonesia, Korea, and Malaysia, R & D efforts are now directed towards modernizing the agriculture sector. Such moves entail the mechanization of agricultural operations, thus, improving labor use efficiency. These countries have the lowest percentage of the population dependent on agriculture among the countries in the Region with 21.4 and 29.4 percent for Indonesia and Korea as of 1991, respectively (FAO-RAPA, 1993). These countries, likewise, are now going into high technology agriculture through biotechnology and the development of new products made from existing agricultural products.

Malaysia is quite explicit in its concern to enhance the adoption of the technologies developed. This is complemented with the NARS effort to promote the commercialization of the technologies developed. This reflects the shift in the Malaysian agriculture sector concern from the self-sufficiency approach to a more commercial agriculture supportive of the country's industrialization plan.

TABLE 6. AGRICULTURAL R & D GOALS/OBJECTIVES

Country	Increase Farm Productivity	Food Self-Sufficiency	Resource Sustain-ability	Agricultural Moderni-zation	Improve Farm Income/ Welfare	Export Promotion	Crop Diversi-fication	High Technology Agriculture	Technology Adoption
Cambodia	X								
China									
Indonesia	X	X	X	X	X	X	X	X	X
Korea	X		X	X	X	X		X	
Laos	X	X	X			X	X		
Malaysia			X	X			X	X	X
Myanmar	X		X				X		
Philippines	X	X	X	X	X	X	X		X
Thailand	X		X		X		X	X	
Vietnam	X	X	X						

Source: FAO-RAPA (1992), Country Profiles (Appendices), Personal Communication (DOA,CARP-AARD, PCARRD).

TABLE 7. MAJOR COMMODITY RESEARCH AREAS

Commodity	Country									
	Cambodia	China	Indonesia	Korea	Laos	Malaysia	Myanmar	Philippines	Thailand	Vietnam
1. Cereal										
Rice	x	x	x	x	x	x	x	x	x	x
Wheat		x	x	x			x			
Corn		x	x	x	x	x	x	x	x	x
2. Rootcrops									x	
Cassava		x	x			x		x	x	x
Sweet Potato		x	x	x				x	x	x
Irish Potato		x	x	x	x	x		x	x	
3. Legumes										
Mungbean			x			x	x	x		x
Peanut		x	x	x			x	x	x	x
Soybean		x	x	x		x	x	x	x	
4. Vegetables and Fruits										
Tropical Vegetables		x	x	x	x	x	x	x	x	x
Starchy Bananas					x			x		x
Fruits		x	x	x	x	x	x	x	x	x
5. Plantation Crops										
Rubber			x			x	x	x	x	x
Palm Oil		x	x			x		x	x	x
Coconut		x	x			x		x	x	x
Tea		x	x			x	x		x	
Coffee		x	x		x	x		x	x	x
Cacao		x	x			x		x	x	x
Spices		x	x			x		x	x	x
Cotton		x					x	x	x	
Sugarcane		x	x				x	x	x	x
Tobacco			x	x	x	x		x	x	

TABLE 7. MAJOR COMMODITY RESEARCH AREAS (Cont....)

Commodity	Country									
	Cambodia	China	Indonesia	Korea	Laos	Malaysia	Myanmar	Philippines	Thailand	Vietnam
6. Livestock and Poultry										
Cattle/Carabao		x	x	x		x	x	x	x	x
Goat/Sheep		x	x			x		x	x	
Swine		x						x	x	x
Chicken		x	x	x		x	x	x	x	
7. Fisheries										
Aquaculture		x	x		x	x	x	x	x	x
Artisanal Fisheries		x	x			x	x	x	x	x
Deep Sea Fisheries		x	x	x		x	x	x	x	
8. Farming Systems										
Farming Systems Research			x			x		x	x	
On-Farm Research		x	x					x	x	
9. Post-Harvest										
Crops		x	x	x		x	x	x	x	x
Livestock		x	x			x		x	x	
Fisheries		x	x	x				x	x	
10. Resource-Based										
Agrometeorology		x	x	x		x		x	x	
Soil Resources		x	x	x	x	x		x	x	x
Water Resources		x	x			x		x	x	
11. Agricultural Engineering										
Farm Machinery		x	x	x			x	x	x	
Small Tools Development		x	x				x		x	
12. Biotechnology		x	x	x		x		x	x	
13. Socio-Economics		x	x	x		x		x	x	x

Source: ADB (1988), Personal Communication (DOA, PCARRD, CARP-AARD).

The increasing importance of R & D to a country's development effort prompted the Lao PDR to give priority to strengthen its agricultural R and D capability in the medium term. Perhaps, this is in anticipation of an increased role of the NARS as the country moves towards a market-oriented economy.

The list of priority commodities of the countries in the Region is presented in **Table 7**. This reflects the priority commodities that will be used in attaining a country's agricultural and national development goals. The commodities were identified for use in the food self-sufficiency programs and its importance in foreign exchange generation. The list is indicative of the diversity of the agriculture sector in a particular country. China and the Southeast Asian countries which have the most priority commodities in the list exhibit this diversity of their respective agriculture sectors.

Among the commodities listed, rice, tropical vegetables, and fruits are given high priority by all countries in the Region. For livestock, cattle and carabao are given importance. For fisheries, aquaculture is the priority research area. Post-harvest research on crops and soil resources research are also major research areas in the Region. Thailand and Indonesia have a wide array of plantation crops that have been given research focus. These crops are primarily destined for export and are important to these countries' export promotion objective. Other countries that are giving importance to their export agriculture are China, Malaysia, and the Philippines.

The selection of priority commodities is dependent on the country's politico-economic and social significance to development efforts. For instance, priority is given to a commodity if it is a staple food or a primary source of foreign exchange and upon which a large part of the population is dependent. In Korea, however, identification of priority commodities is also influenced by external factors. The commodities are selected in anticipation of the restructuring of the world trade scenario as a consequence of the operationalization of the General Agreement on Tariffs and Trade (GATT). The realities brought about by the GATT are also being anticipated by other countries in the Region. But it is only now that they are redirecting their research programs from food self-sufficiency, particularly on rice, to a more dynamic nature of promoting a country's agricultural trade competitiveness.

The process of research prioritization in most countries of the Region is based on the development thrusts of a country. Most often, these are formulated subjectively. However, in the case of the Philippines, the NARS has adopted a system of research prioritization that ensures an objective mechanism of allocating research resources among priority commodities and major geo-political subdivisions. The scheme provides one of the major bases for prioritization, and was combined with other information in formulating the country's research and extension agenda for the medium term known as NAREA 2000. The system was developed through the Research Priorities for Philippine Agriculture Project (RPPAP) funded by the Australian Centre for International Agricultural Research (ACIAR). Research priorities are determined based on the maximization of-national welfare gains, regional welfare gains, gains to target groups, and import replacement/export enhancement.

VI. FUNDING OF AGRICULTURAL R & D

Generally, funding support to agricultural R & D activities comes from either the public or private sector. These are generated either internally or from external sources. However, the funding of agricultural R & D in the Region is synonymous with public sector funds. As in most countries outside the Region, the public sector is the foremost source of agricultural R & D funds.

Generating financial support for agricultural R & D activities is of prime importance to the NARS. Often at times, the success of R & D activities hinges on the level of support and its continuous availability.

Given that public sector financial resources are quite limited particularly in the developing countries of the Region, agricultural R & D must compete with other uses of public funds. Even considering that the widespread benefit of R & D activities justifies large public sector support, these are often limited.

From 1961 to 1985, public sector support in terms of agricultural research intensity (ARI) ratio among the countries in this study, except for China, have on the average been increasing (Pardey et al., 1991). ARI expresses the expenditure on public sector agricultural research as a proportion of agricultural gross domestic product (AgGDP). This measures the relative importance given by the public sector to R & D activities. On the average, the ARI of these countries in the region has fluctuated, although increasing, from 0.49 percent during the period 1961-1965 to 0.68 percent in 1981-1985. Since this figure is far from the ideal of 1-2 percent, nonetheless, it represents a significant increase in fund allocation given to agricultural R & D in the Region.

Based on the purchasing power parities with 1980 as base year, agricultural R & D expenditure in the Region has increased substantially between 1961 to 1985 **(Table 8).** Overall, it increased by about 3.5 times during this period. Among the countries in the Region, Malaysia registered the highest rate of increase. Increase in R & D expenditure occurred after the formation of its NARS. This is likewise, evident in Indonesia which doubled its R & D expenditure between 1971 and 1985, right after the formation of AARD. China, owing to its vast research network, recorded the highest R & D expenditure between 1961 to 1985. For the 1981-1985 period, it accounted for about two-thirds of the total research expenditure during that period.

In terms of research investment per researcher, Malaysia provided the highest funding support to an individual researcher with 136.62 thousand purchasing power parities (PPP) dollars per year **(Table 9)**. This level, however, is less than its peak rate of 241.36 thousand PPP dollars per year during the first half of the 1970s. Indonesia also provided high funding support to its researchers. In general, however, there is a declining trend in the level of support given to individual researchers in the Region between 1975 and 1985. This can be attributed to the rapid increase in the number of agricultural scientific manpower during this period. Agricultural research expenditure during this period did not increase substantially relative to the increase in scientific manpower. If this trend continues, it could indicate that the NARS in the Region have reached a threshold in their capacity to provide enough support to its manpower, unless additional financial resources are put into the system.

With regard to current prices, Malaysia consistently provided the highest funding support to individual researchers **(Table 10)**. Moreover, Malaysia as well as Thailand has a well-supported NARS in terms of funding support in the mid-1980s. Research investments in terms of ARI are very ideal at 1.9 and 1.6 percent for Malaysia and Thailand, respectively. For other countries in the Region, there is a need to provide more public sector investments in agricultural R & D activities.

There are three major funding sources for R & D activities in the public sector. These are: taxes in the form of production or export tax; direct government appropriations, and; external fund sources (Gomez, 1986).

All NARS in the Region received direct government appropriations to finance their R & D activities. In addition, Malaysia and the Philippines practiced either a production or export tax on its export commodities. These are used to finance R & D activities for these commodities. In Malaysia, this is done for rubber and palm oil. In the Philippines, coconut, sugarcane, tobacco are taxed for this purpose. Funding of R & D activities through this mechanism makes the NARS directly responsible for the development and performance of these specific commodities from which it derives support.

TABLE 8. TOTAL NATIONAL AGRICULTURAL RESEARCH EXPENDITURE

Country	Total Agricultural Research Expenditure (Millions 1980 PPP Dollars per Year)*				
	1961 - 1965	1966 - 1970	1971 - 1975	1976 - 1980	1981 - 1985
Cambodia					
China	271.4	296.2	485.4	689.3	933.7
Indonesia	40.7	57.3	73.9	114.9	141.1
Korea	8.9	24.6	25.7	28.0	50.0
Laos	1.5	1.5	1.5	1.5	1.5
Malaysia	14.0	29.4	71.2	74.1	110.8
Myanmar	1.5	1.2	3.4	13.9	12.0
Philippines	17.6	27.0	41.9	35.4	28.6
Thailand	39.0	67.8	55.5	56.3	77.8
Vietnam					

** Please see Pardey and Roseboom (1989) for a description on deriving the Purchasing Power Parities (PPP) with 1980 as base year. PPP measures the domestic cost of buying a particular bundle of goods and services in a particular country at its own price relative to the corresponding cost in dollars of the same bundle in the USA.*

Source: Pardey et al. (1991).

TABLE 9. RELATIVE RESEARCH INVESTMENT PER RESEARCHER, 1961-1985

Country	Relative Research Investment per Researcher* (Thousand 1980 PPP Dollars per Year)				
	1961-1965	1966-1970	1971-1975	1976-1980	1981-1985
Cambodia					
China	38.96	29.92	41.98	34.38	28.98
Indonesia	98.07	132.33	164.22	114.33	104.60
Korea	17.08	31.70	28.97	26.62	36.87
Laos	51.72	51.72	51.72	51.72	51.72
Malaysia	92.72	171.93	241.36	111.76	136.62
Myanmar	71.43	48.00	61.82	72.40	44.94
Philippines	46.93	52.02	43.06	25.47	14.55
Thailand	126.62	138.93	94.87	41.92	46.42
Vietnam					

* *Derived from Pardey et al. (1991).*

TABLE 10. RELATIVE RESEARCH INVESTMENT PER RESEARCHER AND ITS SHARE OF AGRICULTURAL GROSS DOMESTIC PRODUCT

Country	Annual Research Budget**	Estimate Number of Researchers	Relative Research Investment per Researcher*	Research Investment as % of AgGDP	Year
Cambodia					
China	132.2	61,000	2,167	0.12	1984
Indonesia	56.4	2,360	23,898	0.26	1991
Korea	37.5	2,650	4,150	0.42	1985
Laos					
Malaysia	89.9	1,003	89,631	1.90	1986
Myanmar	1.0	267	3,866	0.03	1984
Philippines	6.6	3,046	2,167	0.49	1986
Thailand	51.5	2,012	25,596	1.59	1985
Vietnam	3.9	1,800	2,167		1985

* *in dollars.* ** *in million dollars.*

Source: ADB (1988), Personal Communication (CARP-AARD).

External fund sources consist of bilateral assistance, multilateral support, and private non-government organizations or foundations support. These provided additional financial support to the NARS in the Region. **Table 11** shows the extent of external funding support received by the NARS in the Region. Between 1983 and 1986, the amount of external funding given to the Region amounted to $ 51.52 million. This represents about one-seventh of the total annual research budget in the Region. Among the countries in the Region, Myanmar and the Philippines are heavily dependent on external fund sources for their R & D. External fund sources in these two countries accounted for over half of their total NARS budget. While this provided additional funds to the NARS, long-term dependence on external fund sources can affect the operational viability of the NARS, and can have adverse consequences on the identification of research priorities since external fund sources tend to inject their own priorities in the R & D process. China, Korea, Malaysia, and Vietnam, however, rely heavily on internal fund sources to support their agricultural R & D activities during this period.

From 1967 to 1987, the Asian Development Bank (ADB) has provided a total of about $ 50 million for agricultural research (**Table 12).** Korea accounted for about 40 percent of this amount. The bulk of ADB support to research are in the form of agricultural loans. Other international assistance and financial institutions are believed to allocate a substantial amount of their fund exposure in the region to agricultural R & D.

The inadequate public sector support to agricultural R & D necessitates the NARS to explore alternative ways of fund generation and support. Indonesia is quite innovative in this regard. It is now exploring the possibility of the private sector financing its activities (Pasandaran, 1993). Moreover, it has

commercialized the use of its facilities to generate some funds and has identified other possible sources of additional funds such as tax credits, levy on marketing, establishment of a research foundation, solicitations from private donors, and contracting R & D work. In the future, the key to the financial viability and continued effectiveness of the NARS in the Region is the exercise of financial autonomy in the generation and use of R & D funds.

TABLE 11. ESTIMATED EXTENT OF EXTERNAL FUNDING SUPPORT

Country	Annual Research Budget (in $ Million)	Extent of External Funding	
		Amount (in $ Million)	% of Total NARS Budget
Cambodia			
China	132.2	5.24	4.0
Indonesia	51.7	20.85	40.3
Korea	37.5	1.61	4.3
Laos			
Malaysia	89.9	2.84	3.2
Myanmar	1.0	0.56	56.0
Philippines	6.6	3.66	55.5
Thailand	51.5	16.58	32.2
Vietnam	3.9	0.18	4.6

Source: ADB (1988).

TABLE 12. LEVEL AND SOURCE OF EXTERNAL SUPPORT BY TYPE OF ASSISTANCE

Country	ADB*($ Thousand)	
	Agricultural Loan	Technical Assistance
Cambodia		
China		
Indonesia	3,234	5,929
Korea	18,849	350
Laos	42	369
Malaysia	4,220	1,389
Myanmar	1,859	626
Philippines	4,203	3,616
Thailand	3,135	1,178
Vietnam	117	25

** 1967-1987* *Source: ADB (1988).*

VII. LINKAGES

Linkages are generally classified as internal or external. Internal linkage is a mechanism by which the NARS interact with its different units and other in-country institutions involved in agricultural R & D activities. External linkage is the means by which the NARS is linked with foreign institutions such as bilateral donors, private non-government foundations, multilateral organizations, and IARCs that provide support to the NARS.

Linkages provide the means by which the NARS receive support and inputs from other institutions and through which they also provide support and other inputs to those institutions. The relationship is anchored on mutual cooperation and complementation of resources. In this era of networking, linkages provide the opportunities to expand the organizational capability of the NARS to respond to the challenges inherent in its agricultural R & D activities.

Internal linkages in the NARS consist of the educational and the research-extension systems. This is vital to the operations of the NARS, since traditionally, these systems are the responsibility of separate ministry/department. The continued harmony of the linkage among these institutions greatly affects the effectiveness and relevance of the R & D activities of the NARS in its ability to provide for the needs of the agriculture sector.

Agricultural educational institutions provided a steady stream of knowledgeable manpower to operate the research facilities of the NARS. These institutions are often contracted to do basic and strategic research in support of national development goals. This linkage is very apparent among the NARS in the Region.

In Korea and the Philippines, this linkage is very strong (Senanayake, 1990). Agricultural educational institutions in Korea are tapped to provide research programming and evaluation activities for the RDA. The RDA has even organized a unit, the Institutional Cooperation Committee (ICC), to manage this linkage. In the Philippines, these institutions permeate the national and regional levels of R & D implementation and management. These serve as national multi-commodity research institutions and are often the base of research coordination activities at the regional level. Likewise, these institutions are involved in research policy formulation and programming through the various committees providing advisory support to PCARRD.

The benefits of R & D activities can not be realized if research results are not utilized by farmers. Thus, the NARS must ensure that research-extension linkage is always strengthened. Among the countries in the Region, Korea has the best experience in this regard. Research and extension activities are managed within one organization (Chung et al., 1993 and Murphy, 1983). This assures a fast and efficient system of disseminating research results as well as providing feedback on the performance of developed technologies. Other countries in the Region have limited functional mechanisms to manage this linkage. This is very evident in the Philippines which has recently devolved its agricultural extension to the local government units, thus, straining or paralysing this linkage.

A total of 32 bilateral donors, private non-government foundations, multilateral organizations, and IARCS have maintained linkages and provided support to the NARS in the Region **(Table 13)**. These institutions provide financial, technical, and manpower training support. In addition, the IARCs provide germplasm and information resources through the dissemination of new research findings. In most instances, the establishment of the NARS in the Region was influenced by these institutions. In Indonesia, Korea, the Philippines, and Thailand, the development of the NARS was generously supported by these institutions.

TABLE 13. SOURCE OF EXTERNAL SUPPORT TO NARS, 1980-1988

Type of Institution	Name/Agency
Bilateral Donors	Australia (AIDAB)
	Belgium
	Canada (CIDA)
	France
	Germany (GTZ AND DSE)
	Italy
	Japan (JICA AND OECF)
	Netherlands
	Norway (NORAD)
	Sweden (SIDA)
	Switzerland
	United Kingdom (ODA)
	United States of America (USAID)
Foundations	ACIAR
	Ford Foundation
	International Development
	Research Centre (IDRC)
	Swedish Agency for Research
	Cooperation (SAREC)
Multilateral Organizations	ADB
	CGIAR
	EEC
	FAO
	IFAD
	UNDP
	World Bank/IBRD
International Agricultural Research Center	CIAT
	CIMMYT
	CIP
	IBPGR
	ICRISAT
	IFPRI
	IRRI
	ISNAR
Others	AVRDC

Source: ADB (1988).

Available information indicates that inter-NARS linkage in the Region is very limited, although some NARS are now starting to initiate information exchange and manpower training among other countries in the region.

The linkages established by the NARS in the Region will continue to provide the necessary support and, exert influence in the management and implementation of R & D activities. These linkages provide an extension of the NARS internally and externally. To maximize the benefit from this relationship, it is necessary that the NARS develop a mechanism to manage such relationship.

VIII. IMPACT OF AGRICULTURAL R & D

The impact of R & D activities on agricultural development takes a lot of form. More often, it is associated with increases in agricultural production. R & D activities and the resulting technologies developed create a number of spillover effects that can be beneficial to other sectors of the society. As such, the impact of agricultural R & D activities is quite difficult to qualify and quantify.

Available empirical evidence indicates that agricultural research activities are efficient users of resources. In fact, investments in R & D generate returns of over 25 percent annually **(Table 14)**. Specifically, investments in rice R & D activities in Asia generated an annual rate of return ranging from 32 to 78 percent. In the Philippines, rice research produced a relatively lower return of 27 percent from 1966 to 1975. This figure, however, is expected to improve further considering that significant increases in rice production in the Philippines occurred after 1975. Investments in mango research in the Philippines can give a high rate of return ranging from 85 to 107 percent. In Malaysia, returns from investment in rubber research amounted to 25 percent. Studies of this nature involving other commodities in the Region are lacking. These are needed in rationalizing the allocation of research investments.

TABLE 14. ESTIMATED RATES OF RETURN ON INVESTMENT IN AGRICULTURAL RESEARCH

Commodity	Coverage	Period	Annual Rate of Return (%)	Source
Rice	Asia	1950-1965	32-39	Evenson and Flores (1978)
Rice	Asia	1966-1975	73-78	Evenson and Flores (1978)
Rice	Indonesia	1965-1977	133	Salmon (1984)
Rice	Philippines	1966-1975	27	Flores-Moya et al. (1978)
Corn	Philippines	1956-1983	29-48	Librero and Perez (1987)
Sugarcane	Philippines	1956-1983	51-71	Librero et al. (1987)
Mango	Philippines	1956-1986	85-107	Librero et al. (1988)
Rubber	Malaysia	1932-1973	25	Pee (1977)

Source: Pinstrup-Andersen (1982), Librero et al. (1985-1988), Echeverria (1990).

The relative impact of agricultural R & D activities is also reflected in the production growth rate of commodities. Available literature indicates that increased farm productivity for the past decades was due to the adoption of improved technologies generated through R & D. **Table15** presents the production growth rate of selected commodities in the Region. Countries with a relatively high investment in agricultural R & D, such as, China, Indonesia, and Malaysia, registered a relatively high production growth rate

TABLE 15. AVERAGE ANNUAL GROWTH RATE OF PRODUCTION, 1982 - 1992

Country	Paddy Rice	Corn	Cassava	Sweet Potato	Total** Fruits	Total*** Vegetables	Total Meat	Total**** Fisheries
Cambodia	3.80	10.00	4.50	7.00	5.20	1.60	7.70	7.20
China	1.20	4.70	-1.80	-0.70	9.90	3.80	8.00	10.50
Indonesia	3.30	6.50	3.20	0.70	2.60	6.90	5.80	4.80
Korea	*3.73	11.80	2.72	3.33	3.54	13.02	7.09	8.80
Laos	1.90	7.80	-1.00	5.60	2.70	1.10	2.30	0.00
Malaysia	0.80	11.00	1.30	5.70	1.90	0.40	6.90	-2.30
Myanmar	-0.70	-4.00	-3.50	2.10	2.00	1.10	0.00	2.40
Philippines	2.00	4.30	1.10	-1.70	-0.80	2.10	4.60	2.90
Thailand	0.20	0.60	1.80	-5.40	1.80	-0.60	4.40	4.00
Vietnam	4.00	4.80	-1.50	0.50	3.80	4.10	4.90	3.60
Asia-Pacific	2.00	4.30	1.30	-0.70	3.60	2.90	5.80	3.40
World	2.00	1.90	1.90	-0.60	1.60	2.00	2.80	2.40

** CARP-AARD data*

***excluding melon*

**** including melon*

*****1981-1991*

Source: FAO-RAPA, (1993), Personal Communication (CARP-AARD).

TABLE 16. SELECTED NATIONAL AND AGRICULTURAL INDICATORS

Country	% of Agricultural Land to Total Land	% Change of Agricultural GDP	Agricultural Production Indices*					
	1991	1981-1991	1981	1983	1985	1987	1989	1991
Cambodia	17.4	0.7	110.18	142.41	146.83	156.53	189.26	191.21
China	10.4	-4.3	103.58	122.09	131.37	141.37	145.85	163.61
Indonesia	12.3	13.0	106.36	115.25	126.40	137.41	151.37	164.65
Korea	21.2	-4.4	98.54	101.30	111.28	105.55	108.91	106.51
Laos	4.0	3.1	110.71	114.23	134.44	126.55	139.64	146.65
Malaysia	14.9	0.4	103.52	107.28	132.21	152.28	171.51	173.73
Myanmar	15.3	0	107.34	122.57	138.37	140.22	117.23	123.68
Philippines	26.8	1.9	103.83	102.28	99.79	105.94	114.41	116.28
Thailand	45.3	23.8	105.08	111.27	122.25	115.20	129.30	133.14
Vietnam	19.6	-3.0	104.19	114.11	120.20	136.63	149.31	161.06
Asia-Pacific	15.1	2.2	104.17	114.77	123.20	127.93	138.69	148.17
World	11.1	1.6	102.70	105.96	114.53	116.72	122.73	125.26

** 1979 - 1981 = 100, Gross Production of Agricultural Products including all crops and livestock products.*

Source: FAO - RAPA (1993).

between 1982 and 1992. The increase in food production of these countries surpassed the average increase in world production of commodities, namely, rice, corn, cassava, sweet potato, and fruits and vegetables, among others. This was achieved despite the limited change in agricultural land area. Growth in production is caused by increases in agricultural area planted and the yield. Considering the negative change in agricultural land area in China and the slight increase in the agricultural land area in Malaysia, it can be deduced that the growth in production was influenced more by yield increases. This increase in yield is often attributed to the adoption of yield-enhancing technologies generated from agricultural R & D activities. The effect is also evident in the overall agricultural production increases **(Table 16)**. During this period, China increased its agricultural output by about 60 percent. Malaysia's agricultural production also grew by about 68 percent during the same period.

Agricultural R & D activities also affect the viability of future agricultural production activities. This is done primarily though the improvement of crop and animal genotypes. This promotes biodiversity in the agricultural production environment, thus, spreading the risk of crop failure due to pests and diseases. In the Philippines, rice breeding researches have produced over 50 varieties which have been introduced to farmers since 1970. Likewise, crop breeding researches in China developed more than 3,000 varieties of field crops and 300 species of fruit and vegetable crops which were released to farmers for the past 35 year (ADB, 1988)

Likewise, agricultural R & D activities have been instrumental in intensifying land utilization (Gomez, 1986). This was made possible with the development of technologies that allowed the planting of a second crop after the first cropping in areas that were traditionally a one-cropping area. Intercropping technologies developed during the past decade also maximized the productive use of agricultural lands.

Agricultural R & D activities have also produced indirect effects on agricultural development. These activities generate information that are useful for policy formulation and decision-making. The results produced from research activities provide additional inputs to the wealth of existing information which can benefit the future generations.

Agricultural development can not be solely attributed to technological change. Agricultural R & D activities which produce technological change require a complex interplay of factors to make it successful. These factors are the availability of an appropriate package of technical support services like credit, market and post-harvest facilities among others, and the formulation of a package of relevant and complementing public policies (Murphy, 1983). Thus, agricultural development is the end-effect of the synergism among several factors for which technological change serves as the sparkplug.

Despite the intensified investment in agricultural R & D and the numerous technologies that have been developed, limited progress have been made in developing the agriculture sector and uplifting the socioeconomic conditions of the agricultural populace. Perhaps, the answer lies not entirely on agricultural R & D but more on determining the right combination of factors that can spur agricultural development.

IX. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

Agricultural research in the Southeast Asian Region began at the turn of the twentieth century. However, the establishment of most NARS occurred only in the 1960s. This gap reflects the low priority given to agricultural R & D prior to the establishment of the NARS. Had the NARS been established much earlier, the agriculture sector in the Region could have been more advanced relative to its present status.

There are three types of apex agricultural research organization in the Region. These are the ministry level, the autonomous agency, and the coordinating council. Regardless of the type of apex organization existing in a particular country the NARS differ only in the way they are operationally managed. In terms of policy and program formulation, however, they are quite similar. The NARS is directly linked with the individual country's politico-economic system which ensures that research priorities are within the context of the national development goals.

The NARS in the region are basically organized along three levels: the national, the regional, and the provincial or location-specific research facilities. The national level research facilities conduct basic and strategic researches of national or long-term importance. The regional level conducts applied researches of regional significance. The provincial or location-specific facilities conduct verification researches and fine-tuning of technologies generated by the national and regional level research facilities. This system developed work specialization and provided the need for location-specificity of agricultural production technologies.

Generally, the NARS is mandated to manage a country's research program and its resources. However, there is limited operational capability and clout in managing these research resources.

The promotion of commercially viable technologies is emerging as an added role of the NARS in the region. This role is new to the NARS but it provides the means to accelerate the use of research results and enhance the effectiveness of the system.

The massive investment in human resources by the NARS in the Region was done to improve its agricultural research capability and place it at par with the world's best. To sustain the gains made from this investment, continuous human resource development should be adopted. This measure assures not only a steady supply of skilled and knowledgeable manpower but also keeps the system abreast with the rapid changes occurring in agricultural research of other countries.

The research infrastructure among the NARS in the Region consists of the national or central research facilities, regional facilities, and provincial or location-specific research stations. The development of research infrastructure was patterned on the technology development process adopted by most NARS in the Region. It allows for work specialization and complementation in the system.

Information is becoming an important resource of the NARS. Efforts to manage this resource have recently been started by most NARS. This is due to the increasing complexity of acquiring and transferring information, and its rapid turnover.

The primary concern of agricultural R & D in the Region is the provision of appropriate technologies for increased agricultural productivity. The research priorities of the NARS are dependent on the politico-economic and social priorities of a country as it relates to its development efforts. However, external realities faced by countries in the Region are also being considered such as the GATT. It is only now that countries in the Region are redirecting their research programs from food self-sufficiency to a more dynamic nature of promoting agricultural trade competitiveness in anticipation of the GATT.

The funding of agricultural R & D in the Region is derived mainly from public sector funds. As such, agricultural R & D must compete with other uses of public sector funds.

Generating financial support for agricultural R & D activities is of prime importance to the NARS. Oftentimes, the success of R & D activities hinges on the level of support and its continuous availability.

Public sector support to R & D activities is generally increasing but still inadequate for most NARS as evidenced by the low ARI ratio which is less than the ideal of 1-2 is percent.

There are three major funding sources for R & D activities in the public sector. These are: taxes in the form of production or export tax; direct government appropriations, and; from external fund sources. External fund sources consist of bilateral assistance, multilateral support, and private non-government organizations or foundations support. These provide significant contribution in the development of NARS in the Region.

The uncertainty of increased public sector support to agricultural R & D necessitates that the NARS must explore alternative ways of fund generation and support. Perhaps, the key to the financial viability of the NARS in the Region is to exercise financial autonomy in the generation and use of R & D funds.

Linkages provide the means by which the NARS receive support and inputs from other institutions and through which it also provides support and other inputs to those institutions. The relationship is achieved on mutual cooperation and complementation of resources. Linkages provide the opportunities to expand the organizational capabilities of NARS as they respond to the challenges inherent in their agricultural R & D activities. Inter-NARS linkages in the Region are very limited and should be strengthened. To maximize the benefit from these linkages, it is necessary that the NARS develop a mechanism to manage such relationships.

Available empirical evidence indicates that agricultural research activities are efficient users of resources. In fact, investments in R & D generate returns of over 25 percent annually.

Agricultural R & D activities also affect the viability of future agricultural production activities. Improvement of crop and animal genotypes promote biodiversity in the agricultural production environment of the Region. Likewise, agricultural R & D activities have been instrumental in intensifying land utilization.

Agricultural R & D activities also produce indirect effects on agricultural development. These consist of information that are useful for policy formulation and decision-making and which provide additional inputs to the wealth of existing information which can benefit future generations.

Agricultural development can not be solely attributed to technological change. Agricultural R & D activities which produce technological change require a complex interplay of factors to make it successful. These factors are the availability of appropriate package of technical support services like credit, market and post-harvest facilities among others, and the formulation of a package of relevant and complementing public policies. Thus, agricultural development is the end-effect of the synergism among several factors.

CONCLUSIONS

The agricultural research systems in the Region have evolved from the relatively simple botanical gardens to a more complex and integrated research system called the NARS. The process was influenced by the changing development needs of a country and its agriculture sector. The long period of transformation from the botanical gardens to the establishment of the NARS has not been able to sustain the gains made from the earlier research efforts. Only when the NARSs were established did R & D efforts pick up.

Most NARS in the region have existed for over 20 years and investments in developing their R & D capability have been substantial. Considering these factors, increases in agricultural productivity should have been tremendous. However, the Region still faces the problem of food shortages and subsistence agriculture. While R & D activities have been instrumental in increasing farm productivity, these have

not been enough to transform their benefit into a form that positively uplifts the welfare of the rural population in a sustainable manner.

Significant accomplishments have been achieved in developing the human and infrastructure resources of the NARS in the Region. Most NARS have upgraded their scientific workforce through strong and deliberate manpower development programs. The development of infrastructures has also been enhanced which makes possible work specialization and complementation in the technology development process. These efforts are quite strategic since these resources are the cornerstone of an effective research system.

Information is becoming an important resource for the NARS. Most NARS in the Region, however, have not been able to establish a mechanism that will allow for a centralized and systematic management of its information resources.

The NARS in the Region have not formally developed the capability to conserve and manage the vast genetic resources available.

R & D priorities are influenced to a large extent by the politico-economic and social development priorities of a country. As such, R & D concerns of the NARS greatly reflect and are attuned to the development goals specific to their country. This scenario is quite logical, but it has not promoted an active interaction between development planners and the NARS. The tremendous knowledge base of the NARS has not been often tapped by development planners in determining national priorities particularly for the agriculture sector.

Funding of agricultural R & D is derived mainly from public sector funds. Overall, public sector support to agricultural R & D has been increasing although it is still inadequate. Public sector support is quite understandable since R & D activities are considered public goods. The availability of adequate funds in a sustained manner is essential to the continued effectiveness of the NARS. As such, the NARS has to exert more effort and it must readily justify its effectiveness to be more competitive in availing of public sector funds. In the long term, the NARS should not limit itself to using public sector funds but to consider other non-traditional sources of support to finance its activities.

The NARS in the Region are quite adept at managing internal and external linkages particularly with the IARCs and other sources of financial support. These linkages nourishes the NARS and provide opportunities to expand its agricultural capabilities. Inter-NARS linkage, in the Region, however is very limited.

Generally, the impact of agricultural R & D in the Region is inherent in increasing agricultural productivity, intensifying land use, promoting biodiversity in the agricultural production environment, and improving the existing information base. Studies indicate that agricultural research investments generate high returns. The complexity, however, in which research impacts are determined requires that agricultural R & D must combine with other factors supportive to agricultural development to achieve its desired effects.

RECOMMENDATIONS

Agricultural R & D has traditionally played a significant role in a country's development effort. This is most often used as an argument in acquiring the necessary support for the conduct of R & D activities. As the Southeast Asian Region embarks on a new path to development, R & D efforts must keep pace with this changing scenario. A lot has been done in the past and more opportunities have been created for

the future. The challenges that lie ahead call for a firm and continuing resolve among the NARS in the Region to expand the role and contribution of agricultural R & D in the development efforts.

The bulk of agricultural R & D activities are geared towards increasing farm productivity based on the perception that food insufficiency remains as a major threat to the economies of the Region. Although the problem belongs to the past and still remains a development concern of most countries in the Region, focusing of R & D efforts on averting food shortages has not squarely addressed the major problem of rural poverty affecting the agriculture sector. Development of productivity-enhancing technologies has not been effective in equitably distributing the benefits from R & D investments particularly in the economies where production resources are inequitably distributed. Efforts to increase its relevance along this line requires the redirection of R & D activities towards developing technologies that generate more employment opportunities and enhance value-added in the agriculture sector. These measures directly attack the root cause of rural poverty and should be given priority over farm productivity in the medium-term. For rural poverty remains as the key "stumbling block" in our pursuit to modernize the agriculture sector rather than enhancing farm productivity.

The time lag between the development of a technology and its adoption by farmers is long. Often at times, the effectiveness of the technologies has decreased as and when these eventually reach the end users. To make R & D more effective, the process of technology development and adoption must be hastened.

A lot of innovative efforts have been done by some NARS in the Region, the most notable of which were the organizational structuring done in Korea and the mandate setting in Malaysia. These efforts can be adopted by other NARS in the Region and modified accordingly to suit the specific circumstances prevailing in individual countries. More importantly, the conduct of R & D should be "business-like", strategic, goal-oriented, and time bounded. This will improve the impact of R & D activities particularly in transforming the technologies and information generated by these activities into profitable realities.

As a system, the NARS in the Region must continuously strive to improve the management of their resources. This move will enable them to be better prepared for the uncertainties of the future and exploit new opportunities thus making them more effective players in the national development efforts. Specifically, improving the management of information resources, genetic resources, fund sourcing, and linkages provide some avenues for growth among the NARS in the Region.

The trend towards globalization should now be anticipated by these NARS. This requires the strengthening of linkages among the NARS which apparently are still limited. The agricultural production environment of the countries in the Region and the economic development concerns are quite similar. There is a need to collectively articulate our interests and, if possible, rationalize R & D across country over the long term.

Ultimately, the role of the agricultural R & D sector in terms of generating scientific knowledge must be sacrificed in favor of addressing a country's immediate development efforts. It now becomes imperative to change the character of agricultural R & D in the region from a reactive problem-oriented into a more proactive endeavor that anticipates the needs of an emerging agro-industrial economy.

X. ABBREVIATIONS AND ACRONYMS

AARD	-	Agency for Agricultural Research and Development (Republic of Indonesia)
ACD	-	Applied Communication Division (of PCARRD)
ACIAR	-	Australian Centre for International Agricultural Research
ADB	-	Asian Development Bank
ADC	-	Agricultural Development Council
AgGDP	-	Agricultural Gross Domestic Product
AIDAB	-	Australian International Development Assistance Bureau
ANU	-	Australian National University
APO	-	Asian Productivity Organization
ARI	-	Agricultural Research Intensity
ASEAN	-	Association of Southeast Asian Nations
AVRDC	-	Asian Vegetable Research and Development Center (Republic of China)
BAR	-	Bureau of Agricultural Research (Republic of the Philippines)
BAS	-	Bureau of Agricultural Statistics (Republic of the Philippines)
CASS	-	Chinese Academy of the Agricultural Sciences (Peoples' Republic of China)
CAS	-	Chinese Academy of Science (Peoples' Republic of China)
CALREC	-	Center for Agricultural Library and Research Communication (of AARD)
CARP	-	Center for Agricultural Research Programming (of AARD)
CGIAR	-	Consultative Group of International Agricultural Research
CIAT	-	Centro Internacional de Agricultural Tropical (International Center for Tropical Agriculture - Cali, Colombia
CIDA	-	Canadian International Development Agency
CIMMYT	-	Centro Internacional de Mejoramiento de Maiz y Trigo (International Maize and Wheat Improvement Center - Mexico City)
CIP	-	Centro Internacional de la Papa (International Potato Center - Lima, Peru)
DA	-	Department of Agriculture (Republic of the Philippines)
DANIDA	-	Danish International Development Agency
DENR	-	Department of Environment and Natural Resources (Republic of the Philippines)
DOA	-	Department of Agriculture (of MOAC)
DOAE	-	Department of Agriculture Extension (of MOAC)
DOST	-	Department of Science and Tenchnology (Republic of the Philippines)
DSE	-	Deutsche Stiftung fuer Entwicklungslander (German Foundation for International Development)
EC	-	European Commission
EEC	-	European Economic Community
ERDB	-	Environmental Research and Development Bureau (of DENR)
ESCAP/CGPRT	-	Economic and Social Commission for Asian and the Pacific/Center for Coarse Grains, Pulses, Roots, and Tuber Crops (Bogor, Indonesia)
FAO/RAPA	-	Food and Agriculture Organization of the United Nations/Regional Office for Asia and the Pacific
FPRDI	-	Forest Products Research and Development Institute (of DOST)
FRG	-	Federal Republic of Germany
FSP	-	Fisheries Sector Program (of DA)
GATT	-	General Agreement on Tariffs and Trade
GDP	-	Gross Domestic Product
GTZ	-	Gesellschaft Fuer Technische Zusammenarbeit (German Agency for Technical Cooperation)
HYVs	-	High Yielding Varieties
IAEA	-	International Agricultural Economics Association
IARCs	-	International Agricultural Research Centers

IBPGR	-	International Board for Plant Genetic Resources
IBSRAM	-	International Board for Soils Research and Management
ICC	-	Institutional Cooperation Committee (of RDA)
ICLARM	-	International Center for Living and Aquatic Resources Management (Makati, Philippines)
ICRISAT	-	International Crop Research Institute for the Semi-Arid Tropics (Hyderabad, India)
IDRC	-	International Development Research Centre (Canada)
IFAD	-	International Fund for Agricultural Development
IFPRI	-	International Food Policy Research Institute
IIMI	-	International Irrigation Management Institute (Kandy, Sri Lanka)
IITA	-	International Institute for Tropical Agriculture (Ibadan, Nigeria)
IRRI	-	International Rice Research Institute (Los Baños, Philippines)
ISF	-	Institute of Soils and Fertilizers (Socialist Republic of Vietnam)
ISNAR	-	International Service for National Agricultural Research (The Hague, Netherlands)
JICA	-	Japan International Cooperation Agency
LCASS	-	Library of the Chinese Academy of Agricultural Sciences (of CAAS)
LGU	-	Local Government Units (Republic of the Philippines)
MARDI	-	Malaysian Agricultural Research and Development Institute (Government of Malaysia)
MOAC	-	Ministry of Agriculture and Cooperatives (Government of Thailand)
MOSTE	-	Ministry of Science, Technology and Energy (Government of Thailand)
NACA	-	Network of Aquaculture Centre for Asia
NAREA	-	National Agricultural Research and Extension Agenda (of BAR)
NARP	-	National Agricultural Research Project (Government of Thailand)
NEDA	-	National Economic Development Authority (Republic of the Philippines)
NESDB	-	National Economic and Social Development Board (Government of Thailand)
NIAS	-	National Institute of Agricultural Science (Socialist Republic of Vietnam)
NORAD	-	Norwegian Agency for International Development
NTA	-	National Tobacco Administration (of DA)
ODA	-	Overseas Development Administration (United Kingdom)
OECF	-	Overseas Economic Cooperation Fund (Government of Japan)
PCA	-	Philippine Coconut Authority (of DA)
PCAMRD	-	Philippine Council for Aquatic and Marine Research and Development (Republic of the Philippines)
PCARRD	-	Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development (Republic of the Philippines)
PPP	-	Purchasing Power Parities
PRDA	-	Provincial Rural Development Administration (of RDA)
R & D	-	Research and Development
RDA	-	Rural Development and Administration (Republic of Korea)
RPPAP	-	Research Priorities for Philippine Agriculture Project (of ACIAR)
RRIM	-	Rubber Research Institute of Malaysia
SAREC	-	Swedish Agricultural Research Cooperation
SCU	-	State Colleges and Universities
SEAFDEC/AQD	-	Southeast Asian Fisheries Development Center/Aquaculture Department (Iloilo, Philippines)
SEARCA	-	Southeast Asian Regional Center for Graduate Study and Research in Agriculture (Los Baños, Philippines)
SIDA	-	Swedish International Development Authority
SLS	-	Scientific Literature Service (of PCARRD)
SRA	-	Sugar Regulatory Administration (of DA)

TDRI	-	Thailand Development Research Institute
TIC	-	Technical Information Center (of RDA)
UN	-	United Nations
UNDP	-	United Nations Development Programme
UPCA	-	University of the Philippines College of Agriculture
UPLB	-	University of the Philippines at Los Baños
USAID	-	United States Agency for International Development
USSR	-	Union of Soviet Socialist Republics

XI. REFERENCES

Agency for Agricultural Research and Development. AARD. Jakarta, Indonesia: AARD.1992.

Asian Development Bank. Agricultural Research in the Asian and Pacific Region: Current Situation and Outlook. ADB Staff Working Paper. Manila, Philippines: ADB.1988.

Asian Productivity Organization. Agricultural Research Management in Asia. Tokyo, Japan: FPO.1983.

Bureau of Agricultural Research. On-Farm Research Manual Module 1: Overview and Directions of Agricultural Research.BAR, Manila, Philippines. 1991.

Chung, M.N., S.H. Lee, and T.S. Yang. Agricultural Research Activities in Korea. Paper Presented during the Expert Group Meeting on Sensitizing Agricultural Research to Community Needs, August 17-20, 1993, ESCAP, Bangkok, Thailand. Suwon, Korea: RDA.1993.

Drilon, J.D., Jr. Agricultural Research Systems in Asia. Los Baños, Laguna, Philippines: SEARCA.

Echeverria, R.G., ed. Methods for Diagnosing Research System Constraints and Assessing the Impact of Agricultural Research. Vol.II Assessing the Impact of Agricultural Research. The Hague: Netherlands. ISNAR.1990.

Food and Agriculture Organization. Selected Indicators of Food and Agriculture Development in Asia-Pacific Region, 1982-92. RAPA Publication: 1993/26. Bangkok, Thailand: FAO/RAPA. 1993.

Food and Agriculture Organization. National Plans for Agricultural Development in Asia-Pacific Region: A Compilation. RAPA Publication: 1992/23. Bangkok, Thailand: FAO/RAPA. 1992.

Agricultural Research System in the Asia-Pacific Region. RAPA Publication: 1986/17. Bangkok, Thailand: FAO/RAPA. 1986.

Gomez, A.A. Philippines and the CGIAR Centers: A Study of their Collaboration in Agricultural Research. CGIAR Study Paper No.15. IBRD/The World Bank, Washington, DC, U.S.A. 1986.

Jain, K.H. Organization and Structure in National Agricultural Research System. ISNAR Paper No.21. The Hague, Netherlands. ISNAR.1989.

Librero, A.R., N.E. Emlano, and M.B. Ocampo. Estimating Returns to Research Investment in Mango in the Philippines. PCARRD Book Series No. 73/1988. Los Baños, Laguna, Philippines. PCARRD. 1988.

Moseman, A.H., ed. National Agricultural Research Systems in Asia. New York, U.S.A. The Agricultural Development Council Inc. 1971.

Murphy, J. Strengthening the Agricultural Research Capacity of the Less Developed Countries: Lessons from AID Experience. AID Program Evaluation Report No.10. Washington, DC. U.S.A. USAID. 1983.

Pardey, P.G., J. Roseboom. ISNAR Agricultural Research Indicator Series: A Global Database on National Agricultural Research Systems. Cambridge, U.K.: Cambridge University Press. 1989.

Pardey, P.G., J. Roseboom, and J.R. Andersen, eds. Agricultural Research Policy: International Quantitative Perspectives. Cambridge, U.K.: Cambridge University Press.1991.

Pasandaran, E. Sensitizing Agricultural Research to Community Development Needs in Indonesia. Paper Presented during the Expert Group Meeting on Sensitizing Agricultural Research to Community Needs, August 17-20, 1993 at ESCAP, Bangkok, Thailand. Jakarta, Indonesia: Center for Agro-Socioeconomic Research. 1993.

Pinstrup-Andersen, P. Agricultural Research and Technology in Economic Development. New York, U.S.A. Longman Inc. 1982. Rural Development Admistration. Annual Research Report for 1992. Suwon, Korea: RDA. 1992.

Senanayake, Y.D.A. Overview of the Organization and Structure of National Agricultural Research Systems in Asia. ISNAR paper No. 32. The Hague, Netherlands: ISNAR. 1990.

Southeast Asian Regional Center for Graduate Study and Research in Agriculture. Agricutural Research Management; Asia. Volume 2. Los Baños, Laguna, Philippines: SEARCA. 1977.

Southeast Asian Regional Center for Graduate Study and Research in Agriculture. Agricultural Research Management: Asia. Volume 3. Los Baños, Laguna, Philippines: SEARCA.1981.

XII. APPENDICES: AGRICULTURAL RESEARCH SYSTEM

DEMOCRATIC REPUBLIC OF CAMBODIA

AGRICULTURAL RESEARCH SYSTEM

The agricultural research system in Cambodia is starting to be rebuilt after the ravages of the civil war for the past 17 years. Agricultural research in the country is conducted mainly through the Ministry of Agriculture and some agricultural schools.

The Ministry of Agriculture operates 18 provincial research stations throughout the country. It conducts technology verification researches on rice varietal improvement and integrated pest management.

The research program of the country particularly on rice is supported by the International Rice Research Institute (IRRI) which provides technical assistance and training support to researchers of the country.

PEOPLE'S REPUBLIC OF CHINA

EVOLUTION

China's agricultural research system started at the beginning of this century with the establishment of the first agricultural experiment station in 1902 in Hebei province, and another experiment station in Beijing in 1906. The 1911 revolution which overthrew the Qing dynasty paved the way for modernizing the country. This precipitated the establishment of a number of agricultural experiment stations. Likewise, several universities started their research activities in agriculture. In 1932, a Central Experiment Institute was founded near Nanjing, then the capital of China.

The establishment of the People's Republic of China in 1949 provided a positive environment for the agricultural sector particularly on agricultural research. The new government gave significant attention to the development of the country's agricultural research capability through the establishment of the Chinese Academy of Science (CAS) in 1949. Initially, the CAS was responsible for research in the general and agricultural sciences. In 1952, it reorganized the existing agricultural research institutions into seven major research institutes, of which, five were area-based and two were specialized institutes on veterinary and sericulture researches.

In 1957, Chinese agriculture undertook a strategic step with the establishment of the Chinese Academy of Agricultural Sciences (CAAS) and local-level academies of agricultural sciences in each province, municipality, and autonomous region. This move enabled the country to organize a functioning national agricultural research system. CAAS was mandated to conduct national agricultural researches with multiple disciplines and to serve as an academic center for agricultural research.

The cultural revolution in 1967 shifted the focus of agricultural research to a more practical and problem-solving approach. Most national research institutes were disbanded and many resources and personnel were transferred to the rural areas. Agricultural research was done off-station with the direct participation of farmers. Basic research in the agricultural sciences was almost nonexistent. These changes, however, formed a four-level agricultural sciences and technology network below the provincial level which facilitated the transfer of new techniques to the farmer's field.

The end of the cultural revolution in 1979 made the government realize that the key to increasing agricultural productivity was based on an effective research system. Soon after, many research institutes were reconstituted and relocated back to the cities to conduct more formal experimentation and basic research.

At present, the CAAS is under the Ministry of Agriculture. It is the principal national-level agency mandated to conduct and coordinate agricultural research. Specifically, its main tasks are as follows :

1) Undertake research on applied science and basic theories in agriculture, to solve primarily the key problems which have significant economic value and technical means so as to continuously raise national agricultural production.
2) Strengthen fundamental research, to exploit new techniques and methods in various fields, and to train research personnel, so as to constantly improve agricultural research work.
3) Organize nationwide research coordination in order to tackle many important subjects and to provide professional institutions in agricultural production and research.
4) Edit and publish agricultural periodicals and other works, organize academic activities and carry out international exchanges and collaborations so as to keep up with the development of agricultural science and technology at home and abroad.

The national agricultural research system of China consists of research institutes of the CAAS and other state level research institutions under the Ministry of Agriculture, the Institute of Agricultural Mechanization Sciences under the Ministry of Machine Building, and the Institute of Water Construction under the Ministry of Water Conservancy. The CAAS operates 35 institutes or laboratories, including a post-graduate school of agricultural sciences and a library. Overall, there are 59 national, 359 provincial and 671 prefectural level research institutions. In addition there exists an adaptive research network in each of the prefectures, with a total of over 100,000 facilities. China's 64 agricultural colleges and universities also conduct research in agriculture most of which are funded by the CAAS.

GOALS/OBJECTIVES

The agricultural research program of China is influenced by the following research goals :

1) Development of under-exploited regions and establishment of stable yield and commodity production bases.
2) Protection of the farm environment.
3) Intensification of basic researches.
4) Development of efficient storage techniques and prevention of post-harvest losses.
5) Intensification of germplasm conservation.
6) Analysis of socioeconomic aspects of various production systems.

RESOURCE GENERATION

The Chinese government provides substantial support to strengthening its agricultural research capability. Funding support to its agricultural research programs are generated internally. External assistance is quite limited although in recent years the country is increasingly becoming open to international collaboration in agricultural research particularly with the IARCs.

SYSTEMS SUPPORT

A. Research Programming

The guiding principle for science and technology in China is "economic construction relies on science and technology". The purpose of agricultural research follows this principle.

At the national level, the CAAS provides the overall guidance in the formulation of research programs and priorities. For specific research institutions at the different levels, the task is done by the institution's academic committee. The committee discusses, studies and evaluates the research orientation; determines the task, programs and plans of the institutions; nominates talented staff for advanced training; and, provides guidance in the scientific management of the institution.

B. Infrastructure Development

The scientific infrastructure of China has grown tremendously over the past 40 years. The build-up of scientific infrastructure was financed almost internally. The establishment of national agricultural research institutions are supported by the Ministry of Agriculture, the State Planning Commission, the State Economic Commission, and the State Scientific and Technological Commission. The establishment of local level research institutions, however, are funded by the local governments. In case, the institution will undertake a national project, the State Commissions provide funding support.

C. Human Resource Development

Until the 1980s, the scientific manpower of China was equipped mostly with basic educational qualifications. Advancement in scientific skills and knowledge are provided through non-degree trainings. Only in the mid-1980s did the country adopt an academic-degree system that produced its first batch of graduate students with a Master's degree. The situation indicates that most of the country's scientific manpower have limited graduate degree trainings.

D. Research Policy

In order to support the economic construction program of China, agricultural research activities must develop appropriate technologies to farmers, increase the competitiveness of commercial crop production, and adjustments be made in the existing system, policy, task, and cost of research. Moreover, the level of management of agricultural research must be raised further.

E. Information Resource Development

The management of the information resources of the CAAS is undertaken by the Library of the Chinese Academy of Agricultural Sciences. It is responsible for safekeeping the Academy's collection of books and the publication of the research output of the various institutions of the Academy.

F. Linkages

The CAAS maintains linkage with the country's agricultural colleges and universities. These educational institutions are often tapped to do research work and to train its scientific manpower.

During the past decade, China started the conduct of collaborative work with international development organizations including the IARCs. This collaboration is designed to introduce advanced foreign technology

to China's agriculture, acquire advanced equipment for its agricultural research institutions, and participate in an international exchange programs involving scientists, genetic materials, and biological control of pests.

REPUBLIC OF INDONESIA

EVOLUTION

Agricultural research in Indonesia started during the Dutch colonial period with the establishment of the Estate Botanical Garden in 1876. The Garden was a pioneering research institute that tested the adaptability of potential crops particularly export commodities. This was followed by the establishment of single-commodity experiment stations for important export crops such as sugarcane, coffee, and tea in the late nineteenth century. In the early twentieth century, research facilities for veterinary medicine, forestry, fisheries, soils and agro-geology were likewise established. By 1941, most of the agricultural research conducted were done by the private sector. However, more than half of the research workforce were employed by the state-owned research institutes. Most of these research institutes were located in Java.

Recognizing the importance of agricultural research in supporting the Indonesian government's overall agricultural development programs and to alleviate the weakening cooperation among research institutes, the government established the Agency for Agricultural Research and Development (AARD) through a Presidential Decree in 1974. Since then, it has undergone two reorganizations designed to improve its organizational effectiveness. The AARD is the national agricultural research agency under the Ministry of Agriculture. At present, most agricultural research in Indonesia is done through state-owned research institutes and centers under the supervision of AARD.

The current mandate of AARD which was formulated in 1984 is to conduct and coordinate agricultural research to support national development. Specifically, its functions are as follows:

1) Plan programs and coordinate the management of research and development within the Ministry of Agriculture.
2) Formulate technical policies to guide and control all agricultural research matters, including the setting-up of programs and methods involving personnel recruitment, financial administration/management, equipment supply and maintenance of scientific reports, research and development.
3) Manage agricultural research centers, institutes, stations, laboratories, experimental farms, and libraries.
4) Control the management, maintenance and development of all research units which are the main responsibility of the Ministry of Agriculture.
5) Evaluate the research findings and performance of all research units.

The current organizational structure of AARD consists of a Secretariat, two research centers (Soil Research and Socio-Economic Research), two centers (Agricultural Research Programming, and Agricultural Library and Research Communication), five research coordinating centers (Food Crops, Industrial Crops, Horticulture, Animal Science, and Fisheries), and sixteen research institutes (six for food crops, three for industrial crops, two for horticultural crops, two for animal science, and three for fisheries). In addition, the AARD provides financial support and coordination to six research centers for estate crops through the chairmanship of the Director-General of AARD in the Management Boards of

these estate crops. Collectively, the AARD has 40 research stations, 181 experimental farms and ponds, 63 laboratories, and several research vessels located throughout the archipelago under its jurisdiction.

The national agricultural research system of Indonesia is largely autonomous though subject to the directions and priorities of the Ministry of Agriculture to support its agricultural development programs. Since its establishment, it has become increasingly strong in advancing policies and spearheading the implementation of agricultural research supportive to the development thrusts and priorities of Indonesia.

GOALS/OBJECTIVES

For its current planning phase, the research programs of AARD are guided by the following research goals:

1) Support the sectoral goals of sustaining rice self-sufficiency.
2) Promote diversification for export purposes, import substitution, and agribusiness development.
3) Improve the well-being of the farmers.
4) Optimize the use of agricultural resources.
5) Expand employment opportunities.

RESOURCE GENERATION

The Indonesian Government provides strong support for strengthening its research and development activities through funding of its research programs from sectoral development funds.

This is complemented by foreign assistance in the form of technical assistance and project aid. For the past two decades, numerous research units within AARD have benefited from foreign assistance which were used partly to finance the development of its research infrastructures and the development of its human resources.

Currently, the AARD is looking into the possibility of private financing to supplement public funding for agricultural research. It has identified the following possible sources of additional funds:

1) tax credits
2) levy imposed on commodities during marketing
3) research foundation
4) private donors
5) contract research

Moreover, some research units of AARD are already practicing the commercialization of its facilities which can generate a significant amount of research funding if institutionalized within the AARD.

SYSTEMS SUPPORT

A. Research Programming

The research programs of AARD are guided by government policies for agricultural development and the overall national development goals. Research priorities are determined based on their effect on

the country's strategic concern on diversification, extensification, and rehabilitation; efficiency of regional resource endowments; creation of new opportunities for agricultural growth and development; distributive impacts; and a concern to achieve sustainability in agricultural production and incomes. Moreover, in line with the government's concern for the role of women in development, the AARD has been actively involved in supporting various studies related to women.

The Center for Agricultural Research Programming (CARP) is the organization within the AARD that is responsible in programming the financial and human resource allocation for its various agricultural research programs.

The following criteria are proposed to be used in identifying research priorities:

1) Responsiveness to commodities and research areas that are of political, economic, and social strategic importance.
2) Probability that the research will generate a fair balance of growth and equity-oriented development expenditures that can:
   (a) provide ample social and economic benefits
   (b) provide a broad spread of such research benefits to include the low income population and to areas of marginal resource endowment.
3) Allocation to pioneering research such as biotechnology and new product development that will expand the frontiers of the agricultural sector or lead to greater diversification of the farm sector.

B. Infrastructure Development

The research infrastructure during the late 19th century until the establishment of AARD was concentrated on the island of Java where most of the economically important export crops were cultivated. The establishment of AARD puts emphasis on the development of an adequate infrastructure essential to a productive research program. Likewise, the location-specific nature of most agricultural technology and the diversity of resources owing to the archipelagic nature of Indonesia prompted AARD to develop 10 research complexes. These complexes are located in Northern Sumatra, Central Sumatra, Southern Sumatra, Western Java, Eastern Java, Kalimantan, Northern Sulawesi, Southern Sulawesi, Maluku, and Nusa Tenggara.

Each complex is made up of research institutes, laboratories, germplasm centers, and experimental stations. They perform location-specific technology adoption and testing to support agricultural development programs in their respective regions as well as research programs of national importance. Agricultural colleges and universities in each of these complexes, although not part of the AARD, provide additional facilities to support the research effort.

C. Human Resource Development

Along with infrastructure development, the development of the country's scientific workplace was the other half of AARD's pursuit of a productive research program. With financial support from foreign and domestic funds, AARD was able to implement a significant manpower development program that almost doubled its manpower resources from a total of 3,608 in 1975 to 7,567 in 1985. More importantly, it produced over 100 PhDs in 1985 compared to 16 in 1975. It is projected that by 1995, the AARD could have provided advanced degree training to an additional 3,000 staff.

Personnel in the support services are continuously trained to provide ample assistance to the technical staff. Critical shortages of personnel are often experienced in the areas of library, farm management, field and laboratory techniques, information and publication.

D. Research Policies

In consonance with Indonesia's second 25-year national development plan, the AARD has established eight research policies laying the groundwork for the new era of development. These are:

a) Development of location-specific technology packages that are integrated with overall development aims.

b) Development of specific agricultural commodities on a regional basis.

c) Increased diversification in the agricultural production system in relation to agro-industrial development and consumer/market requirements.

d) Increasing production efficiency in anticipation of the transition to an agricultural system based on more capital investment and reduced labor requirements.

e) Encouraging the shift from subsistence to commercial agriculture to achieve greater efficiency of scale.

f) Promotion of more balanced development between regions.

g) Preservation and protection of the nation's natural resources through the development of sustainable agriculture.

E. Information Resource Development

AARD has recently put emphasis on research communication. It has even established a center (Center for Agricultural Library and Research Communication) assigned to coordinate and strengthen the communication and informational needs of the agency as well as its agricultural information networks and exchanges.

F. Linkages

The AARD has developed linkages and working relations with Indonesian agricultural universities and international agricultural research centers. Likewise, bilateral assistance from various sources has made it possible to develop linkages with universities and research institutions in developed countries.

The International Rice Research Institute (IRRI) has been the foremost and strongest international agricultural research center to link with AARD. The ESCAP/CGRPT, an international research coordinating institution, is based in Bogor, Indonesia.

REPUBLIC OF KOREA

EVOLUTION

Organized agricultural research in Korea started in 1905 when an agricultural demonstration farm was established at Seoul. In 1906, the farm was moved to Suwon. It was intended to obtain basic data for farming and to introduce modern agricultural farming techniques to farmers. In 1929, the farm was expanded

and renamed as the Agricultural Experiment Station with several branch stations established in different localities.

After the second world war, the station was again renamed as the Central Agricultural Experiment Station. Additional institutes, the Central Livestock and Horticulture, were established in 1952 and 1953, respectively. In 1957, an Agricultural Extension Act founded the Institute of Agriculture which formed the nucleus for conducting organized research, extension, and training programs that rehabilitated, reorganized, and reconstructed badly damaged agricultural facilities during the Korean War. The institute made rapid progress in many fields of agricultural research particularly in developing superior varieties of food grains, improved cultural practices, plant nutrition, animal breeding, forage production, and cash crop production.

In 1962, the Rural Development Act established the Office of Rural Development which succeeded the Institute of Agriculture. It was tasked to develop Korean agriculture through scientific studies. By the 1970s, the Office of Rural Development was renamed as the Rural Development Administration (RDA) to systemize the organization for agricultural development. The RDA is under the Ministry of Agriculture, Forestry and Fishery and is responsible for agricultural research and extension (research on fishery and forestry is not considered part of agricultural research).

To date, the RDA is composed of six bureaus (Planning and Management, Research, Rural Guidance, Technical Dissemination, Farm Management, and Institutional Cooperation), 15 research institutes and experimental stations (Agricultural Science Institute, Agricultural Biotechnology Institute, Veterinary Research Institute, Agricultural Mechanization Institute, Fruit Trees Research Institute, Agricultural Chemical Research Institute, Crops Experiment Station, Horticultural Experiment Station, Semicultural Experiment Station, Livestock Experiment Station, Alpine Experiment Station, Jejn Experiment Station, and Rural Nutrition Institute), and nine provincial rural development administrations (PRDAs). In addition, it operates a Technical Information Center and a General Services Department.

Basic fundamental studies are conducted in the central institutions while region-specific and commodity-oriented studies are done in the PRDAs. In some cases, country offices of extension services are equipped with partial research capability.

GOALS/OBJECTIVES

The RDA has taken on the important tasks of renewing Korean agriculture through self-reform and self-purification, and operationalize by its new agricultural farm management approach-technology, high quality sustainability, and export agriculture. This will result in improving the efficiency of farm technologies to meet the demands of competitive agriculture and the need for substantial increases in farmers' income. Korean agro-technology development activities are based on the following objectives:

1) Stable and labor-efficient production of major grain crops.
2) Quality improvement and cost-efficient production of cash crops and livestock.
3) Safe and pollution-free crop production and adequate pest management.
4) Creation of extra revenues by exploiting high-technology agriculture.
5) Technical support on the production for special local or export markets.
6) Development of sustainable agriculture.

RESOURCE GENERATION

Agricultural research and extension activities conducted by RDA are exclusively supported by the Korean government. Private sector participation in agricultural research is becoming significant based on its sizeable budget, but still very limited. However, some special research projects are funded from various sources - domestically and internationally.

In 1993, the RDA allocated some 25% of its research budget to the improvement of research facilities and some 10% for the purchase of new equipment.

SYSTEMS SUPPORT

A. Research Programming

The Research Bureau coordinates the programming of the various research programs of the research institutes, experiment stations, and PRDAs. Priority is given to programs that contribute to the welfare of rural communities particularly those that increase farmers' income, solve farm problems, reduce production cost, and enhance product quality.

The Research Bureau sets research priorities through information collected from the Ministry of Agriculture, Fisheries and Forestry, researches, the Agricultural Institutional Cooperation Committee, PRDAs, and extension channels. The information collected is used to prepare the Guidelines for Research Projects.

B. Infrastructure Development

The development of the RDA's research infrastructure was made possible through substantial financial assistance from the USAID, FAO, and other sources during the mid-1970s.

C. Human Resource Development

The manpower resource of RDA has increased significantly from its early beginning as an experiment station with 106 staff, of which 95 were involved in research, to a total of 7,673 staff during the start of the Office of Rural Development. Of this, 856 were involved in research and 6,587 were involved in rural guidance (Extension). A total of about 10,000 staff, of which 2,000 are research staff and 7,000 are extension staff are now employed by the RDA. The shift from purely research organization in its early beginning to a more extension-oriented organization reflects the Korean Government's commitment to the modernization of the rural sector. Higher salaries and more opportunities for professional advancement provide incentives to make a career in research and extension worthwhile.

After the Korean War, advanced degree trainings for its research and extension staff were provided through generous financial assistance from foreign development agencies like the USAID and FAO, among others.

D. Research Policies

The structure of the Korean economy has already shifted from an agriculturally-oriented to an industrial economy. Tremendous changes have taken place in the Korean rural society due to rapid urban

industrialization. The previous program on "food self-sufficiency" concentrated research and extension resources to rice which limited the development of other commodities. Thus, changes to be made should be in its basic approach of increased food production to the concept of achieving agricultural competitiveness locally and internationally. This is in anticipation of the restructuring of the world trade scenario with the approval of the General Agreement on Tariffs and Trade (GATT).

The change in orientation should provide support to develop advanced agricultural technologies and at the same time ensure that the technologies developed are sustainable. Likewise, the intensification of agriculture should aim at cost minimization through farm mechanization and automation of production-processing-marketing systems.

E. Information Resource Development

The information resources of RDA is managed by the Technical Information Center. The center operates and manages the library, the publication of all available research data, and the exchange and procurement of reference publications. The center also provides technological information from the research sector to the Technical Dissemination Departments for the training of extension workers and knowledge transfer to farmers.

F. Linkages

The RDA maintains close linkages with agricultural colleges and educational institutions, the private sector companies involved in agribusiness, and various international agricultural research institutions.

Within the RDA structure, an Institutional Cooperation Committee manages the cooperation and linkages between RDA and agricultural educational institutions. The linkage mechanism of RDA is more domestically-oriented.

LAO PEOPLE'S DEMOCRATIC REPUBLIC

AGRICULTURAL RESEARCH SYSTEM

The development of agriculture is the responsibility of the Lao Government's Directorate of Agriculture. The main thrusts of the Directorate are the development and maintenance of irrigation facilities, agricultural crop research, production of vegetable crops, and dissemination of agricultural production and home economics information to farmers and their wives.

In charge of the production of rice and vegetable crops is the Bureau of Research. During the early years of its existence, the Bureau did not establish priorities and project assistance were spread very thinly over crops, resulting to very insignificant research outputs.

Almost all of agricultural research in Lao PDR is adaptive. Basic research was never undertaken. Research is conducted by research centers working on rice, maize, legumes, rootcrops, sorghum, groundnuts, and vegetables. These are:

1) Na Phok Agricultural Research Center
2) Salakham Agricultural Research Station
3) Hat Dok Keo Agricultural Research Station

RESOURCE GENERATION

The Lao PDR research system relies quite heavily on external funding. The major sources of foreign funding are the UNDP and FAO. Although this is inadequate, the country's R & D activities are nevertheless continuously supported. Other sources of external funding are ADB, Swedish International Development Authority (SIDA), USAID, World Bank, Australia, Cuba, Czechoslovakia, EEC, German Democratic Republic, Hungary, India, New Zealand, and the USSR.

SYSTEMS SUPPORT

A. Research Programming

The country aims to diversify into cotton, jute, sugarcane, animal feed and other raw materials. Other programs given emphasis are food self-sufficiency; the promotion of export crops such as coffee, cardamon, and benzoin; intensification of crop production in the lowlands; promotion of organic recycling and use of manure; reduction of slash-and-burn cultivation in the uplands; and promotion of the use of renewable energy sources.

The major research priorities in agriculture include:

1) characterization of soil types and agro-ecological zones
2) crop capability analysis
3) crop diversification
4) crop improvement and management
5) supply of animal feed resources
6) infectious diseases and parasites
8) freshwater aquaculture systems

B. Human Resource Development

The research staff are sent abroad, particularly to the Philippines and Thailand, to earn technical competence in the conduct of adaptive research. Teaching on rice technology is undertaken by the Salakham Experiment Station. The station also conducts seminars on program planning and evaluation. Degree trainings are pursued in the U.S. and other European countries

GOVERNMENT OF MALAYSIA

EVOLUTION

The establishment of the Department of Agriculture in 1905 institutionalized the agricultural research in Malaysia which was tasked to conduct research on all crops including natural rubber and livestock. The expansion of the rubber industry prompted private agricultural companies to establish their own research stations (Dunlop Research Station and Chemera Research Station) in 1920. Not to be outdone, the government established the Rubber Research Institute of Malaysia in 1925. Its primary task was to conduct research in all aspects of rubber cultivation and latex production, and was later on expanded to include technological end-use studies.

In 1969, the Malaysian Agricultural Research and Development Institute (MARDI) was established to address the diversified commodity structure of Malaysian agriculture. Initially, palm oil research was done by MARDI but the rapid expansion and increasing importance of palm oil motivated the government to establish the Palm Oil Research Institute of Malaysia in 1979.

To date, agricultural research in Malaysia is dominated by public research institutions. It consists purely of four monocrop autonomous research institutions (Rubber Research Institute of Malaysia, Palm Oil Research Institute of Malaysia, Forestry Research Institute of Malaysia, and the Malaysia Cocoa Board), one multi-crop autonomous research institution (MARDI), two national department-based research institutes (Veterinary Research Institute and Fisheries Research Institute), and several state department-based research divisions. In addition, three state-owned universities have active research programs in the various areas of agricultural sciences.

Among these institutions, the MARDI by virtue of its multicrop responsibility functions is regarded as the premier and largest agricultural research institution in Malaysia. Originally, MARDI was tasked to conduct scientific technological, sociological, and economic research on the production, utilization and processing of all crops (except rubber and palm oil), livestock, and freshwater fishery. Freshwater fishery research was transferred with the establishment of the Fisheries Research Institute. Subsequently, MARDI was instructed to be a center for specialist extension services and technical training of workers in the agricultural industry. Recently, MARDI's mandate was expanded to conduct commercial ventures either solely or jointly with the private sector in order to promote commercially viable technologies.

GOALS/OBJECTIVES

The goals and objectives of the various agricultural research institutions are guided by prevailing economic policies and the national agricultural policy.

For MARDI, its research goals and objectives has shifted from that of a production-based self sufficiency approach until recently, to a more commercialized agriculture, supportive of the industrialization plan of the country. Specifically, its new major R & D objectives are:

1) Diversification and commercialization of the agriculture sector.
2) Development and modernization of food processing industries.
3) Management and conservation of environmental and natural agricultural resources.
4) Exploitation of innovative and frontier R & D.
5) Strengthening and enhancing the effectiveness of technology transfer and adoption.

RESOURCE GENERATION

Agricultural research activities conducted by the public sector are funded either from the central budget or from the collection of research cess (export or production levy), as in the case of the Rubber Research Institute of Malaysia and the Palm Oil Research Institute of Malaysia.

However, fluctuations in the export market and production of rubber and palm oil have made the cess revenue inadequate to support the activities of these institutes. Thus, the current financing of rubber and palm oil research activities now comes from both the central budget and cess revenues. Moreover, the revenue-earning measures instituted by MARDI from its contract research activities, consultancy and

expert services, production of farm products, publications, and commercial joint-venture projects have provided additional funds to support its research activities.

SYSTEMS SUPPORT

A. Research Programming

Research activities that are conducted by the different research institutions are guided by committees, councils or governing boards which support the leadership of these institutions in setting the research program and in priority determination. Though these committees/councils/governing boards are named differently depending on the institutions they are under, it seems that they are all multi-sectoral in their representation.

The establishment of the National Council for Scientific Research and Development threatens the autonomy of these research institutions in research programming as it intends to function as an apex organization for R & D coordination. However, it has not exercised enough clout.

B. Infrastructure Development

Each autonomous research institute maintains its own network of research stations throughout the country. MARDI has the largest network of nine research stations, followed by PORIM with six research stations, and RRIM and FRI with five each. The development of these research facilities was funded generously in recognition of the importance of R & D to agricultural growth and economic development.

For the medium-term (1991-1995), the Malaysian government is allocating RM 83 million for the physical development of MARDI.

C. Human Resource Development

The expansion of agricultural research entails a corresponding increase in the number of its scientific workplace. In 1983, a total of 708 agricultural scientists were employed by the various research institutions, of which 432 were from MARDI. In 1993, MARDI's research workforce totaled 456.

During the last decade, MARDI and RRIM aggressively pursued a post-graduate training program designed to increase the number of agricultural researchers with advanced degrees such that by 1993, about 50% of the Ph.D. degree holders in agriculture could be found in these institutions.

D. Research Policies

Research policies determination in most cases is left to the discretion of the research institutions concerned. Although there is a National Council for Scientific Research and Development, its functions have been streamlined to an advisory nature.

Generally, research policies are determined based on:

1) Economic indicators
2) Potentials of the commodity for commercialization
3) Socioeconomic condition of the farmers/fishermen
4) Scientific and technical indicators

5) Researchability
6) Information gaps
7) Government directives

E. Linkages

Agricultural research institutions directly link with both domestic and international institutions. Generally, these institutions link with the extension agencies of the different ministries, the government development agencies, and the private sector. External linkages are established through bilateral and multilateral agreements with international funding and agricultural research institutions. These linkages are in the form of agricultural technologies transfer and exchange of information.

UNION OF MYANMAR

AGRICULTURAL RESEARCH SYSTEM

Agricultural research in Myanmar evolved from rice research particularly on irrigated and rainfed areas. Current research efforts are focused on crop diversification and farming systems research involving other agriculturally important commodities such as corn, cotton and jute, oilseeds, pulses, sugarcane, fruits and vegetables. In addition, livestock and fisheries research are given substantial support.

For crop research, the country maintains a network of research facilities spearheaded by the Agricultural Research Institute located near Yezin. The Institute conducts basic and applied research on agronomy, botany, soils and agricultural chemistry, plant pathology, and entomology for rice and other important commodities. The research work at the Institute is oriented to increase production through quality seeds, improved crop management and protection techniques, more efficient nutrient methods and better cropping systems suited to each agro-ecological condition. Likewise, it provides training of research staff of the Central Agricultural Experiment Stations and extension workers. Under the Institute are 16 Central Agricultural Experiment Stations and 54 substations located in different regions of the country. The results from the research programs of the Institute are passed on to these stations/substations for further testing under specific regional conditions. These stations/substations are also responsible for solving specific agricultural problems in their respective areas of responsibility.

For livestock research, two departments (Veterinary and Animal Husbandry, and Livestock Development and Marketing) are mandated to provide R & D support to the livestock industry. The Veterinary and Animal Husbandry Department conducts research in livestock breeding, livestock farming, veterinary medicine, and artificial insemination. The Livestock Development and Marketing assists farmers in building up the infrastructure for the livestock industry, provide good quality breeding stock, economical and scientific feed stuff, and production of appropriate vaccines.

Fisheries research is handled by the Fisheries Research Section of the Department of Fisheries. It is responsible for sustainable exploration of the country's fisheries resources, identification and bionomic studies of various fishes and crustaceans of economic importance, assessment of fisheries stock, assessment of water pollution in fisheries and improvement in induced breeding techniques. Research in this sector is hampered by an acute shortage of trained manpower.

The research system of Myanmar is manned by about 267 scientists-researchers, most of which are involved in crop research.

LINKAGES

The research system maintains linkages with several bilateral and multilateral agencies such as the International Rice Research Institute (IRRI) and the Food and Agriculture Organization (FAO), among others. The IRRI provides support to the rice research program of the country while the FAO has supported fisheries research during the 1980s. These linkages provide additional financial, technical, and training support for the country's research system.

REPUBLIC OF THE PHILIPPINES

EVOLUTION

Agricultural research in the Philippines started with the establishment of the Bureau of Agriculture in 1910. Research activities were mainly done by government agencies and received minimal support until after the second world war. Only in the mid-1950s was agricultural research intensified through the efforts of the University of the Philippines College of Agriculture (UPCA). In 1971, agricultural research system in the country was characterized as fragmented and had no noticeable impact on the economy. This was attributed to the absence of a planning and coordinating body which would orchestrate research nationwide. The need to upgrade the national research capability in agriculture (including forestry and fisheries) gave birth to the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD).

The Council has been the central research coordinating authority which endorses government- funded research in agriculture and natural resources. In addition, the Council was given the responsibility to formulate national research programs and implement policies and guidelines governing the conduct of research within the NARS.

Agricultural research in the Philippines is basically conducted by five groups of agencies, namely:

1) the Department of Agriculture (DA)
2) Department of Science and Technology (DOST)
3) State Colleges and Universities (SCUs)
4) the Local Government Units (LGU)
5) the private sector

The research and development activity in agriculture and natural resources are coordinated by PCARRD which was established in 1972. With the very broad area of coverage, the coordination of research on fisheries was withdrawn from PCARRD and transferred to a newly created council, the Philippine Council for Aquatic and Marine Research and Development (PCAMRD) which was established in 1987. Both councils are under the DOST.

The government reorganization of 1987 limited the authority of PCARRD to directly coordinate the R & D activities of the various Department of Agriculture (DA) research implementing units, being under the Department of Science and Technology (DOST). This prompted the DA to establish the Bureau of

Agricultural Research (BAR) in 1987. The BAR is the central research coordinating body of the Department of Agriculture, operating under the PCARRD umbrella known as the National Agriculture and Resources Research and Development Network (NARRDN).

In the Department of Agriculture, (DA), the central research coordinating responsibility is lodged in the Bureau of Agricultural Research (BAR). Created in 1987, BAR carries out the direct coordination and monitoring of the DA research activities, a function which it has taken over from PCARRD. Currently, PCARRD merely deals with BAR to keep abreast of the Department's research activities.

There is a division of responsibility for agricultural research in the country. The upstream or basic type of research are usually done by the SCUs, while the downstream type or development research remains with the DA. The SCUs are assigned the lead role in technology generation, despite the well equipped and strategically located field stations and laboratories of the DA. This is attributable to the former's overwhelming concentration of research expertise.

The NARRDN consists of various agencies involved in the generation of technologies for agriculture and natural resources sectors. The network is composed of national research centers, regional research centers, cooperating stations and other specialized agencies. These include leading SCUs, the Department of Agriculture, the Department of Environment and Natural Resources (DENR), leading private agencies, and other specialized agencies like the Bureau of Agricultural Statistics (BAS) of the DA.

For a more effective coordination of research at the regional level, PCARRD organized the Regional R & D Consortium in each of the 13 regions of the country with a designated lead institution. The member agencies of these consortia are the leading SCUs in the respective regions, DA Regional Field Offices, PCARRD, PCAMRD, BAR, Environmental Research and Development Bureau (ERDB) of the DENR, DOST, and the National Economic and Development Authority (NEDA).

Research undertaken by the private sector focuses on plantation management, seeds, pesticides, livestock, and processing. For crops, the object of research activities are rice, corn, sugarcane, coconut, tobacco, fruits and vegetables, and other crops.

GOALS/OBJECTIVES

For the medium-term, the conduct of agricultural R & D will be geared towards the following concerns:

1) Improvement of farm productivity,
2) Improvement of the quality of farm products,
3) Increase in volume of export of agricultural products, and
4) Promotion of sustainability of resource base.

RESOURCE GENERATION

Funding for public sector R & D in agriculture comes from three main sources. These are taxes, budget allocations, and loans and grants. Taxes on production of certain agricultural commodities are used for R & D on those specific commodities. Taxes on coconut, sugarcane, tobacco, and forest products are used to fund research activities of the Philippine Coconut Authority (PCA), Sugar Regulatory Authority (SRA), National Tobacco Administration (NTA), and the Forest Products Research and Development

Institute (FPRDI). Other substantial amounts of taxes generated are from the registration of motor vehicles, called special science fund. This is administered by the DOST and distributed to various research institutions as grants-in-aid.

The bulk of the research fund is appropriated by the national government, a sizeable portion of which is allocated to DA and DENR. Other substantial sources are loans and grants from international institutions. The major grant donors are USAID, IDRC, JICA, ACIAR, EC, UN agencies and the Federal Republic of Germany (FRG). Other funds are in the form of loans from the World Bank and the ADB.

Funding support to agricultural research have been variable through the years. From 1971 to 1980, there was an increasing trend in R & D fund appropriated by the government. From P 44.5 million in 1971, the appropriation increased to P 83 million in 1980. In 1981, the amount went down to P 61.8 million and further to P 47.6 in 1983. Since then, funding support has increased substantially. In 1993, funding support to R & D activities amounted to P 476.3 million.

SYSTEMS SUPPORT

A. Research Programming

The BAR formulates the medium-term National Agricultural Research and Extension Agenda (NAREA) in coordination with PCARRD and PCAMRD. The NAREA aims to correct the imbalance in the allocation of research resources among development zones, namely: the uplands, hillylands, lowland rainfed/irrigated, marine waters, brackishwaters, and inland waters. The Agenda also provides for an alignment of research to the real needs of farmers and fishermen through regional consultations. The consultations are conducted with representatives drawn from member-agencies of the Regional R & D Consortia, Provincial Agricultural Offices, and farmers' and fishermen's organizations.

The process of research prioritization utilized in the recently formulated agenda (1993-1998) was influenced by the decision-support system for research prioritization developed through the Research Priorities for Philippine Agriculture Project (RPPAP), which was supported by the Australian Centre for International Agricultural Research (ACIAR). The RPPAP model was utilized to minimize subjectivity in setting research priorities with the use of some quantifiable parameters. These are production, consumption, and price data; supply and demand elasticity estimates; probability of research success, spill-over effects of research, and ceiling levels of technology adoption, among others. The RPPAP model was a joint undertaking of the DA through the BAR, BAS, and the Planning and Monitoring Service, PCARRD, UPLB, and the Australian National University (ANU).

B. Infrastructure Development

In the DA, R & D activities are done nationwide. These are undertaken by its Regional Field Offices located in each of the thirteen regions of the country, four staff bureaus, and six attached agencies.

The DA staff bureaus and attached agencies operate a total of 46 national research centers. The Regional Field Offices manage a total of 88 regional research facilities, consisting of 13 Regional Integrated Agricultural Research Centers and 75 Research Outreach Stations.

The PCARRD through the SCUs maintains six national research centers and six regional research centers, and numerous cooperating centers for agricultural R & D.

Provincial level verification researches are conducted through the LGUs. Overall, the LGUs operate a total of 143 provincial level facilities which were devolved to the LGUs by the DA along with its extension service under the Local Government Code enacted by the Congress.

The DA, through the initiative of BAR, embarked on the rationalization of its research stations to improve the delivery of its technology support to the clientele. The objective was to reduce the number of stations and maintain only those located in strategic areas. The rationalization program was enhanced by the implementation of the Local Government Code which devolved the provincial service stations of the DA to the local government units. As a result, the Department's regional R & D stations were trimmed down to 88.

However, these stations need some upgrading and improvement in terms of infrastructure and facilities development/acquisition. The development of these facilities, however, is constrained by the lack of funds for this purpose from the national government. Other sources of funds, specifically foreign donors or loans, are being tapped for the purpose.

C. Human Resource Development

The Philippine NARS has a fairly strong research staff, but most of these are concentrated in the SCUs. This is the case since these universities/colleges have tie-ups with international foundations and other institutions which offer scholarships for postgraduate degrees.

At the DA, there is limited fund appropriation for human resource development, mostly intended for short-term non-degree trainings. Very few research staff are given the opportunity to pursue postgraduate degrees. These are available only through the few scholarships granted by PCARRD and foreign universities/ institutions.

Another source of funding for training is the ADB-funded Fishery Sector Program (FSP) Research Component being administered by BAR. The scholarships are granted to the Department's research staff engaged in fisheries research and allied fields. The BAR prepared a comprehensive manpower development program for the DA research staff and funding for this is being sourced out from local and international funding institutions.

D. Linkages

Linkages with IARCS have been useful in improving the Philippine NARS and, hence, agricultural productivity in the country. The IRRI, which is based in the country, dominates all other centers. A number of research agencies in the NARS have collaborative research undertakings with IRRI. Other international/regional institutions headquartered in the Philippines and which have contributed significantly to the improvement of the NARS are:

a) International Center for Living and Aquatic Resources Management (ICLARM)

b) Southeast Asian Fisheries Development Center (SEAFDEC) Aquaculture Department

c) Southeast Asian Regional Center For Graduate Study and Research in Agriculture (SEARCA)

GOVERNMENT OF THAILAND

AGRICULTURAL RESEARCH SYSTEM

The Ministry of Agriculture and Cooperatives (MOAC) is the agency in charge of agriculture, fisheries, forestry and rural development in Thailand. Under the MOAC is the Department of Agriculture (DOA) which is responsible for crop research. It manages all research centers and experimental stations. The Department of Agricultural Extension (DOAE) is responsible for all extension work including demonstration farms.

The DOA conducts the bulk of agricultural research. Other ministries, academic institutions, and an independent foundation are also involved in some aspects of R & D in support of agricultural and rural development. The Department operates 25 research centers and 67 research stations working on various aspects of research. These are:

Areas of Research	Number of Centers	Number of Stations
Rice	6	7
Field Crops	7	13
Rubber	3	17
Sericulture	3	11
Horticulture	6	9
Total	25	67

Other areas of research are implemented by other departments in the MOAC (Table 1).

TABLE 1. MOAC AGENCIES WITH R & D ACTIVITIES

Name of Department	No. of Stations	Area of Research
Department of Livestock	37	Livestock
Department of Land Development	7	Soil and water conservation
Royal Irrigation Department	5	Water requirement
Department of Fisheries	8	Fisheries and coastal agriculture
- National Inland Fisheries Institute		
- National Institute for Coastal Agriculture		
- Freshwater Fisheries Division		
- Brackishwater Fisheries Division		
- Marine Fisheries Division		
- Exploratory Fishery Division		
- Fisheries Technology Division		
- Marine Biological Center		

Aside from the DOA, there are other ministries conducting agricultural research. These are the ministries of Industry (sugarcane), Interior (highland agriculture), Finance (Tobacco), and Science. Under the Ministry of Science are the Agricultural Research Department and the National Technology Center for Genetic Engineering, Biotechnology and Energy.

The Thailand Development Research Institute (TDRI), an independent foundation, does policy-oriented research at the national level. Other research activities are undertaken by academic institutions, namely:

1) Kasetsart University
2) Khon Kaen University
3) Chiang Mai University
4) Prince of Songkhla University
5) Mae Joe Institute of Technology

There is no national mechanism to effectively coordinate the research programs of research institutions. The coordination function of the National Agricultural Research Project (NARP) is limited to crops research of the DOA.

R & D activities of Thailand are also implemented by the private sectors. These activities pertain to livestock (swine breeding and feeds), agro-processing, and plantation research. Other areas include seeds, pesticides, and farm machinery.

RESOURCE GENERATION

Research funds in Thailand are appropriated by the NESDB and by the National Research Council of Thailand (NRCT) in the MOSTE. The Budget Bureau allocates a lump sum for research which is managed by the NRCT. Individual researchers request funding directly from the NRCT.

The research stations and centers (with the exception of the Rubber Institute) are poorly funded and staffed. Another source of research funding is external grant assistance. Funding from foreign assistance comprises a significant portion of the total research expenditures. The major source of grants are the USAID, the World Bank, IFAD, and AIDAB. Other donor agencies are Ford Foundation, ACIAR, ADC, DANIDA, FAO/UNDP, IDRC, JICA, NORAD, ODA, Belgium Government, EEC, and the FRG.

SYSTEMS SUPPORT

A. Research Programming and Infrastructure Support

Agricultural research and technology in Thailand is disjointed due to the neglect of proper monitoring and evaluation. Research programs are formulated by scientists themselves based on their functional responsibilities and their own rather than national needs. Managers of research institutes are more pre-occupied with day-to-day operations rather than with developing long-term research programs. With this situation, agricultural research needs focus.

In the 1980s, the government organized the NARP under the DOA. The NARP is mandated to develop the research infrastructure and manpower to establish an effective NARS. With the establishment of the NARP, coordination began to improve, both within the DOA and the MOAC, other ministries, the

universities, and the private sector. The long-term aim for the creation of the NARP is to have a national level council to coordinate and give direction to the whole gamut of research.

The NARP formulated guidelines geared toward strengthening work on breeding improved rice varieties adaptable to local conditions and expanding work on rice-based cropping systems for both rainfed and irrigated conditions.

Research Programs are compiled by the Planning and Technical Division of DOA. These are formulated by researchers of the centers/stations, and evaluated by the Research Scrutinization Committees at the center/institute/ department levels before being implemented.

The horticultural R & D programs cover fruits, coconuts, oil palm, vegetables, flowers, and other ornamentals. Greater emphasis is placed on the development of seed gardens, coconut nurseries, and varietal and agronomic research on palm oil. Research work is also aimed at maximizing all the components of the farming systems to enhance the over-all farming enterprise.

B. Linkages

Thailand NARS has linkages with IRRI, CIMMYT, CIAT, AVRDC, IIMI, ICRISAT, and IBPGR. Other IARCS/regional institutions that have been involved in research collaboration with Thailand are ISNAR, ICLARM, IITA, IAEA, SEARCA, SEAFDEC, ASEAN, the East-West Center, the U.S. Academy of Science, IBSRAM, and FAO/RAPA.

Those whose offices are headquartered in the country are:

1) FAO/RAPA
2) ESCAP
3) ASEAN Development Planning Center
4) Network of Aquaculture Centers for Asia (NACA)
5) SEAFDEC
6) AVRDC's Regional Research and Training Center

These institutions provide genetic materials, forge collaborative research, provide technical publications on global or regional research activities, and training opportunities.

SOCIALIST REPUBLIC OF VIETNAM

AGRICULTURAL RESEARCH SYSTEM

The leading agricultural research institution in Vietnam is the National Institute of Agricultural Science (NIAS). Together with the Institute of Soils and Fertilizers (ISF), it supports 40 institutes specialized in various subjects or geographical areas. The Institute of Agricultural Technology based in Ho Chi Minh City, caters to the needs of the southern part of the country. Other research institutes work on various areas. The foci of research activities are on:

Food Crops	Cotton
Technical Crops	Corn
Animal Husbandry	Pulses
Plant Protection	Sericulture
Veterinary Medicine	Rubber
Agricultural Mechanization	Forestry
Agricultural Economics	Inland Fisheries
Highland Agriculture	Shrimp Culture

The Scientific Council of the Department of Agricultural Science and Technology established in 1967 serves as the coordinating body for agricultural research and is in charge of formulating R & D programs.

RESOURCE GENERATION

The government's agricultural research institutions in Vietnam are faced with lack of funds for the conduct of research and research-related activities. As such, the Government encourages raising of research funds through contracts between research institutes and production units. This scheme provides incentives to research institutions to develop better technologies.

SYSTEMS SUPPORT

A. Research Programming

Research in Vietnam is directed towards increasing agricultural productivity to guarantee food supply at adequate nutritional levels. Research priorities in Vietnam are placed on soil and water management and rainfed agriculture, and animal disease control.

The agricultural research programs in Vietnam are implemented by the Ministry of Agriculture. The Scientific Council of the Department of Science and Technology formulates the five-year R & D programs. Since 1980, the national R & D programs on the aforementioned commodities have been implemented. Each program is directed by a board of scientists.

R & D funds are allocated by the Council to the different research institutions. Results of research cannot be applied at the field level without the approval of the Scientific Council. The government encourages the raising of research funds through contracts between the research institutes and production units. This system provides incentives to research institutions to develop better technologies. A multi-disciplinary approach is advocated, as well as the systems approach to integrate agricultural production.

B. Resource Development

Aside from research, the country gives high priority to resource development. This includes the strengthening of the agrometeorological facilities to increase the capability for early weather warning system and improvement of library facilities. Efforts for the latter is concentrated on increasing the number of international publications which are very limited due to lack of foreign exchange for the acquisition of such materials.

At the National Institute of Agricultural Sciences, postgraduate trainings (foreign and local) are organized for scientists from all research institutions of the country. However, the number of postgraduate students enrolled at any given time is restricted. In-service trainings for laborers are also organized to increase their technical capabilities.

C. Linkages

The major sources of external support are the UNDP and FAO, which implement major programs for improving the country's NARS. Other external assistance comes from CIMMYT (corn), IRRI (rice), Denmark (sugarcane), India (dairy buffalo) and France (coconut, rubber, and cotton).

Appendix Table 1. Medium-Term Development Goals, Strategies, and Priorities

Country, Period Covered	National	Agricultural	Research and Development
China 1991 - 1995	Goals: 1. Control of aggregate supply and demand. 2. Structural adjustment. 3. Improvement of efficiency. 4. Improvement and deepening of reform. Basic Tasks: 1. Give priority to economic structural adjustment. 2. Fully tap the potential of existing facilities and actively carry out the technical transformation. 3. Adopt appropriate methods and steps. 4. Further develop science, technology and education in order to promote structural reform and raise economic quality and efficiency. 5. Develop foreign trade more effectively. 6. Concentrate efforts in invigorating state-run large and medium-sized enterprises and in promoting enterprises' sound operational mechanism. 7. Promote the formation of a new system in a planned socialist commodity economy. 8. Further improve the government administrative system. 9. Strengthen the building of socialist spiritual civilization and promote the all-round development and progress of the society.	Objectives: 1. Reform agro-production management in the light of China's national conditions. 2. Reform marketing system of agricultural products. 3. Adjustment and improvement of rural industrial structure. 4. Reform the system of agricultural science and technology and education to accelerate agrotechnology extension. 5. Giving freedom function to state and agricultural banks and rural credit cooperatives to strengthen agricultural supporting services. 6. Support to poverty stricken areas to boost economic development. Strategies: 1. Stabilize rural policies, and household responsibility/system linking income with output. 2. Protect the cultivated land conscientiously and organize large scale comprehensive agricultural development. 3. Increase the input to agricultrue. 4. Strengthen the agricultural scientific research and extension and develop agriculture vigorously with science and technology. 5. Strengthen rural education and improve the quality of population.	Tasks: 1. Increase agricultural production harvests. 2. Store and process agricultural products.
Indonesia 1989 - 1994	Goals: 1. To increase the standard of living of the entire population. 2. To build a strong foundation for the next development stage. Policy Directions: 1. Achieve a balanced economic structure, with emphasis on the agricultural sector for consolidating food self-sufficiency and promoting industries that export, absorb substantial manpower, process agricultural products and produce industrial machinery. 2. Acceleration of structural transformation of the Indonesian economy, leading towards a more diversified, efficient and dynamic economy. 3. Deal with the urgent problems of providing productive employment opportunities for the rapidly growing labor force. 4. Economic development must also be undertaken in a sustainable manner. 5. Attain adequate economic growth with a more equitable distribution of income and greater national stability.	Objectives: 1. Increase production. 2. Diversify agricultural products for domestic food and industry requirements and export promotion. 3. Increase the income and living standards of farmers, livestock breeders and fishermen. 4. Promote activities that expand and equitably distribute business and employment opportunities. 5. Support regional development through intensification of transmigration activities.	
Korea 1992 -1995	Goals: 1. To expedite the process of enhancing the nation's socioeconomic status. 2. To achieve national unification in the 21st century.	Policy Directions: 1. Improvement of rural strategies. 2. Comprehensive structural improvement. 3. Fostering specialized labor. 4. Enlargment of farming scale. 5. Technological innovations for scientific farming.	Policy Directions: 1. Improving rice quality and rice product processing as well as streamlining rice distribution system.

Appendix Table 1. Continued .....

Country, Period Covered	National	Agricultural	Research and Development
Korea (Cont.)	Objectives: 1. Continue innovations in the management systems. 2. Restoration of the industrious work ethics. 3. Establishment of civil ethics and rationality. Strategies: 1. Strengthen industrial competitiveness. 2. Enhance social equity and spur balanced industrial development. 3. Implement internationalization and liberalization and pave the way for national unification.	Policy Directions: (Cont.) 6. Efficient utilization of forest resources. 7. Structural adjustment of the fisheries industry. 8. Increasing farm income. 9. Development of agricultural income sources. 10. Improvement of rural living environment and development of farmer welfare program. 11. Reform of the rural support system.	Policy Directions (Cont.) 2. Development of production technologies for agricultural goods that will be competitive regardless of the outcome of the on-going Uruguay round on multilateral trade negotiations.
Laos 1991 - 1995	Goals: 1. To develop the regulatory framework for managing the emerging market economy. 2. To redirect public expenditure to establish or strenghten the public institutions required to regulate the economy and to provide the basic infrastructure necessary for efficient operation of the market. Objectives: 1. Consolidate the microeconomic reforms to ensure a smooth transition to a market-oriented economy. 2. Improve the efficiency and performance of power sector. 3. Accelerate socioeconomic development and improvement of living standards by expanding economic and social infrastructure and increasing the quality and availability of social services including those for health and level of human capital. 4. Halt the degradation of the natural resource base by conservation management approaches to the use of natural resources thereby improving living standards in the long term.	Policy Directions: 1. Public sector's withdrawal from direct investment in the agricultural sector. Strategies: 1. Finalization of the regulatory and legal framework covering agriculture and forestry. 2. Further regulation of markets and trade involving opening up of farm service and input markets and credit. 3. Investment in economic infrastructure to improve the farmers' terms of trade and, hence, incentives to adopt more productive methods. 4. Improvement of efficiency in delivering support services through the adoption of system of national programs which cover the priority areas for the government intervention. 5. Divestment of state-owned enterprises. 6. Improved management of the delivery and resource allocation of foreign assistance to the sector.	Policy Directions: 1. Focus on upland areas. 2. Finding "systems approaches" to stabilizing shifting cultivation where it is degrading watershed areas and destroying valuable forests. 3. Focus on adaptive farm-level development approaches. 4. Improving farm-level communications. 5. Strengthening of research institutions and coordination.
Malaysia 1991 - 1995	Goals: 1. To attain balanced development in order to create a more united and just society. Objectives: 1. Striking an optimum balance between the goals of economic growth and equity. 2. Ensuring a balanced development of the major sectors of the economy so as to increase their mutual complementarities to optimize growth. 3. Reducing and ultimately eliminating the social and economic inequalities and imbalances in the country to promote a fair and more equitable sharing of the benefits of economic growth by all Malaysians. 4. Promoting and strenghthening national integration by reducing the wide disparities in economic development between states and between urban and rural areas in the country. 5. Developing a progressive society in which all citizens enjoy greater welfare while simutaneously imbued with positive social and spiritual values, and an increased sense of national pride and consciousness.	Policy Directions: 1. Provide complimentary growth to ensure a reliable and sufficient supply of agricultural inputs to the manufacturing and services sector. 2. Promote sustainable development and improvements in income for those remaining in the agriculture sector. 3. Growth from a more commercial approach that emphasizes efficient utilization of resources.	Policy Directions: 1. Increase agricultural productivity. 2. Promote a commercial approach to production. Objectives: 1. Development of high-yielding production materials and breeds. 2. Improved agronomic practices. 3. Mechanization of farming. 4. Development of technological innovations to widen end-use consumption.

Appendix Table 1. Continued .....

Country, Period Covered	National	Agricultural	Research and Development
Malaysia (Cont.)	Objectives: (Cont.) 6. Promoting human resource development including, creating a productive and disciplined labor force and developing the necessary skills to meet the challenges in industrial development through a culture of merit and excellence without jeopardizing the restructuring objectives. 7. Making science and technology an integral component of socioeconomic planning and development which entails building competence in strategic and knowledge-based technologies, and promoting a science and technology culture in the process of building a modern economy. 8. Ensuring attention to the protection of the environment and ecology so as to maintain the long-term sustainability of the country's development.		
Myanmar 1992 -1993	Goals: 1. Develop the agricultural livestock and fishery sectors. 2. Enhance the production, processing and manufacturing, and mining sectors through effective capacity utilization. 3. Promote exports through the introduction of new export commodities. 4. Enhance foreign exchange earnings from services. Objectives: 1. Revitalize the export industry and increase foreign exchange through services. 2. Export not only traditional items but also new ones. 3. Take measures for obtaining foreign exchange through services. 4. Fully utilize the productive forces of the country. 5. Increase economic efficiency and labor productivity in state, cooperative and private enterprises. 6. Pave the way in anticipation of the forthcoming constitution.	Objectives: 1. Expand the production of crops, livestock and fishery, and forestry. 2. Promote the export of agricultural and forestry products.	
Philippines 1993 - 1998	Themes: 1. Global excellence. 2. People empowerment. Goal: 1. A politically, economically, and socially stable Philippines with an empowered citizenry enjoying a better quality of life. Objectives: 1. Per capita GNP of $1,000. 2. Average annual GNP growth rate of 6 to 8 %. 3. Reduction of poverty incidence to 30 %.	Goal: 1. To increase the income of farmers and fisherfolks. Objectives: 1. To increase farm productivity. 2. Empowerment of farmers and fisherfolks. 3. To ensure Food self-sufficiency. 4. To promote exports of agricultural products.	Objectives: 1. To improve farm productivity. 2. To improve the quality of farm products. 3. To increase exports of agricultural products. 4. To increase the sustainability of the resource base.
Thailand 1992 - 1996	Objectives: 1. Maintain economic growth rates at appropriate levels to ensure sustainablity and stability. 2. Redistribute income and decentralize development to regions and rural areas more widely. 3. Accelerate the development of human resources and upgrade quality of life, the environment and natural resource management.	Objectives: 1. Restructuring of the sector to enable it to produce in response to market demand. 2. Develop further the agro-processing industry. 3. Intensive application of higher agricultural technology to boost productivity.	Objectives: 1. Develop new plant varieties. 2. Develop post-harvest technology. 3. Reduce cost of production of new products to diversify farm production further and to be used as raw materials for industrial factories.

Appendix Table 1. Continued .....

Country, Period Covered	National	Agricultural	Research and Development
Thailand (Cont.)			Objectives: (Cont.) 4. Prevention and elimination of pests and insects by using plants, plant extracts and other organic elements to replace the use of chemical products together with their eventual development and promotion of commercial private sector production for use on a wider scale. 5. Development and production of agricultural machinery.
Vietnam, 1991 - 1995	Policy Directions: 1. Reduce the scope of administrative intervention in the economy and enlarge the scope of market activity. 2. Increase the financial and decision making autonomy of individual enterprises involved in production, distribution, and service provision. 3. Increase the degree of competition faced in all activities. 4. Increase the degree of ownership (public, private, cooperative, or mixed).	Goal: 1. Food self-sufficiency. 2. Generation of foreign exchange earnings and repayment of foreign debts from exports of agricultural products. 3. Maintaining a leading role for cooperatives and farms. 4. Providing an acceptable level of rural income while maintaining urban consumption levels. 5. Protection of the natural environment.	Thrusts: 1. Establishment of economic, optimum application levels of major plant nutrients by crop, season, locality and soil type. 2. Evaluate the viability of water conservancy. 3. Development of new breeds of crops. 4. Pest control. 5. Design and manufacture of small scale equipment.

Source: FAO/RAPA (1992), Philippines 2000, NAREA 2000.