ISSUES OF RESEARCH SYSTEM ORGANIZATION AND MANAGEMENT IN THE DEVELOPING COUNTRIES

By

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A Plan B Research Paper

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

1984

ACKNOWLEDGEMENTS

This paper benefited substantially from the interest and support of a large number of people. Darrell Fienup's unfailing advice and persistence drove what initially was a brief sketch of a few vaguely worded ideas into a structured investigation of commonly encountered problems. At times when I believed I had answered most of my own questions, he pushed me to recognize the questions of others. This paper would not have been written without his great assistance.

Several others also provided extensive comments which facilitated the analysis and contributed to an improved product. Warren Vincent helped clarify many ideas which previously appeared disjoint descriptions of experience. Skip Bittenbender, Russ Freed, and Harold Riley also provided extensive comments which clarified evidence extracted from the literature and confirmed the widespread nature of its validity. Useful advice was similarly gained from Ev Everson, Robert Tripp, and Ken McDermott. Ken was instrumental in sparking my original interest in research system institution-building. His continuing encouragement in this vein is much appreciated.

If I have one regret which still overshadows this paper, it is my failure to become deeply immersed in the management literature. Win Oberg and Stan Stark helped me formulate a beginner's perspective of management theory. This strongly contributed to the conceptual framework underlying the analysis. If many of the problems described in this paper are to be resolved, development planners must find ways to make better use of such expertise.

The paper has less directly benefited from numerous discussions with a large number of practitioners highly committed to the institution-building process. Among these are Carl Eicher, Mike Weber, Roger Cuyno, Michael Collinson, Ralph Cummings, Jr., Dan Goodman, Dale Harpstead, George Axinn, and Jay Artis who have each shared experiences directly relevant to the formulation of this undertaking.

Lastly, but not least, I would like to thank Deb Greer for working her way through my chicken scrawl in typing an original draft of this paper and to Jeanette Barbour and Julia McKay for scouting their way through an awkward set of revisions in retyping this into final form.

PREFACE

The Committee on Agricultural Research System Organization and Management (CARSOM) was established in September 1981 as an interdepartmental unit under the auspices of the Institute of International Agriculture. Its purpose has been to coordinate and facilitate research and teaching activities concerning the issues and problems in improving the organization and management of agricultural research systems in developing countries.

CARSOM has three principal objectives:

1) To improve the services provided by MSU in its overseas project work and advisory missions.

2) To strengthen the quality of the training received by professionals from developing countries studying at MSU.

3) To contribute directly to the analysis and development of agricultural research policy making through research studies.

The subject of research systems is broad and complex. In any country situation, a multitude of interrelated factors is operating simultaneously to influence the effectiveness of the technology innovation process. There is no "ideal" system but we are searching for principles to guide us toward better structures and more efficient operation. Strong institutional management needs greater emphasis.

Mr. David Rohrbach has been a key member of CARSOM since it was established three years ago. His review and systematic analysis of the literature on organization and management of agricultural research systems in developing countries has greatly increased our understanding of the major issues, their underlying causes, and potential solutions.

This working paper was developed while Mr. Rohrbach served as Research Assistant to CARSOM during 1981/82 and 1983/84. He is currently a Ph.D. graduate student in the Department of Agricultural Economics at Michigan State University.

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October 1984

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INTRODUCTION

The successes of the Green Revolution highlighted the importance of agricultural research for Third World development. The dramatic impact of improved technologies both underscored the contributions of increased agricultural productivity to economic growth and demonstrated the benefits of strengthening developing country research capacities. Indications of the substantial returns being reaped from research investments stimulated significant growth in research-related expenditures. As a result, many national research institutions have begun to play a major role in national agricultural development strategies.

Despite these manifold gains, there remains broad scope for further improvement in national research capabilities. If the advances of the Green Revolution are to be sustained, increased commitment must be directed toward both the continuing expansion of research resources and the consolidation of research programs into well-functioning institutions. The large number of systems which remain poorly endowed require strengthened funding and manpower support. Of perhaps greater importance, most developing country systems need to improve the use made of those resources already available. Without more efficient institutional organization and management, the future impact of ongoing programs and potential value of increased investments are likely to remain limited.

A simple listing of problems frequently identified in research program evaluations illustrates the justification for this concern. Research-extension linkages are commonly described as poor. Manpower turnover rates, fueled by low levels of remuneration and unsatisfactory terms of service, are high. Few

countries have long-term manpower development plans. Research priorities are not aligned with either national agricultural development objectives or farm family needs. There is little coordination of information flow and resource usage within and among various components of highly complex national research systems. The distribution of power and resources among distinct organizational components is perceived more important than accountability to system-wide objectives. Budgets are developed for funding requests, but forgotten when funds are allocated. Frequently, support for field investigations must be sacrificed to pay additional manpower or is exhausted part way through the cropping season. No one is held accountable. The widespread incidence of such problems suggests that successful research may be as much the product of gaps in administrative control as the result of efficient program management.

In late 1981, an interdisciplinary group of faculty at Michigan State University established an Ad Hoc Committee on Agricultural Research System Organization and Management (CARSOM) with a mandate aiming to meet this challenge. This Committee sought to determine why so many basic organizational and managerial problems severely constraining the operations of agricultural research programs remain common and persistent. It initiated a reevaluation of the causes underlying these difficulties and the strategies frequently employed in response. This paper was prepared to help focus and inform these deliberations.

Most broadly, this report aims to review the current level of understanding of the major problems of agricultural research system organization and management. It examines the rapidly growing literature of research program evaluation and development planning. It summarizes what are perceived to be critical institution-building issues as discussed by many individuals involved in research program development projects. The paper does not attempt to formulate recommendations for dealing with the identified problems, though it does, at times, note the nature

of suggestions offered by others. Instead, it seeks, primarily, to provide a perspective of organization and management issues which can help provide one basis for the development of a more fruitful response.

If a single hypothesis underlies this analysis, it is that current emphases on promoting the growth of agricultural research systems need to be reconsidered in the context of constraints demanding program consolidation. Over the past several years, research program development efforts have largely been directed toward expanding program size and diversity, and toward the decentralization of program focus. In comparison, the necessary corresponding concern for some of the more basic problems of institutional development has received secondary emphasis. Simply put, the growth of physical and manpower resources has not been matched by the improvement of managerial capabilities required to employ these resources efficiently.

In view of this concern, the paper identifies eight basic administrative activities required for the establishment and maintenance of developing country institutions. A few of the most important decisions characterizing each activity are highlighted and some of the tradeoffs underlying these decisions are reviewed. The analysis hypothesizes why certain national programs have been managed much more successfully than others. More generally, it simply attempts to specify what managerial variables are most important in the institution-building process.

It should be noted that this assessment focuses specifically on the publicly funded, national, agricultural research system in the developing world. This system is defined as the group of research organizations primarily pursuing technological investigations that depends on direct, public financial support for its existence. It includes public agricultural colleges and universities, though generally views these to be peripheral to the main grouping of state-supported experiment stations.

The analysis well recognizes that public research organizations cannot be understood independent of their environment. It identifies the significance of the interdependent responsibilities of many agricultural development organizations, and draws attention to many of the difficulties entailed in working within the bounds of a complex political bureaucracy. Most of the analysis concentrates, however, on outlining the demands of the institution-building process in the context of efforts to improve the operations of the research organization alone. This allows emphasis to be placed on outlining priorities for institutional development rather than simply redefining strategies for achieving agricultural development goals. The importance of this distinction is highlighted throughout the exposition.

In order to further clarify this presentation, several additional definitions might also be briefly noted. The term research organization is used generically to refer to the system of publicly supported programs as a whole, or in a specific context, to a grouping of programs under a distinct office of administrative management. A research institution is defined as a research organization with a self-defining set of values which help determine its priorities and reinforce the stability of its program regardless of the identity of the organization's leadership. To organize a research system is to define its structure, the distribution of its authority, and the allocation of its principal resources. To manage an organization is to provide leadership, set up and enforce standard operating procedures, and resolve conflicts encountered in the performance of the group's responsibilities. Research resources are identified as all inputs into the research process including manpower, facilities, equipment, and operational funding. Finally, research system development is considered to be the establishment and maintenance of stable research institutions which contribute to national agricultural development objectives in a recognizable way.

The analysis is divided into nine brief chapters, each describing a distinct category of organization and management problems. The first reexamines the context in which an interest in issues of research system organization and management in the developing countries has become widespread. This provides a framework for the discussion of specific issues which follows. The next eight chapters outline the character of organization and management constraints and note some of the most prominent reforms that have been offered in response. Chapter Two examines the policy issues underlying a nation's commitment to support a public research program. Chapter Three looks at questions of agricultural research funding with a review of investment trends and an interpretation of their significance. Chapter Four provides an analysis of issues underlying the determination of research priorities. Chapter Five reviews problems associated with the structure of public research organizations. Chapter Six assesses the nature of linkages between public research agencies and their intra and international support institutions. These include extension programs, universities, private research groups, credit and marketing agencies, and the international research centers. Chapter Seven examines issues of manpower development. Chapter Eight reviews key issues relating to organizational management. Chapter Nine describes problems of program monitoring and evaluation. The paper concludes with a brief comment on the directions in which further investigation of the aforementioned issues might most productively be pursued.

CHAPTER 1

RESEARCH SYSTEM DEVELOPMENT PERSPECTIVES

Problems of agricultural development are most frequently described in terms of the goals of increasing food production, expanding export earnings, and improving the welfare of rural populations. Investments in agricultural research represent a major component of government strategies for attaining these goals. These investments aim to develop national research system capacities as gauged by the size of program budgets, the quantity and level of training of research manpower, the extent of research facilities, and the breadth of program focus. The resulting benefits are measured by increases in aggregate production and relative yields. This is the context in which research institution-building strategies have been defined.

The Setting

In 1974, the World Food Council estimated that a 4 percent annual growth rate in agricultural production was necessary to meet world food requirements. International Food Policy Research Institute (IFPRI) reassessed this figure in 1977 for the developing market economies. A 4.4 percent food production growth rate was now deemed necessary to meet 110 percent of national per capita calorie requirements. This assumed a constant rate of market demand. More rapid production growth rates would be necessary to meet both increasing market demand and basic consumption targets (IFPRI, 1977, p. 21).

Lower levels of past and projected production growth rates reveal the difficulty of this objective. IFPRI has estimated that if average annual production growth rates over the 1960-1975 period can be matched over the following 15 years, an annual increase of the order of 2.7 percent is likely (IFPRI, 1977, pp. 17-22). Larger growth rates were in fact evident, in the developing market economies, over the 10-year period from 1971-1980. Average annual production advances reached a 3.2 percent level. Yet this figure conceals the fact that over the last half of the decade, the rate of production gain was declining. From 1976 through 1980, only a 2.5 percent growth rate was achieved. More disturbingly, the developing market economies have experienced absolute declines in per capita food production. In the often cited case of Africa, total food production posted an annual, absolute gain of 1.8 percent, but a per capita loss of 1.1 percent (World Food Council, 1982, pp. 2-3).

The achievement of a 4.4 percent annual increase in any country's agricultural productivity is almost unprecedented. The grain exporting developing countries attained a 4 percent growth rate in cereal production fostered by the dramatic improvements in wheat yields identified with the Green Revolution (IFPRI, 1977, p. 20). Yet such advances have never been maintained for periods longer than a few years. Agricultural output in the U.S. and Japan has only grown at an annual rate of 1.6 percent over the last century (Ruttan, 1981, p. 2). In view of these statistics, the 4.4 percent objective could best be viewed as a measure of the magnitude of developing country problems rather than an approachable goal.

Accompanying the declaration of world food production objectives have been appeals for massive new investments in developing country research endeavors. Whereas past production gains have been largely the result of the extension of cultivated area, future increases in productivity must primarily be found through the intensification of land use made possible by the employment of improved

technologies. The availability of these technologies can only be assured by strengthened agricultural research institutions. Stepped-up program funding and manpower training have been proposed as the key components of this strategy.

A target level for investments in developing country agricultural research systems was also proposed by the World Food Conference in 1974. Expenditures equal to at least 0.5 percent of each country's agricultural GDP were sought by 1985. Recent evidence gathered by IFPRI (1981) suggests such investments are already being made. While data describing the specific resource commitments of every national program are still incomplete, that available indicates levels of research system funding have been increasing dramatically. From 1975 to 1980, research expenditures in the 76 countries IFPRI surveyed rose from approximately $550 million to $890 million (1975 prices). This translates into a rise in the average level of developing country investment as a percentage of agricultural GDP from 0.3 percent in 1975 to 0.56 percent in 1980 (Oram and Bindlish, 1981, p. 2).

The quantity of scientific manpower registered similar gains. Oram and Bindlish estimate that over the 1975 to 1980 period the number of developing country researchers rose from approximately 26,000 to 36,000 (1981, p. 2). Information available for 32 countries employing almost 20,000 of these scientists reveals that about 9 percent hold Ph.D.s, 27 percent have M.Sc. or unspecified post-graduate degrees, and 64 percent are at the first degree level. The small amount of time series data available suggests a rise of 42 percent in post-graduate staffs in the late 1970s alone (Oram and Bindlish, 1981, pp. 36-39).

Donor agency investments in developing country agricultural research also substantially increased in the 1970s. Available information indicates that bilateral and multilateral expenditures for agricultural research rose from $243 million to $490 million (1975 prices) between 1976 and 1980. This represents an average real growth rate of over 13.5 percent per year (Oram and Bindlish, 1981, pp. 8, 66).

Total annual donor and developing country expenditures in support of developing country research programs are presently estimated to exceed $1.6 billion (IBRD, 1981, p. 8).

In its 1981 Research Sector Policy Paper, the World Bank proposes a further annual growth rate of 10 percent in public sector research investments. According to this schedule, total expenditures were to reach a $2.73 billion annual level by 1984 (IBRD, 1981, p. 8). A recent Consultative Group for International Agricultural Research (CGIAR) report suggests that this target level is also currently being met (1982, p. 1). Clearly, the appeals for the expansion of developing country research resources have been well received.

The principle justification most commonly cited for these investments is the likelihood of exceptional economic payoffs. Estimates of internal rates of return based on data from both the developed and developing countries ordinarily arrive at figures in excess of 25 percent. Annual returns greater than 75 percent are not uncommon. Ruttan notes these are considerably greater than the 10 percent to 15 percent level of real returns private firms generally deem necessary to attract investment (Ruttan, 1982, pp. 241-246). They are also said to be 2-3 times greater than the returns which can be expected from most alternative development expenditures (IBRD, 1981, p. 19).

Research-related project documents often refer to these figures in their requests for funding. The calculations are used to imply that the value of any kind of new research expenditure is self-evident. The persistence of a large number of basic problems characterizing research system institution-building efforts in the developing countries indicates the need, however, to reconsider this assumption.

First, a closer look at the returns to research data reveals some of its limitations. Most estimates of internal rates of return have been derived from investigations of the better endowed national systems. Ruttan's summary listing of

these studies in his recent book on agricultural research productivity includes no studies from the developing countries of Africa. The only aggregate national system analyses shown conducted for a developing country are those for India. The remainder are commodity-specific, and generally limited to crops for which research has achieved obvious success (Ruttan, 1982, pp. 242-243). In addition, as Ruttan notes elsewhere, these returns data display greater variability than the overall average suggests. They do not explain unsuccessful investments, and reveal little concerning the distribution of research benefits (Arndt and Ruttan, 1975, p. 6).

Such limitations need not detract from the most useful aspect of these figures. The high rates of return clearly indicate the potential value of research investments. Yet the efficacy of any particular research expenditure still needs to be questioned. The research needs and capabilities characteristic of any given country remain widely variable. The quality of different programs within particular countries substantially differs. Benefits attributable to past investments may provide little indication of likely returns to be expected from investments in the future, particularly if a research organization is undergoing rapid change. In sum, the above cited data provide little basis for diagnosing the health of a research organization, much less directing the appropriate allocation of future funding. While additional funding appears easy to justify, the determination of the best use to be made of increased resources is a much more difficult sort of issue.

Future Investment Requirements

One response to the question of how best to promote the development of agricultural research institutions has been the categorization of development stages based on resource endowments and research focus. Such classifications depict an evolutionary pattern of development characterized by an initial concern

to build manpower and facilities and a later interest in the allocation and management of these resources. Evenson describes a pattern of development beginning with a "pioneer" stage wherein a country has few well-trained scientists with low salaries and the government allocates few resources to the establishment of a research infrastructure. This is followed by an "adaptive" stage involving a heavy dependence on external assistance and an increasing number of experiment stations. In the "advanced" stage, administrative capacity becomes more important for the management of a more elaborate infrastructure and to guide cooperative research among centralized and regional programs. In-country advanced degree training capacities have been institutionalized and greater numbers of highly qualified scientists are available (Ampuero, 1981c, pp. 8-9).

Oram and Bindlish (1981, p. 3) identify three similar categories based upon the distribution of research resources. Almost one-third of the 76 countries studied may be adequately equipped to perform some degree of applied research, but due to resource limitations will likely never develop a comprehensive research capacity. Approximately 25 countries are classified at an intermediate stage with the staff to carry out research on key commodities, but lacking a critical mass in all areas. A similar number of systems are said to be adequately staffed and funded for self-sustaining growth. Differences in national resource levels suggest these differing capabilities will likely be maintained.

The World Bank (IBRD, 1981, p. 6) claims 30 percent of all national systems are in countries only requiring limited adaptive research on a small number of economically important commodities. Almost 50 percent of the developing countries require a strong national program, but lack essential infrastructure or manpower. Ten percent are described as having adequate expertise, but national programs are poorly organized and managed. The top 10 percent have strong enough programs to provide weak programs with assistance.

A fourth categorization was proposed by the Consultative Group for International Agricultural Research (CGIAR) in a report justifying the existence of ISNAR (1978, pp. 11-12). This, again, classifies systems according to their most essential needs. Out of 91 countries considered, approximately 35 are said not to produce large enough quantities of a single crop to warrant building a large national system. Limited adaptive research capacities are viewed to be adequate. Some 40 countries lack essential research infrastructure, scientific manpower, and effective administrative organization and management. Ten countries have adequate manpower, but their research activities are fragmented and poorly managed. Only six countries have adequate research resources to maintain self-supporting programs.

Several observations can be drawn from this representation of research system development. First, there are dramatic differences in research program capabilities relating in part to the size of national research investments. Oram and Bindlish explain that 62 percent of all expenditures and 46 percent of all scientific manpower among those countries studied are concentrated in five national programs. Eighty-eight percent of expenditures and 85 percent of the scientists are found in only 15 countries. Asian countries generally had the largest number of scientists and technicians, though research expenditures tended to be higher in Latin America. Perhaps surprisingly, no direct relationship was found between scientist numbers and agricultural productivity (1981, pp. 3, 25). Yet those few systems with the vast majority of research resources are the ones described as most advanced.

Second, Everson's evolutionary development model appears contradicted by the belief that most small countries with limited production capabilities need only establish small adaptive research programs. It then makes sense to question whether "intermediate" size countries need programs of only "intermediate" capacity. If so, the implied link between program size and the advancement of

national research capabilities appears much more complex than these classifications suggest. The appropriate level of national commitments depends much more heavily on the particular nature of local needs and resources than on any ideal model.

Third, while "advanced" models exist, the program development strategies these employ may not necessarily be useful to the "poorer" systems. Resource levels alone provide one major distinguishing characteristic of national programs. In addition, however, the management of different programs and allocation of each program's resources must be aligned with the demands of their distinct political and agroecological environments. The lack of a relationship between the quantity of manpower or expenditures and national agricultural productivity suggests the possible overriding significance of managerial capabilities. While the size of national resource commitments is important, the ability to manage these resources effectively may be a more critical determinant of program development.

This point was affirmed in the context of an attempt to elicit the chief concerns of agricultural research managers in Africa and Asia during two International Service for National Agricultural Research (ISNAR) workshops. These managers cited the importance of resource constraints. In conjunction with such concerns, however, they described the often greater significance of managerial problems. These limited the ability of their national programs to use available resources efficiently.

The African managers stressed their own responsibility to improve the coordination of their programs. Most countries were said to still lack coherent research policies and few effectively coordinated research priorities with national development objectives. The managers noted that links between public research organizations and the universities are poor. Data bases necessary for program planning are weak. Research managers have not effectively articulated their

funding needs to politicians and policy makers. The training received by research scientists has not always matched research needs. Technical support staffs employ too few trained technicians. Pay scales are inadequate to retain skilled manpower. Staff responsibilities need to be more clearly delineated and incentives facilitating work at remote sites should be improved. They claimed research-extension links remain poorly developed and called upon donors to be more sensitive to the independence of national development efforts (ISNAR, 1981a, pp. 5-9).

The Asian national research programs are generally viewed as among the most advanced in the developing countries. Yet these managers voiced a similar series of concerns. Institutional fragmentation was said to prevent the coordination of research focus, though the value of increased institutional autonomy was noted. Links between research and extension units, particularly those housed in different ministries, were described as inadequate. The managers claimed that the training of scientists, many of whom have urban-based backgrounds, sometimes fails to encourage research relevant to farmer needs. Personnel policies promote disciplinary competition rather than problem-solving teamwork. Program monitoring capabilities need improvement (ISNAR, 1981b, pp. 4-9).

Trigo and Pineiro suggest public research programs in Latin America have been undergoing a process of progressive deterioration. Institutional fragmentation, declining national budgetary support, and an increasing dependence on the allocative guidance of market mechanisms are threatening the capacity of a number of these systems to produce public goods (Trigo and Pineiro, 1981a). Manpower turnover rates are high, but the training necessary to replace departing staff has been cut back (Ardila, Trigo, and Pineiro, 1981). The lack of close research-extension coordination has limited the capacity of many national programs to recognize or respond to small farmer needs. Evaluations considering the history of many national institutions corroborate these claims.

Given these concerns, continued pursuit of development strategies that primarily involve organizational expansion may be unwarranted. If institutional development is to occur, greater attention may need to be directed toward the consolidation of existing resources into strong and consistently productive programs. Major investments in facilities probably do not make sense if there are not enough scientists to run them. Similarly, the wisdom of large investments in manpower can be questioned in the many cases where systems of remuneration are too poor to prevent rapid turnover. The continual realignment or expansion of research priorities can disrupt the necessary consistency of any given research program. Significant gains in research productivity may be achievable with relatively simple managerial refinements; for example, the creation of a management information system or a well-documented file of past research results. Many of the benefits expected from organizational expansion may not be achievable until such seemingly minor reforms are implemented.

Oram and Bindlish have suggested (1981, p. 7) that "almost a third of the (67) countries studied have now reached a stage in the evolution of their agricultural research systems where the main constraint on their impact is not lack of money, buildings, equipment or absolute lack of trained researchers, so much as weaknesses in the management of these resources." The Director General of ISNAR expands this conclusion by explaining that "although few developing countries have more than a fraction of the scientists they need, most lack systems that fully utilize those available" (Gamble, 1981, p. 9). The following exploration of these issues confirms the validity of these claims.

CHAPTER 2

AGRICULTURAL RESEARCH POLICY

The purpose of agricultural research policy is to provide a systematic series of objectives necessary for the specification of research priorities and the allocation of research resources. Well-defined research policies, insofar as they fit within a framework of agricultural development goals, also provide a basis for the delineation of relationships between the research service and its associated agricultural development agencies. They cannot be defined independently from the delineation of agricultural development policies overall. Rather, they should be widely recognized as a subset of those policies.

Few countries have clearly articulated their national agricultural research policies. This has led to poorly defined research priorities, irrelevant scientific investigations, unstable project and program funding, the failure to make use of technologies which are of value, and declining institutional credibility of the research program. The blame for each of these deficiencies has been widely spread. But each must be attributable, at least in part, to the failure of all actors in the agricultural development process to understand the role and responsibilities of the research organization. If research is to receive the coordinated support of the national agricultural bureaucracy, policies defining the goals and justification for institutional coordination are essential.

Research Policy and Agricultural Development Goals

National development plans commonly identify a multitude of objectives justifying funding decisions. Investments in agricultural research are designed to

meet a broad range of agricultural and economic goals. Improved technologies are sought as a means to increase production. Productivity advances are viewed as means to reduce imports, expand exports, slow rural-to-urban area migration, supply food to the urban poor, lessen unemployment, reduce inequality, improve nutrition, and advance rural standards of living. Agricultural research has also been described as an "engine of growth." An expanding agricultural economy provides a source of government revenue necessary to support the development of a nascent industrial sector. Increased rural purchasing power increases the demand for domestically produced industrial goods. At the same time, it provides cheap food allowing the maintenance of low industrial wages. Also, political discontent can be limited if the farm sector provides a residual source of livelihood for the majority of a nation's population unable to be absorbed into the industrial or service economy.

Ideally, each one of these objectives should reinforce one another. Efforts to fulfill one should promote the achievement of others. This may be possible to a degree, but it is more likely that some of these objectives or the means chosen to pursue them will be contradictory. Expanded cash crop production may worsen nutrition and lead to the consolidation of land holdings in the hands of the early adopters of such enterprises. National policies emphasizing low food costs can discourage the adoption of improved technologies. Concerns to promote the rapid growth of aggregate production may distract attention from the unique needs of impoverished smallholders. Limited research resources necessitate a trade-off among development priorities. But the values underlying the delineation of this trade-off are seldom clear.

Few governments explicitly elucidate the relative priorities attached to diverse development goals. When interpretations are expressed in the course of program planning, they are often contradicted during program implementation.

The conflict between various agricultural objectives may simply fail to be recognized. Or such conflict, and the underlying goals, may simply be ignored. National development goals may be largely irrelevant to the incentives motivating actors throughout the agricultural development bureaucracy.

The response to national development policy often depends more on the institutional circumstances of the implementing organization than the policies themselves. The resolution of these conflicts hinges on the relative power of diverse interest groups both within and outside the national bureaucracy. The changing health of the international economy or the size and direction of donor funding may also significantly affect these decisions. Some development theorists have observed that the continuing influence of past colonial policies can provide an implicit basis for such judgments. The lack of a clearly defined research policy also leads to situations where program goals appear to result from rather than guide system development efforts. The impact of these biases has received little attention.

The Policy Making Process

Two principal issues characterize descriptions of agricultural research policy making. First, research system analysts have decried the absence of clearly defined goals. Justification for program funding, in many countries, is not clearly established. As a result, the consistency of government support for the development of research programs is compromised. Second, where explicit policies do exist, the underlying decisions are said to have been based on political rather than agricultural or economic criteria. Research managers have not appreciably contributed to this process.

Government commitments to support strong national research programs have long been questioned by international development planners. The appearance of

inordinately low funding levels in relation to evidence suggesting high research returns has been commonly criticized as a sign of failure to recognize the potential contributions of research to economic growth (e.g., IBRD, 1981, p. 24). Evenson has suggested the low levels of investment are indicative of a larger pattern of discrimination against the agricultural sectors of most developing countries (in Bernsten and Herdt, 1981, p. 3). Recent documentation of the widespread growth of research expenditures seems to contradict these sorts of assessments. Many questions remain, however, regarding the character of the commitment these expenditures represent.

Many national systems, particularly those in Africa, still lack coherent science and technology or research policies (ISNAR, 1981a, p. 5). As a result, program development seems to depend largely on the transitory interests of political decision makers guiding the distribution of development resources. Programs are expanded at the times and places where political interests are served. Funding may be redistributed each time these interests change. This pattern of inconsistent support compromises research effectiveness insofar as technological investigations must be recognized as long-term endeavors. Programs receiving small or widely variable investments tend to yield low output which can be used to justify further reduced levels of assistance (CGIAR, 1978, p. 8). Similarly, the lack of recognizable national priorities allows little basis for judging the value of research results. Many Latin American systems are said to have gone through a period of strong government support which later declined when technologies produced were described as irrelevant. Ampuero argues, however, that the lack of government commitment to a consistent series of rural development policies strongly contributed to this result (1981c, pp. 9-10).

Policy makers must be persuaded of the importance of research and informed of the resources necessary and time constraints involved. Yet the relationships

between research managers and administrators have ordinarily been poor. Dialogue between the two groups of decision makers is generally infrequent, if not absent altogether (Oram and Bindlish, 1981, p. 49). There is said to be a strong tendency for national policies to be simply passed down from higher or totally separate bureaus (ISNAR, 1981a, p. 5). Research scientists charged with the responsibility to implement these policies may never be informed of their content. Arndt and Ruttan have noted (1975, p. 8) the scarcity of information explaining how political or bureaucratic institutions direct and condition the process of technological change. Some analysts have speculated about the political nature of this process. Anderson suggests (1981, pp. 162-164) government lenders have generally sought to impose research policies which favor their most supportive or threatening constituencies. These include the large farmers, urban consumers, and industrialists. But the process by which these needs are translated into operational research policies remains unclear.

Efforts to promote or clarify the involvement of research managers in the policy-making process have recently advanced with the establishment of autonomous research councils. Many of these administrative units have received mandates allowing them to take charge of the coordination of research policies and plans. In 1972, the Philippine Council for Agricultural Research was created with the responsibility to define the purpose and scope of all national agricultural research programs. The Bangladesh Agricultural Research Council was organized in 1973 and further strengthened in 1976 with the authority to develop national research plans within the framework of national policy on agriculture (SAREC, 1980a, p. 80). The Kenyan Agricultural Research Institute was established in 1979 with a similar responsibility. Two justifications advanced for EMBRAPA's creation in 1973 were poorly defined policies and the prevalence of research personnel who did not understand the nation's major agricultural needs (SAREC, 1980a, pp. 152-153).

The full impact of these agencies has yet to be gauged. Despite government pronouncements, some have clearly been granted greater authority than others. The degree of their influence over government policies seems distinguishable accordingly. But little seems known about the character of this influence and whether it truly reflects farmer needs. Nor is much information available describing the contributions being made to the coordination of research with the broader range of agricultural development policies often determining its usefulness.

Research as a Component of the Agricultural Development System

The success of any research investigation depends on the adoption of improved technologies. It requires the support of extension programs capable of disseminating knowledge of how to use these technologies, effective marketing agencies providing a consistent supply of inputs and stable source of demand for increased output, and product prices allowing adequate remuneration for the costs of production. Technologies offered without this support will either not be adopted or may adversely affect the welfare of those who adopt the new technology. In both cases, the credibility of research institutions is diminished.

This means that research policies cannot be identified independently of the goals guiding support service operations. The determination of the appropriate trade-off between conflicting national agricultural development policies must consider how best to align the goals of all agricultural development institutions. Organizational capabilities must be coordinated.

The quality and scope of analyses investigating the relationships between agricultural development programs vary widely. Most discussion has concentrated on the evaluation of research-extension linkages, and this has largely emphasized the character of information flows. More broadly focused assessments of the

impact of interagency coordination have highlighted two key constraints. First, the relationships between government agencies have been characterized as more competitive than cooperative. The allocation of limited resources within government bureaucracies has been perceived by recipients in terms of the adjudication of conflicting claims for independent institutional authority. Additional funding for one organization often means support taken away from another. Such competitiveness similarly promotes efforts to preserve each agency's unique jurisdiction. This problem has particularly affected the ties between research and extension. The impact of certain farming systems research programs dependent on the realignment of interagency responsibilities has been threatened by the difficulty of this task.

Policy coordination has also been compromised by perceived distinctions between research and action programs (SAREC, 1980b, p. 18). The payoffs associated with research activities depend upon program size and generally require long-term investments. But support for agricultural development priorities may be contingent on the need to solve immediate problems. The strength of national support for research may decline if the benefits are not directly apparent. Similarly, when new technologies are made available, the adaptation of support service programs required for technology adoption may be slow. The policies guiding each organization defined to meet past or current needs may simply fail to respond to changing technological opportunities.

Two commonly cited examples of national policy constraints show the basis for these concerns. Government price policies play an important role in guiding the allocation of farm-level resources. The World Bank has noted the almost overriding importance of producer prices in affecting production outcome and production levels, often cutting across the quality of technical packages and extension services. Seven out of nine projects implemented under unfavorable

prices achieved or surpassed their production objectives; 13 out of 18 under unfavorable prices failed to do so (IBRD, 1981, p. 55). Improved technologies for particular commodities may never be employed if product prices are too low or input prices too high. Farmer responsiveness to price incentives facilitating the adoption of improved technologies is well documented. Higher-priced commodities also tend to attract greater attention from the research community (Anderson, 1981, p. 164). Lower prices satisfying the demands of the urban poor have similarly been recognized to discourage the adoption of expensive and risky new technologies. The failure to coordinate pricing guidelines and technology development goals has resulted in much wasted research effort. The conflict now tends to be resolved by means of the adaptation of technologies to pricing constraints. While input subsidies have facilitated certain technological improvements, price fluctuations tend to inhibit reliance placed on such assistance. Greater coordination of long-term production goals seems a necessary but difficult requirement.

Marketing policies likewise determine the impact of technological advancements. Objectives guiding the operation of marketing channels can determine the size of production returns as well as the ability of a farmer to sell his produce. Here again, however, government intervention has commonly distorted the impact of production and research goals. Biases favoring the marketing of cash crops have been enforced at the expense of necessary food commodities. Marketing board corruption has increased the uncertainty of production returns. Integrated agricultural development projects designed to promote the adoption of specific improved technologies have been reduced to failure when limited marketing channels fail to absorb the expanded production.

Such constraints have particularly hurt the small-scale producers. This farm family has the most to gain from the adoption of new technologies, and the most to lose if the requisite support services are deficient. Too often the contradictions

which may arise between the goals of production growth and smallholder welfare are resolved with the farmer's needs being sacrificed. Agricultural development agencies independently resolving the demands of conflicting national policies will do so in the manner which best suits their individual interests and capacities. Without coordination, no one's interests may be fulfilled. The propensity to view institutional welfare as best served through the consolidation of independent authority limits the viability of common organizational goals. Change becomes difficult. Yet the successful development and application of new technologies require institutional flexibility and accommodation. The overriding administrative policies necessary have generally not been clarified or collectively pursued.

The Response of Research Agencies to Ill-Defined Policies

Two sorts of response have been elicited by poorly defined policies. First, some research planners seem to believe that the contradictions between opposing policies can be resolved simply through the expansion of research programs. If a certain group of farmers, type of commodity, or agroecological region is not being adequately served, new programs can be established to do so. The orientation of on-going research can be shifted as new needs are identified or new priorities chosen. Institutional development hereby becomes identified with the requirement for larger decentralized programs. Concern for the quality of each research enterprise is subverted by ambitions to achieve or at least aim for a growing series of goals. The potential impact of consolidated efforts is then sacrificed.

The expansion of research programs into the semi-arid zones provides an example of this orientation. The establishment of such programs in countries with relatively limited research resources that have failed to exploit the potential productivity of their high potential agroclimatic zones reduces research productivity. The capacity to achieve a more critical national need of greater food production may be diminished.

The failure to evaluate the trade-off between priorities weakens overall program strength. Alternatively, agricultural development policies not congruent with the interests of staff scientists or research managers may be ignored. Many national programs are still said to be biased toward investigations in the export crops initiated while they were colonies. Research on less valuable food crops has been neglected. Technologies aimed at the smallholder have stressed production priorities at the expense of their socioeconomic needs. Smallholder technological requirements have simply not been adequately identified. In many cases, this oversight may not be a conscious endeavor. But it may well result from the lack of clear policy guidance.

All told, there seems little evidence that these policy problems have been well considered. The character of agricultural development policy has been examined by those interested in the orientation of national economic growth. However, the link between policy identification and program implementation has been viewed only in piecemeal fashion. Assessments of how broadly defined policies can best be implemented with limited resources, how agricultural development institutions must coordinate their efforts to do so, and whether on-going programs effectively respond to these goals, have been narrowly defined or deficient. Once program funds are allocated, accountability seems lost. One then begins to hear questioning of national agricultural development commitments.

CHAPTER 3

RESEARCH FUNDING

Much of the concern voiced in the international donor community about research program development has revolved around questions of funding. Aggregate investment levels have been interpreted as indications of national commitments to build strong research programs. Only relatively recently have assumptions regarding the necessity of much larger expenditures been qualified by concerns over absorptive capacity and the management of program growth. Past investments have, in many cases, not been well coordinated with long-term priorities of program development. Support for system expansion has drawn resources away from more pressing operational requirements. The consideration of these issues has made the evaluation of optimal investment patterns a much more complex sort of issue.

Investment Commitments Questioned

The strength of national research programs in the developing countries has long been measured in terms of the proxy variable of aggregate funding levels. The returns to research data "proved" that virtually all programs were undervalued. Evidence of gross underinvestment seemed particularly cogent when compared with the yields of alternative development expenditures. Efforts to convince developing country planners of the need to reorient the allocation of government expenditures were led by the establishment of investment targets. The 1974 goal sought funding equal to 0.5 percent of each country's agricultural GDP by 1985. This was achieved

by 1981. But the developing countries are still said to be spending only a quarter of the proportion of the value of agricultural production invested by the developed nations (CGIAR, 1978, p. 3). Relative investments are much larger in extension programs. Yet a commonly cited reason for extension inefficiency has been the lack of adequate numbers of appropriate technologies to extend. The failure to make use of technologies developed in the IARCs has been used to justify newly proposed higher investment target levels of annual research expenditures equaling 2 percent of agricultural GDP (IBRD, 1981, p. 8). This would represent a fourfold growth of funding commitments.

Despite increases in research funding, most programs are still said to lack sufficient resources to conduct programs in more than a few key commodities. The distribution of expenditures among developing countries remains heavily skewed. The efficacy of donor support continues to be compromised by "the inadequate appreciation by governments of the role effective research plays in agricultural growth and development" (IBRD, 1981, p. 24). International development analysts are questioning why only certain countries have chosen to support strong national programs. The economic justification for larger investments has been forcefully argued. Yet as developing country food requirements have grown, the impact of underinvestment has increased in significance.

A number of hypotheses have been advanced explaining low government commitments. Several of these are summarized by Anderson in a recent report to the International Association of Agricultural Economists (1981, pp. 163-164). First, despite evidence of high returns, the gains likely to accrue to any particular research project remain uncertain. The risks associated with these investments appear even larger when research managers have failed to inform government leaders of their program capacities and needs. Politicians and planners have not been convinced that past research achievements and on-going investigations have

substantially contributed to national development. This may in part be a public relations problem.

Second, the long-term nature of investments required to build strong agricultural research institutions appears infeasible to a government looking for immediate solutions to its most pressing needs. If political instability represents a major government concern, smaller yields on investments in the short term may hold greater value than larger long-term returns. Such interests could explain why extension expenditures tend to be larger in the developing countries.

Third, research provides no obvious 'monument' to development. The contributions of research tend to be difficult to envision, particularly when they take the form of a relatively small gain experienced by a large number of farmers. These benefits may be difficult to employ as a basis for rallying political support. This rationale could, however, explain efforts to expand experiment station networks despite the lack of operating resources to support them.

A fourth related justification is that there may be little effective demand among the populace for these investments. According to this argument, the benefits of research appear so small to each individual producer (or consumer) that no cause is apparent for active program support. In most developing countries, the organization of farmers' associations has been discouraged as they are viewed as a threat to political stability. No channels are available for the articulation of peasant concerns. Only larger farmers who are generally supportive of government policy individually hold the power to affect research resource allocations. Biases toward export crop research may be the result.

Lastly, despite the pronouncements of national development plans, industrial growth and low food prices may simply be receiving higher priority than agricultural development. The concentrated political power of an urban-based industrial elite and wage labor force is commonly perceived to outweigh the interests of the

farm-based majority. High agricultural taxes and low commodity returns therefore limit the impact of those research investments which are being made. Incentives promoting the adoption of improved technologies or growth in food production have been considerably reduced.

Evidence collected by Oram and Bindlish (1981) shows that in many countries research expenditures have been rising. If underinvestment is still taking place, research institutions may themselves need to individually prove their effectiveness. High rates of return characterizing the better endowed systems may have little meaning to a government planner in a poorer country who remains unconvinced of his own country's capabilities. Many of the problems cited in this paper suggest that the perceptions of this planner may well be correct.

Funding Constraints Reconsidered

The major investment priorities proposed for most national systems are the expansion of research infrastructure and enlargement of scientific manpower numbers. These are identified as the key attributes of program development. According to Oram and Bindlish (1981, pp. 21, 52), an average of 15 percent of annual research expenditures is currently being allocated to capital costs. Most of the remainder covers staff salaries with little left to meet operational expenses. In Africa and Latin America, this recurrent cost constraint is said to have become so severe in some systems that scientists are leaving. According to Pineiro and Trigo, "professional staff (in the Central American research systems), in general, are not being used effectively and one important reason is the lack of budgeting support for operational costs. There is a limit to the number of investigations that can be properly supported, and new ones should not be added unless there is a firm commitment to provide the budget needed to support them" (quoted in Oram and Bindlish, 1981, p. 52).

Some have suggested that the donor community must take greater responsibility for covering these recurrent cost deficits. As research manpower returns from overseas training, those who have provided training opportunities have an obligation to ensure that these scientists are effectively employed. But the pattern of allocation of development resources must also be reconsidered. Biases toward program expansion may need to be balanced by a period of program consolidation. Improved use of existing investments may yield returns far in excess of those to be expected from another 10 percent rise in development funding. The recurrent funding problem should be viewed first as a question of program planning and resource allocation and only secondly as an issue of aggregate funding levels.

Even where greater resources have been forthcoming, the strength and stability of national commitments have not always been assured. Recent reports from Africa and Latin America describe major fluctuations and in some cases reductions in government support following periods of research system growth. Since the Nigerian oil boom, expenditures for agricultural research have been declining as a percentage of the value of agricultural products. The distribution of research resources among commodity programs has fluctuated widely. After building one of the most advanced national research programs in Africa, a lack of consistent policies guiding research expenditures threatens the effectiveness of with which past investments are employed (Idachaba, 1980). This may have a worse impact on the strength of the research program than the relative decline in government investments.

Falling or unstable financial commitments in a number of Latin American countries have also severely affected the scope and consistency of well-established programs. Donor support for manpower training was not extended by some governments when these investments were withdrawn. When scientists began to leave out of dissatisfaction with their terms of service, many were not replaced

(Ardila, Trigo, and Pineiro, 1981). Despite initially large investments, justifications for continuing program expansion were apparently not evident. As program strength ebbed, declines in research productivity could be used to justify further cuts in support. Initial deficiencies in program management could well be a cause of future funding constraints.

In fact, Oram and Bindlish could find no clear relationship between the relative size of research expenditures and national agricultural growth rates. The difficulty of judging the time lag between investment and research output is noted. But the data covering the 1970-80 period for 51 countries is still surprising. "The 15 slow growth countries spend, on average, almost as much per million population, per scientist, per hectare, and as a percentage of GDP as the 22 high growth countries, and rather more than the medium growth countries" (1981, p. 5). This appears to contradict studies 'proving' high rates of return to research investments, and clearly raises questions regarding assumptions that the justification for expanded investments is self-evident. A more detailed consideration of what factors influence research productivity seems needed.

The rates of return studies must be viewed as providing signs of the potential productivity of agricultural research. Yet no ex ante basis is currently available for identifying optimal rates of investment. An easy response to many of the issues raised in this paper is to make more funding available. Yet if program development is viewed as involving more than the expansion of research capabilities, funding may not be the key constraint. Concerns about underinvestment may need to be tempered by concerns regarding how current investments are employed.

Donor Assistance

At present, virtually all developing countries receive at least some degree of outside financial assistance, usually from two or more donors. Africa receives the

most external funding followed by Asia, Latin America, and the Middle East (Oram and Bindlish, 1981, pp. 66-67). Most of these investments emphasized three avenues of research program development. Research infrastructure was built with the primary objective of expanding program coverage. Scientific manpower was trained in an effort to increase the breadth of disciplinary representation and improve research quality. Specific project financing employing expatriate expertise also aimed to extend the focus of research often with the hope of short-term breakthroughs in specific commodities. The impact of this assistance has been widely variable. While the overall result has likely been favorable, much can be learned from the reassessment of past mistakes. Such problems raise questions regarding the advisability of reliance placed on donor support.

Donor and developing country priorities have not always been congruent. The establishment of new research facilities in regions of low agricultural productivity or areas less likely to contribute to national economic growth tended to create new institutions governments were reluctant to sustain (USAID, 1982b). Even when such support was provided, the size and number of new research facilities often grew beyond national management and staffing capabilities (Anthonio, 1979, p. 44). Research personnel returning from overseas training have found working incentives and operational support below levels for which they have been trained or learned to feel entitled. High staff turnover has resulted. Commodity priorities established by donors have differed from those of host country institutions (USAID, 1982a). Also, efforts to initiate research on large numbers of commodities have threatened country capacities to maintain the strength of on-going research endeavors. In either case, when donor support has been withdrawn, new efforts have not always been sustained.

Relatively little funding has been earmarked for general program operations. Assistance aimed at strengthening managerial or administrative capabilities has

been small. Instead, the overexpansion of organizational responsibility has created greater demands on administrations which are already overtaxed. Growing appeals for recurrent cost financing assistance and support, at least among research managers, for the existence of ISNAR signal the fact that changes are necessary.

The perpetuation of these difficulties seems largely to depend upon the character of future relationships between donors and aid recipients. In the past, this relationship has been guided to a substantial degree by a mutual and reinforcing competition to distribute and acquire funding. Donor agencies, under pressure to allocate their budgets within predetermined schedules to particular countries, have at times failed to ensure that their funds are well utilized. Accountability for implementation problems has generally been low. Developing country administrations may be only peripherally involved in project planning. As a result, donor agency interests and project priorities many times conflict with the perceived needs of host country personnel. When different donors face similar pressures with respect to the same countries and same economic sectors, they may end up competing to fund the same sorts of projects.

By the same token, the developing countries are under pressure to attract external assistance. Even if such funding is not well spent, does not meet local priorities, or does not seem likely to be productive, the mere influx of money is viewed as useful to the home economy. A program administrator who refuses to accept aid may not last long in the bureaucracy. In addition, research representatives may simply not have the time or staff support necessary to judge the appropriateness of each proposed project or the feasibility of maintaining an ever expanding series of donor-established commitments. A reliance on the assessments of transitory donor-supported 'experts' has been fostered in consequence. The end result has too often been a fragmented and poorly managed national research system. One then has to question what a major new increase in these development expenditures will produce.

The long list of problems cited by Crawford and Barclay in an AID-sponsored evaluation of its own research investments is instructive (USAID, 1982a). The New Directions campaign limited project impact by replacing a concern for longer-run institution-building strategies with an emphasis on quick results. Different projects were compromised by the attempt to achieve too many objectives with too few resources; failure to include the host country government in project planning; bureaucratic opposition; weak links between research and extension; macroeconomic constraints; inability to cover recurrent costs; counterpart shortages; scarcity of trained or trainable manpower; failure to keep returned training recipients working on the project; and equipment procurement problems. The experience of other donors is little better.

Yet certain quite productive donor investments have been made. The foundations of most national research systems would have been much more difficult to establish without such assistance. Investments in ISNAR and CDA have arisen out of a concern to reevaluate research program needs in the developing countries, and formulate improved aid strategies. At issue, however, is the character of the relationship between these two groups. A dependency upon donor support can only carry a national research program so far. Program advancement eventually requires a strengthened capacity to guide and manage one's own development efforts. Relatively few countries have achieved this.

CHAPTER 4

PRIORITY DETERMINATION AND THE ALLOCATION OF RESEARCH RESOURCES

Few countries currently have a systematic basis for determining their research priorities. The lack of clearly defined national development policies has circumscribed the formulation of formal criteria to guide the allocation of research resources. Information constraints restrict the application of those funding criteria which have administrative acceptance. Political interests may disrupt the implementation of plans guiding program development. Individual research managers or staff scientists often have their own agenda. Inconsistent objectives, transitory program focus, and institutional fragmentation have resulted.

More effective employment of limited research resources can only be achieved by careful program planning. Investment strategies must align immediate research objectives and long-term program development requirements. The translation of national goals into realistic guidelines first involves the calculation of the tradeoffs between competing national priorities. Agreement concerning program purposes can provide a basis for the evaluation of institution-building demands. Once these are clearly conceptualized, the feasibility and importance of specific project objectives can be appraised. At each stage in this process, an assessment of the promises and productivity of on-going research investigations must be recognized as the foundation upon which future programs are built.

These are difficult requirements. The evaluation of competing claims for research resources demands an ability to coordinate conflicting motivations and interests. Political pressures and donor objectives must be accommodated. The

unvoiced needs of small farmers must be taken into account. Participation of staff scientists themselves is needed to formulate realistic technology goals. This also helps ensure the final acceptance of program priorities. Such concerns suggest that in the context of institution-building endeavors, greater emphasis may need to be placed on the way institutional priorities are set in comparison with past emphasis placed on their content.

The Information Gap

Much agricultural research can be viewed as an evolutionary process, building on the stock of knowledge previously generated, and contributing to this stock while working to solve particular production problems. As scientists change their focus, the groundwork of investigations completed can provide a starting point for the investigations of others. When documentation of past efforts is inadequate or unavailable, new research endeavors must start from scratch. This lack of documentation severely limits the productivity of much developing country research. In cases where past research results are available, they have often been inadequately consulted. Similarly, the potential contributions of related inquiries in other commodities or in different regions have not been considered either when project priorities have been established or research strategies defined. Much duplication of effort has resulted.

Similarly, many research programs lack information about the quantity and quality of resources they currently employ. Such accounting is complicated by the fact that budgetary allocations often do not match actual outlays. Inflation steals the value of what funding is available. The division of research responsibilities among competing government ministries or commodity and region-specific institutes also contributes to the difficulty of supervising or coordinating national research investments. Efforts to impose strict bookkeeping procedures on even the

smallest expenditures may have fostered employment. But, in many cases, these records have not been summarized in a way useful to program planners.

Inventories of research resources and evaluations of the efficiency with which these are being used seems a necessary first step in the planning and allocation of research resources. Before major commitments to program expansion can be justified, the needs underlying existing investments must be considered. The potential impact of new research projects on ongoing commitments should be assessed. Yet few countries have established the information base to do so. The research system inventories requested by IDRC for a June 1981 workshop on research resource allocation were, for many countries, the first ever conducted (Daniels and Nestel, 1981, pp. 9-10).

The relative costs and benefits of various research projects are also frequently unknown. Program administrators, in some countries, have simply failed to keep account of what facilities, equipment, and manpower are working on particular projects. Efforts to monitor research productivity, when these are made, have been bounded by the failure to establish clear criteria upon which the returns should be judged. Yet this information is essential for the evaluation of existing programs and the assessment of future priorities. Without this, investment strategies are likely to be unstable and susceptible to the demands of exogenous interest groups. Daniels and Nestel describe these sorts of biases explaining "whatever the mechanisms for allocating resources, the process by which resources are actually allocated is still ill-defined and often relies more on historical, personnel and political influence than on any formal criteria. Even where specific criteria are defined, they are often not effectively utilized" (1981, p. 22).

The failure to inform research staff members of either the criteria for establishing priorities, or what these priorities are, provides an additional source of concern. Many of these scientists have their own aims to pursue. If their

responsibilities to the broader research program are unclear, or if they have not contributed to the formulation of program objectives, implementation efforts may be biased toward alternative goals. Also, the expectations placed upon these investigators may simply be unrealistic. The scientists are in the best position to judge what sorts of priorities are practical and the size of supporting investments necessary. If this understanding is not used, program priorities may end up either impractical or irrelevant.

Without knowledge of a research institution's capacity, almost any objective may appear feasible. Excessive program fragmentation, overlapping activities, and the construction of new facilities without the manpower or funding necessary for operations have resulted. Efforts to move in too many directions at once have prevented consistent patterns of program development. Current demands for recurrent cost support have been one response.

Investment Priority Models

In the absence of deliberate criteria guiding the coordination of funding commitments, four explanations describing current resource allocation patterns have been advanced. First, the induced innovation model (Hayami and Ruttan, 1972) suggests that the pressures of the free market economy will promote the development of technologies substituting relatively abundant for relatively scarce factors of production. Given a price mechanism which effectively reflects the changing supply of agricultural inputs and demand for farm products, resources will be allocated according to their scarcity value. In the case of Japan, land constraints generated land saving technologies. In the U.S., the rapid advancement of mechanical technologies allowed a declining agricultural labor force to farm more acres per man. Similar pressures in the developing countries have been hypothesized to foster the recognition of research priorities appropriate to

individual country needs and endowments (Ruttan, 1981). This implies little need for elaborate strategies guiding investment planning. Ruttan has expressed an interest in examining the major sources of demand for research (Arndt and Ruttan, 1975, p. 8). But he suggests governments need only accept responsibility for facilitating market guidance. Intervention designed to achieve politically defined development priorities is unnecessary.

This perspective has been criticized on several grounds. Few countries maintain economies without substantial factor price distortions. These have been created to serve the interests of both farm-based and non-farm political interest groups. Urban constituencies have demanded low food prices to maintain minimal standards of living. Subsidies for agricultural inputs have been established to serve explicit production and equity objectives. Policies supporting the maintenance of low food prices and generation of foreign exchange earnings have fostered a research bias toward servicing the cash or export crop producing community (Pineiro, Trigo, and Fiorentino, 1979). Amidst these various claims, poorly organized smallholders have little power to make their "majority" interests known. Research planners must seek out an understanding of these needs. As Beckford suggests, the induced innovation model may provide a strategy fostering the growth of certain segments of the agricultural economy, but it fails to provide a means to support agricultural development (1972).

A second, more interventionist strategy for guiding the allocation of research resources is the parity model in which research expenditures correspond to the gross value of a commodity's share in the country's agricultural GDP. Commodities yielding the largest aggregate production value would receive the largest investment in research resources. This assumes that the production value of a commodity is an adequate proxy for its socioeconomic importance. The relative simplicity of this criteria has been cited as its advantage. But the difficulties

apparent upon closer inspection of its presuppositions, suggest reliance on this measure alone would be ill-advised.

The model assumes both that the opportunities for technological advancement are the same for all commodities and the benefits to be gained are proportional to the size of the investments. Similarly, the model implies that the value of a particular innovation corresponds to the value of the commodity produced (Ruttan, 1982, pp. 264-267). Yet, once again, the goal of aggregate economic growth may not conform with socioeconomic development priorities. The potential bias against smallholder production also arises in the difficulty of assessing the value of agricultural products which never pass through formal marketing channels. Such reservations lead Oram and Bindlish to describe the model as only useful for its ability to provide a rough indication of possible resource misallocations (1981, p. 53).

A third commonly advanced strategy, particularly characteristic of donor investments, is to target research expenditures toward the fulfillment of quite specific development objectives. Unfortunately, these objectives frequently vary widely from project to project and year to year. Some demand a major reorganization of program activities, generally in an effort to decentralize research focus to better meet small farmer needs. Others are more specifically oriented toward meeting certain rural development or commodity production objectives. Donors have also sought to aim assistance toward the development of a region which has previously been ignored. In general, each of these tactics promotes the extension of the scope of national research programs. At issue, is whether they adequately serve program development priorities.

Many of these projects have made a significant contribution to developing country needs. Yet evidence also suggests a persistent insensitivity to the full range of institution-building requirements. Many projects have not been well

integrated into ongoing research endeavors (SAREC, 1980b, p. 23). Most are said to emphasize a limited series of objectives to the detriment of existing organizational goals (CGIAR, 1978, p. 13). The short-term nature of these investments reinforces host country difficulties. Funds drawn off from projects based upon internally formulated priorities prevent the consolidation of past program development gains. The coordination of donor and host country objectives can be substantially improved. As part of this process, the recipients of external assistance must develop the capacity to independently evaluate their own development requirements. The improvement of developing country management capabilities may need to be recognized as a priority in itself.

A fourth model of priority determination and research resource allocation is the supply-push approach to technological development. According to this strategy, the orientation of research in many developing countries has been biased toward the adaptation of technologies developed elsewhere. While the interdependence of national and international research programs has long been promoted, it has been assumed that the development of most systems will allow them to escape strict reliance on exogenous technologies. Yet, in many countries, this dependency continues. Priorities are conditioned by the availability of technologies, particularly from the developed countries and the IARCs. In a description of research in the Pakistan Punjab, Pray notes "the government seemed to think that it could continue to import new agricultural technology from abroad with very little input from local research" (1981, p. 21). Anderson claims this phenomenon is the cause of the labor-saving bias of many new technologies (1981, p. 165). Koppel explains that the international scientific community cannot be simply viewed as a disinterested interpreter of the demand for its services (1979, p. 134). In such circumstances, the predominance of productivity objectives over institution-building concerns should not be surprising. This may similarly explain the general lack of attention to socioeconomic goals.

One further investment strategy provides a view of the type of approach which seems likely to receive increased backing in the future. In 1972, the Philippine government endowed its national research council with the authority to establish research priorities and evaluate all project funding proposals in terms of their conformity with these development goals. The government has expressed the concern that the national system was "characterized by: agricultural research that was not making a substantial impact on the economy despite the large sum of government funds that was being spent annually; uncoordinated activities with hardly any integrated planning among the various agencies; and fragmentary distribution and ineffiecient use of research resources" (Drilon and Librero, 1981, p. 97). The Philippine Council for Agriculture and Resources Research (PCARR) established a formal series of criteria for rating all proposals for funding. These called for the assessment of the contribution of the chosen commodity to agricultural sector income, the relevance to government socioeconomic priorities, contribution to labor productivity, the availability of research manpower and alternative appropriate technology, the contribution to export earnings, and the import substitution potential (Ibid., p. 100). These provide a basis for rating commodity group priorities. Within these groupings, priorities are based upon national development plan objectives which include a broader range of socioeconomic goals (Ibid., p. 101).

Similar schemes have been proposed and to a lesser extent utilized in other national programs. The successful application of these criteria depends, however, on each country's information base, and the degree of budgeting authority granted to planning councils. Few institutions have developed this capability.

Research Planning Versus Scientific Creativity

The advisability of the strict pursuit of well-defined priorities has itself been subject to periodic debate. Such arguments claim that "the essence of successful

research is creativity and creativity cannot be legislated or dictated" (USDA, 1980, p. i). Only scientists themselves can evaluate what types of research hold the most promise, and what forms of analysis make the best use of their training. Schultz defines this as "entrepreneurial activity" (1980). He explains that the need to depend on the perceptions and talent of staff scientists increases with the size of a research organization. The increasing scope of research activities makes top-level administration more difficult, particularly when administrators are not trained in the disciplinary work they are attempting to judge. This logic also implies that a country may receive greater benefit from well-considered investigations of secondary importance than from poorly conducted experiments meeting preeminent national needs.

The fact remains, however, that much past research work, conducted without or perhaps despite the formulation of national priorities, has not been responsive to national needs. Sprague makes this point forcefully with regard to the Pakistani system explaining "when one looks at the tremendous amount of duplication and isolation of research, or in many cases, so-called research, that is not relevant to the needs, but is at the whim of individual researchers or director or head of a research unit, one becomes frightened" (quoted in Tahir, Bertilson, and Arnott, 1980, p. 152). Commonly expressed concerns regarding an insensitivity among researchers to socioeconomic goals or farmers' needs reinforce the demands for strengthened centralized planning. Evaluations of research productivity have long stressed the need for greater accountability to national development goals.

These two perspectives need not be viewed as strictly contradictory. Several systems, India, the Philippines, and Bangladesh among them, have sought the participation of national scientists in decision making aimed at priority determination. Farming systems research offers the opportunity for the involvement of research clientele. Yet as long as research resources remain limited, the strong leadership of centralized planners appears necessary. The resources and authority required to fulfill this responsibility remain lacking in most countries.

CHAPTER 5

RESEARCH SYSTEM ORGANIZATION

Research system organizations provide the framework within which research policies and priorities are interpreted and implemented. They are characterized by a formal distribution of operational and administrative responsibilities, standardized rules or procedures defining functional relationships, structured patterns of communication, and most importantly, the objectives guiding the allocation of research resources.

Such institutional arrangements have evolved in response to three different, and sometimes contradictory, types of pressure. Environmental demands for the services research programs offer provide a justificatory purpose and a measure by which institutional effectiveness can be assessed. They demarcate the scope of research responsibilities. The widely varied nature of these demands, however, often tends to threaten organizational stability.

Organizational structures have also grown out of the unique visions of program planners. Insofar as these visions were initially oriented by colonial interests, developing country research organizations have been built on foundations of distinct programs designed around the major export commodities. Later donor-funded institution-building efforts have been guided by ideal conceptions of the key attributes perceived to characterize successful institutions either at home or in other quite distinct national settings.

Internal interests motivated by opportunities to gain power and concerns to preserve authority represent one further determinant of the pattern of institutional

growth. These interests may or may not conform with overall program goals. Yet they clearly influence the way organizational purposes are identified and implemented. In extreme cases, these interests may come to constitute ends in themselves.

The assessment of institution-building constraints and requirements is made much more difficult by the fact that the dynamics underlying each of these forces may not be explicit. Further, while various stages of research system development have been described, the actual process of organizational development has received relatively little investigation. Inquiries comparing different national systems have emphasized the description of program structure, research focus, and operational constraints. These provide little basis for hypothesizing that strategies implemented in one country will meet the needs of another. They provide even less basis for identifying a likely pattern of institutional development. An understanding of the experiences of other similar organizations may facilitate the recognition of any particular institution's capabilities and limitations. Yet each organization must map its own response to its unique circumstances.

The analysis of organizational structure and change has also been complicated by the fact that most research organizations in the developing countries have been undergoing a relatively drastic and continuing transformation. Program expansion has created and brought the recognition of new needs. Donor intervention has speeded this process and increased its complexity. The organizational characteristics identified above have had to be repeatedly redefined.

These have not been stable periods of growth. Inconsistent organizational leadership has contributed to administrative inefficiency, bureaucratic conflict, and institutional fragmentation. These have compromised research productivity and confused program goals. The atmosphere of uncertainty engendered by frequent changes has fostered the replacement of research priorities with concerns

to protect individual interests. The costs of rapid organizational development have often been high. The search for strategies easing this transition and resolving the conflicts entailed should in itself be viewed as a major development priority.

The following issues represent commonly identified problems found in debates regarding proper or successful strategies for organizational development. These are principally issues of organizational structure. As the discussion frequently indicates, however, such considerations cannot be divorced from decisions about program objectives, methodology, and management. The structural form of an organization must also depend on the quantity and quality of program resources and the complexity of the demands placed upon them.

Considerations of Organizational Size

Discussions about organizational size have tended to emphasize two principal issues. First, the donors, in particular, have been concerned with the question of what minimal research capacities small countries require. Must every country, however small, have its own research service? If so, what minimal resources must this contain? Second, given an organizational base, what rates of organizational growth are feasible? Associated with this question is the issue of how large a program any particular country can afford to maintain, much less develop.

The needs of small, low-income countries have frequently been defined in terms of an ability to make use of the technologies generated by the better endowed national and international institutions. Given the limited size of potential research resources and a small agricultural base as measured by the aggregate value of commodities produced, these countries should primarily aim to establish strong adaptive or applied research programs. The resources necessary for basic research and independent technology generation are perceived as too great to justify the gains attainable.

Insofar as different groups of small countries share common agroecological zones and technological requirements, joint support for regional and international research programs promises technological benefits at reduced costs. By avoiding unnecessary duplication of efforts, the productivity of coordinated national programs can be improved. These strategists are careful to point out, however, that "the country without the capacity to carry out research of its own benefits very little from research done elsewhere" (IBRD, 1981, p. 25). A country must have the capacity to diagnose its own technological problems and needs before it can effectively employ technologies generated elsewhere. It must also have the capacity to identify what exogenously developed technologies meet its needs. Without a basic research capability, this is impossible. In other words, every country, no matter how small, probably needs some sort of research competence.

The necessary base level of program capabilities has only been defined in general terms. Ruttan suggests a primary focus on "the applied fields of agronomy, plant breeding, animal and crop production, farming systems, and agricultural planning and policy" (1982, p. 174). Moseman proposes a fundamental organizational structure encompassing a strong national center for background research, regional centers for adaptive work, and localized stations for verification testing (1970, p. 102). Yet even the development of these limited programs requires a major commitment of resources. The feasibility of building small programs on the basis of well-defined networks of regional coordination has only begun to be explored.

In a related issue, the common identification of research organization development with institutional growth implies possible overemphasis on the significance of program size. Many national research organizations seem to have expanded more rapidly than the administrative capacity necessary to manage them effectively. A preoccupation with an ever increasing range of objectives has

distracted attention from the need to maintain and consolidate previously established institutional expertise. The history of hybrid maize development in Kenya provides a case in point.

Maize research was initiated in the mid-1950s with the hiring of a breeder. By 1963, small farmer production of hybrid varieties surpassed the output of larger farmers. USAID continued the support for maize breeding work through the late 1960s and 1970s. Scientists were trained and national research programs were expanded. Yet when the last American breeder left in 1977, the breeding program closed. The Kenyan government had failed to provide adequate incentives to retain necessary manpower (USAID, 1980b, pp. 1-4). While the overall national research program had grown into one of the largest in Africa, the breeding program for the nation's foremost staple had collapsed. Commitments to organizational expansion had eclipsed concerns for program maintenance. Increased organizational resources failed to ensure strengthened program capabilities.

The deterioration or breakdown of neglected components of expanding systems has been accompanied by institutional fragmentation and the underutilization of new facilities. The issue here is not whether continuing program expansion is necessary. Nor is this a question of optimal program size. The underlying problem is one of how strategies of research organization growth can be coordinated with strategies of institutional development. The construction of new facilities, training of manpower, increase of budgets, and expansion of research scope are important. Such advances must be matched, however, with attention to the delineation of fairly specific standards of performance and operational efficiency. The construction of an organizational framework must be associated with the evolution of procedural guidelines necessary to manage larger programs more effectively. Coordination with this process must be the maturation of overall organizational leadership.

Administrative Autonomy

The establishment of a growing number of national research councils has been associated with the granting of various degrees of administrative, and thereby organizational, autonomy. Government ministries have given up differing amounts of authority over research project planning and the allocation of research resources. In some countries, independence from civil service codes governing the hiring and remuneration of research staff has been the principal objective. In others, autonomy has been sought as a means to depoliticize program leadership.

These trends toward organizational autonomy suggest conditions of service within government bureaucracies have not always been conducive to research efficiency or institutional strength. Clear justifications persist, however, for the maintenance of at least certain ministerial ties. Insofar as research objectives must be coordinated with those of other ministerial departments, some bureaucratic linkages are important to retain. Yet the appropriate distribution of inter-institutional authority has been difficult to define.

The long-term nature of most research activities makes consistency of program focus essential. When investigations are initiated, but not completed, research resources are wasted. Similarly, the failure to build up a consistent base of technological information over time substantially restricts institutional productivity. Such failures are often attributable to poor organizational leadership.

Program planning guided by the transitory interests of non-technical personnel within a government ministry disrupts the development of any given act of research capabilities. Guidance predominantly influenced by broad and shifting development objectives may prevent adequate consideration of the prerequisites of institutional consolidation. Tendencies to create new programs and even new institutes in response to each new development priority threaten national research systems with fragmentation, and foster the needless duplication of administrative and technical capabilities.

Autonomous or semiautonomous national research councils have been sought as means to improve the strength and consistency of research efforts as well as the coordination of system development. These councils have most commonly been invested with responsibility for national research planning. Many simply play an advisory role to ministerial authorities which have retained responsibility for the allocation of research resources. They provide the technical expertise necessary for at least an initial review of research commitments. These can be evaluated in terms of both available organizational resources and longer-term institutional goals. Evidence has shown this decision-making power to be severely circumscribed, however, where it has not been backed by independent budgetary authority.

According to ISNAR (1982, p. 31), the management of program resources has been considerably complicated by organizational schemes which separate financial decision makers from program planners. The domination of non-technical personnel over the allocation of program funds has allowed objectives to be framed without adequate regard to an organization's technical competence or the likelihood of research returns. The coordination sought by centralized planning units has been compromised by the lack of authority or resources facilitating strengthened relationships among various components of the research system. Jurisdiction over research budgets provides a key means of ensuring accountability to longer-term institutional priorities. Without this, autonomous planning units have failed to provide consistent leadership necessary for efficient program growth.

Autonomy has also been sought as a means to adapt bureaucratic rules guiding the operation of research programs to the unique demands of the research process. Independence from civil service codes has been a commonly cited requirement. In a number of countries, research scientists have been classified at salary levels little better than those of low-level bureaucrats. Significantly

greater levels of remuneration have been offered to research administrators. This has fostered the migration of scientists into strictly administrative positions or out of the research service altogether. In order to attract and maintain highly qualified manpower, and keep them working at the experiment stations, revised terms of service have been increasingly recognized as a necessity. Institutional autonomy allows this. Consistent efforts aimed at solving longer-term research priorities may also be facilitated.

Yet there remain advantages to close ministerial ties. The ministry of agriculture, in many countries, is typically one of the strongest government bureaucracies. The support of this ministry can help ensure a consistent and growing commitment of research resources. While an autonomous administrative unit may be better able to define and justify its budgetary requirements, the support of the Minister himself may be essential if the national budget and planning commission is to hear these needs voiced. While this Minister commonly sits on research advisory councils, his commitment to institutional growth may be affected by the range of this administrative jurisdiction. Most support will likely be provided for those programs for which he is held most accountable.

Strict ministerial control may also help ensure better accountability to national agricultural development objectives. Not uncommonly, researchers operating independently perceive their best interests to be guided by incentives outside the national system. Issues of interest within their discipline or commodity grouping may distract attention from more pressing local needs. The lack of accountability to a wider series of development priorities may facilitate the belief that the researcher's responsibility ends at the experiment station. Ministerial authority can help instill sensitivity to the demands of a broader development perspective and align the employment of research resources with a broader series of goals.

Similarly, centralized ministerial authorities are in the best position to promote the coordination among all agencies and policies affecting the pattern of agricultural development. The productivity of much agricultural research has been constrained by poor research-extension linkages, contradictory pricing policies, and the failure of marketing programs. Increasing research system autonomy may increase the difficulty of coordinating these efforts. The disjunctions caused by holding research and extension programs accountable to different administrative authorities, and in some cases different goals, have been widely cited. Price and marketing authorities have experienced similar conflicts. While improved coordination will not necessarily result under the combined jurisdiction of a single agency, greater opportunities to strengthen these linkages may be available.

No easy solution to any of these problems is obviously apparent. Nor is any particular administrative arrangement necessarily subject to each of these constraints. Much depends on the quality of organizational leadership and objectives guiding the delineation of institutional development strategies. Strong independent research programs may well maintain close ties with their support service counterparts. Organizations lacking autonomy may be granted the terms of service necessary for consistent leadership and scientific advancement. Current trends toward increasing autonomy suggest this form of management holds advantages which should be carefully considered. Yet before such changes are sought, the delineation of administrative constraints must be matched by a similar examination of the capabilities inherent in established administrative arrangements. While research system autonomy seems useful, there remains the question of the appropriate degree of institutional independence. This may be different for each system.

Centralization Versus Decentralization

Discussion of the advantages and disadvantages of centralization and decentralization has been closely related to assessments of administrative autonomy. Both issues involve questions of research system accountability and coordination. The solutions to each problem must be closely interrelated. But several of the concerns underlying each are different enough to merit a distinct review. Whereas debates over autonomy have primarily emphasized questions of administrative jurisdiction, comments regarding the distribution of research resources have highlighted the tradeoffs between centralized coordination and the breadth of program focus. The assessment of these tradeoffs has become particularly important under circumstances of rapid research system growth.

Over the past decade, the development of many national research systems has been characterized by a marked trend toward organizational decentralization. This transition has taken two forms. First, greater numbers of experiment stations are being constructed in diverse agroecological zones. This has facilitated the adaptation of improved technologies to a broader range of environmental conditions. It has also increased the likelihood of recognizing and responding to small farmer needs. Many of these smallholders have historically had difficulty making their unique requirements known. More centralized programs have been largely oriented toward research on export or cash crops or biased toward the development of input-intensive technologies favoring their better endowed clientele. With the recognition that much past work has been inappropriate to small farmer conditions, program expansion has been sought as a means to expand research capabilities. Decentralization is said to foster improved responsiveness to a broader range of small farmer interests. In the process, many of these programs have come to be identified as integral components of national strategies promoting rural development.

Decentralization has also involved the establishment of greater numbers of independent research institutions. Some are affiliated with different government ministries. In Bangladesh, nine different ministries now have responsibility for different, mostly commodity-specific, agricultural research institutes. Others, such as the Malaysian Rubber Research and Development Board, operate as autonomous statutory authorities. This division of administrative jurisdiction for various types of research has been justified on two grounds. Some have suggested the division of institutional responsibilities allows strengthened research focus on a limited series of related problems and permits greater operational flexibility facilitating the adaptation of research strategies to problem-specific requirements. The refinement of institutional focus may also motivate greater and more consistent political support (ISNAR, 1981b, pp. 4-5). In addition, new institutions have been established in order to sidestep the inefficiencies and bureaucratic limitations characterizing on-going programs (Anthonio, 1979, p. 44). These arguments suggest the creation of new organizations is easier than reforming or redirecting established programs. Possible conflict with entrenched administrative authorities viewing changes as threatening to their interests can thus be avoided.

Few have questioned the advisability of extending research coverage and focus. The need to attune research to diverse smallholder needs and agroecological environments has been widely accepted. Many of the most productive institutions have been those with limited commodity-specific responsibilities. Yet questions remain regarding the degree of decentralization small resource-poor systems can afford to support.

Institutional fragmentation has been commonly identified as one of the most significant problems rapidly expanding organizations encounter. This affects research capacities to carry out commodity-specific investigations and limits sensitivity to multiple crop or crop-livestock relationships. Certain research

problems require a critical mass of scientific expertise for resolution. If limited research resources are spread too thinly, and if a limited number of scientists are working on too many different problems, the coordination of specialized expertise necessary to solve any specific problem may be unavailable.

Yet the centralization of expertise may likewise prevent adequate understanding of diverse production constraints. Feedback of information about local problems to centralized authorities has historically not worked well. Some have suggested these authorities, particularly those in a position to determine research priorities, must acquire direct experience of local farmer needs. Arndt and Ruttan (1975, p. 12) claim an 'aggressive' centralized planning unit which systematically seeks out such information may meet this requirement. This implies organizational consolidation must be initially sought as a basis for organizational expansion. Once essential centralized capacities are established, the coordination necessary for the efficient employment of limited research resources may be easier to maintain.

The difficulties of integrating the diverse components of decentralized research programs have often been cited. Institutional barriers prevent the coordination of efforts across administrative jurisdictions (Moseman et al., 1980, p. 42). Even within the same institutions, poor communications can lead to the duplication of experiments. Scientists working on similar sorts of problems have been found many times to have no knowledge of one another's activities. The failure to distribute efficiently or share limited research resources has resulted in their underutilization. Needless competition between independent programs has only further increased the expense of decentralized programs.

Assessment of the relative merits of centralization or decentralization must ultimately depend upon the size of available resources, the objectives pursued, and the bureaucratic framework within which these organizations must operate. No ideal organizational model can be postulated. Decentralization can be justified if

sufficient resources are available for sustaining extended commitments. If the maximization of agricultural productivity represents a primary objective, centralized institutions concentrating on the needs of better endowed farmers may be adequate. Strong centralized coordination may also improve linkages with centrally managed support service agencies. Yet agroecological diversity may demand the distribution of program focus.

What seems clear is that current trends toward greater decentralization may need to be reexamined. The costs of institutional fragmentation are high. The lack of coordination can result in both duplicated efforts and the failure to solve problems requiring inter-institutional cooperation. Allegiance to competitive research bureaucracies may replace accountability to farmers' interests. Yet the advantages of expanded capacities fostering the recognition of those interests remain compelling. Experience to date suggests a middle ground must be found.

Organizational Components

Most developing country research systems contain separate agencies for crop, livestock, fisheries, and forestry research. Disciplinary support service programs for water management, engineering, pest control, and economics may be maintained as distinct programs or integrated into the subsector institutions. In some of the larger systems, independent programs have been established for major commodities. Increasing numbers of research organizations are also creating production systems research programs.

Relationships among these various departments range from minimal to strong interdependence. Little generalization can be derived from analyses aiming to identify the most productive structure of ties. The contingencies of local circumstances, including overall program focus and the level of resources available, appear too important.

The modes of coordination between programs may be more significant than the structure of their relationships. Yet when these relationships are reexamined, several issues merit consideration. First, research planners must again confront the problems of critical mass and potential fragmentation. An effort must be made to evaluate what constitutes a minimal number of scientists necessary to ensure program productivity. How should a system's limited resources be distributed among various departments to meet specific project contingencies? Levels of experience and expertise must be evaluated in relation to research priorities and potential opportunities. There seems general agreement that the more different personnel and programs a system contains, the greater the capacity to respond to a broad range of potential needs. Yet, in many cases, the resolution of even a small number of pressing practical problems requires imaginative coordination of the activities of limited numbers of scientists. Some have suggested this may best be achieved if an institution is structured around a problem rather than a disciplinary focus (ISNAR, 1981b, p. 6). This orients researchers toward locally defined priorities and perhaps away from the prejudicial perspectives fostered by separate disciplinary interests. Without strictly institutional role models or responsibilities, researchers can be freed to apply their expertise to different problems as they arise, changing focus and working relationships as research circumstances require.

This strategy implicitly promotes multidisciplinary relationships. The values of these ties have been long recognized, but, in many cases, they remain difficult to implement. Research on a crop-by-crop basis still commonly tends to ignore intercrop relationships or the importance of socioeconomic variables. Investigations of crop-livestock interdependencies remain largely focused simply on forage production. The necessity of a multidisciplinary approach has been particularly highlighted in research aiming to develop and adapt improved technologies for smallholders. Production systems research programs have been established

specifically to facilitate the interaction of scientists across disciplinary or commodity-specific departments. Yet most interdisciplinary or interdepartmental assistance remains limited to the fulfillment of a particular scientist's narrowly defined research project. Many commodity-based scientists have viewed systems research programs as threats to their independent authority. While this may in part be due to the manner in which some of these programs have been implemented, the substantial opportunities greater multidisciplinary interaction promises have become increasingly apparent.

The need to reassess the role of social scientists in agricultural research has emerged in conjunction with these concerns. The few economists directly involved in research programs have historically been granted limited responsibility for the ex post evaluation of the profitability of technologies proposed for adoption. The involvement of sociologists and anthropologists has been minimal. Technical scientists have not recognized how the work of these disciplinary representatives can be applied, and social scientists have not effectively communicated the scope of their potential contributions. At times, when anthropologists have been hired, they have chosen to work independently, following their individual interests, and avoiding coordination with on-going technical research endeavors. Their criticisms of research focus then appear threatening rather than constructive.

With the development of farming systems research programs, these relationships may be changing. Social scientists have begun to play a greater role in the ex ante assessment of research focus. The research methodology specifically promotes multidisciplinary interaction and fosters efforts to understand cross-disciplinary perspectives. The recognition of the importance of socioeconomic constraints to technology adoption by technical scientists has been accompanied by a reevaluation of the potential contributions of these disciplines. Research oriented toward meeting the needs of limited resource small farmers must, in particular, account

for non-technical variables. If much research effort is not to be wasted, these considerations must be integrated at an early stage. The acknowledgement of this necessity could transform what to date have largely been subsidiary social science contributions, into integral components of the technology development process. Years of disciplinary bias, however, may still need to be overcome.

One additional organizational component also merits brief comment. Relatively few national research systems currently include macroeconomics and policy units. Despite mandates calling for the promotion of rural development, most research programs have largely confined their attention to the tasks of creating new technologies. This limited perspective has yielded two problematic consequences. First, improved technologies have not been adopted due to avoidable price and marketing constraints. The lack of ties with separate policy-making agencies has raised questions about the capacity of research organizations to affect policy changes or the advisability of simply working around these problems. The productivity of technological research may be considerably improved with the adaptation of particular policies. But the information describing the need for and impact of such changes may be unavailable. The coordination of micro-level analysis and national planning, fostered by the acceptance of responsibility for the assessment of a broader range of agroeconomic variables, can resolve this weakness.

Confined research perspectives have also limited the strengthened consistency of organizational objectives. Macroeconomics units can test the correspondence between research priorities and agricultural development goals. Where discontinuities persist, research system development plans may need to be redefined. Investigations demonstrating the contributions of research to the fulfillment of national goals can be used to justify stronger commitments of political and financial support.

Most national research systems have been undergoing an almost continuous process of organizational change. This has placed great stress on research managers who have found their authority constantly questioned. Centralized program leadership has been followed by the decentralization of managerial responsibilities. Recognition of the importance of program coordination has fostered the consolidation of power once again. Changing research objectives have likewise prompted the redistribution of organizational relationships. These transitions have been made that much more difficult by the fact that many are initially promoted by outside interests.

No single, ideal organizational model can be hypothesized to meet every country's requirements. Each must evolve out of the experience and objectives guiding national commitments. Each must be viewed in terms of the interests of its staff and the influences of its environment. The lack of consistency characterizing many patterns of research system development suggests considerations of institutional structure require greater understanding of these dynamics of organizational evolution.

CHAPTER 6

LINKAGES

Strong coordination and communication between researchers and extension agents, and between scientists in national programs and their counterparts employed in related research institutions, are of critical importance for research effectiveness. Extension linkages facilitate the dissemination of information about new technologies and provide researchers feedback describing farmers' needs. University ties ensure a steady supply of research manpower and furnish backstop support extending research coverage. Private or wholly autonomous research institutions conduct investigations on profit earning techniques, allowing public programs to concentrate on producing public goods. Technologies derived from the IARCs and other national programs can augment the productivity of limited home country research enterprises.

Most research system development efforts have underemphasized these organizational interrelationships. Strategies promoting institution building or institutional growth have tended to view research programs as independent endeavors. While the importance of ties, particularly with extension agencies, has generally been recognized, few development projects have stressed the improvement of these relationships. By implication, program planners seem to have assumed that once a firm institutional foundation has been established, these linkages will take care of themselves. As appropriate technologies are developed, extension support will necessarily follow. As the demand for the services of exogenous research programs grows, coordination will be sought. Yet without

direct assistance, these relationships have remained underdeveloped. In each case, new strategies for promoting cooperation merit pursuit.

Extension Linkages

One of the most common criticisms of research programs is the lack of effective ties with extension. Four factors can be identified which may contribute to this problem. First, the separation of research and extension programs into distinct organizations with independent objectives obstructs the formation of working relationships. Oftentimes, these programs are directed by different ministries with different standards of accountability based on unique operational goals. In some countries, while research is funded and supervised at the national level, extension is the responsibility of state or provincial governments. Even when the agencies are housed within the same administrative unit, they may be managed as if each is responsible for a unique jurisdiction. This makes joint research-extension appointments difficult to establish. Likewise, it leads to circumstances where communications and interrelationships among the employees of each organization are perceived as more valuable for professional advancement than those between the two institutions. The very justification of extension programs as a communications link between researchers and farmers thus becomes subordinated to the rationality of institutional independence.

The appearance of extension inefficiency can also severely inhibit research-extension ties. Common references to extension inefficiencies have led some scientists to suggest that effective research can promote the dissemination of improved technologies without extension support. According to these arguments, information about technologies which are truly appropriate to farmer needs will be disseminated by the farmers themselves. The rapid adoption of hybrid maize varieties in Kenya seems to have occurred in just this manner.

Yet this ignores several further potential contributions of a national extension service. These agents should be in a position to help researchers identify the major technological needs of their mutual clientele. Similarly, they may provide an important source of information for the assessment of research priorities and a valuable source of assistance in conducting on-farm trials. The agent's perspective of farm problems can help clarify the objectives of commodity-specific projects in relation to the requirements of complex farming systems. Involvement in research can also help the agent better understand and respond to his clients' day-to-day problems. This may entail the simple diagnosis of production constraints or the coordination of input supplies and marketing opportunities.

At present, few extension agencies efficiently fulfill any of these responsibilities. In many cases, poorly structured incentive systems provide greater rewards for agents remaining at headquarters and serving their supervisors than those working with farmers. In others, transportation constraints severely limit staff mobility (Leonard, 1977). Such problems serve only to reinforce researcher perceptions.

Further contributing to these difficulties is the problem of status. Extension agents have traditionally been viewed, even within their own organizations, as subordinate actors in national agricultural development programs. Research-extension relationships have accordingly been operationalized in terms of a top-down information flow. The results of research conducted by "experts" are passed down to "disseminators" who are responsible for delivering them to "ignorant" farmers. Little or no information passes back up the chain. Researchers blame poor adoption rates on extension incompetence. In response, extension agents simply claim that the proposed technologies were inappropriate. Poorly endowed farmers without the power to communicate their needs directly to interested scientists are left unserved.

Differences in training and socioeconomic background reinforce these perceived status distinctions. Researchers possessing relatively higher training commonly view extension agents as communicators of research expertise, and not as sources of information. The training alone provides a basis for authority. Such perceptions are reinforced by the fact that prospective scientists are quite frequently drawn from urban populations. These groups have easier access to a university education. By contrast, extension agents more commonly have rural backgrounds, and view their positions as but a step up from the farm. In many such circumstances, higher status is associated with the movement away from the farm, in essence, contradicting the objectives of agricultural development. This also explains why both researchers and extension representatives often seem to perceive their colleagues and supervisors as their primary clientele, not the farmer.

The lack of coordination between research and extension also simply results from the failure to promote the development of channels of communication. Research findings may be inadequately publicized or presented in such a way that their usefulness is not apparent. The means for an extension agent to communicate his or her concerns may simply not exist. Some research programs have recently created the post of subject matter specialist specifically to facilitate liaison with extension. Certain production systems research programs have also sought extension involvement. Yet the impact of these actions remains unclear. The tendency persists for such personnel to be viewed as either extension or research representatives, or as neither.

Each of these constraints has been broadly described in numerous assessments of agricultural research delivery systems. Two such studies, conducted in Sierra Leone (Lokah and Akinbode, 1981) and Kenya (Leonard, 1977), well describe their specific incidence. Each note the absence of formal linkages between research and

extension. Lokah and Akinbode surveyed both researchers and extension agents to evaluate the extent of their contacts and sources of information. Researchers were found to seek information primarily from their immediate colleagues and supervisors. Scientists outside the country and farmers were cited as second and third sources. Extension agents gained most of their information on new technologies from their supervisors or colleagues. Seldom was such knowledge sought directly from the experiment station. Institutional constraints were blamed. Yet perceptions of divergent roles and relative status reinforced these deficiencies. Leonard draws attention to the significance of status differences and to the basic lack of resources necessary for work away from main offices and stations. In both cases, institutional reforms alone seem unlikely to bridge communication problems. The objectives of coordination and incentives for collaboration need to be redefined.

The World Bank's Training and Visit System requires a highly structured schedule of extension activities which includes a well-defined communications link with research. ISNAR has suggested combining research and extension agencies into a single entity. It has called for studies examining alternative strategies for linking both groups together with farmers (1982, pp. 32-33). Some farming systems research programs have sought extension involvement in on-farm trials. McDermott (1984) argues forcefully that coordination of research and extension can only be achieved when the two services are conceptualized as a single process. Researchers must recognize the aspects of technology dissemination entailed in their on-farm investigations. By the same token, if the extension agent is to be viewed as a credible information source, he must be involved in the technology assessment process. He must directly participate in the research. This perspective suggests that an overlap of responsibilities, and even repetition of activity, can better serve farmer needs than the current poorly defined link. Even some competition between the two services may be fruitful.

University Involvement

Some developing country universities participate strongly in their national research programs. Others have little or no involvement. In certain cases, the coordination of research efforts has been difficult to achieve. Universities have tended to follow their own research agendas. These have corresponded more closely with advanced disciplinary interests than the needs of local farmers. Yet where collaboration with national commitments has been fostered, university research has considerably extended the coverage of public research organizations. Associated training programs have ensured the availability of scientific manpower well attuned to national needs.

The variability of support for university involvement as an integral component of national research programs belies general recognition of the value of such participation. Two major justifications seem apparent. First, universities are often where many of the best trained scientists of a particular country are located. Given the opportunity and incentive, this expertise can make important contributions to national research endeavors. Organizations forced to operate on restricted budgets can gain access to a broader range of disciplinary support than otherwise available. University-based experiment stations may expand the range of research attention, and, as in India, adapt technologies to local agroecological zones. The only constraint to this sort of involvement has been the problem of accountabilility. Incentives for professional academic advancement may preclude sensitivity to the practical needs of nearby farmers. The objectives underlying university funding may contradict those guiding research which receives direct government support. Research managers in both Asia and Africa have suggested their governments should play a stronger role in promoting greater coordination. Small amounts of national funding for university research could affect the orientation of independently defined programs (ISNAR, 1981a, p. 5; 1981b, p. 5). Support for such endeavors seems to be increasing.

University involvement also promises a steady source of research manpower. The expansion and improvement of most national programs depend on a constant influx of highly trained personnel. This need has become particularly critical in the context of high rates of staff turnover. As the expense of advanced degree training overseas increases, fewer scientists will find such opportunities available. Yet as national systems rapidly expand, the need for this expertise becomes more serious. Greater numbers of scientists need to be trained more quickly. Resource constraints demand efforts to expand local training capacities to meet these national requirements more efficiently.

In the past, many research systems have largely relied on donor support to finance their high-level training. When this assistance has been withdrawn, the dangers of dependency have become apparent. If strong local training capacities are unavailable, migrating manpower may not be replaceable. Several research programs in Latin America have recently experienced just this difficulty. Scientist numbers have dramatically declined, threatening even basic institutional capacities (Ardila, Trigo, and Pineiro, 1981).

An additional advantage of in-country training is the assurance of accountability to local needs. Universities involved in research can provide instruction specifically geared to national program priorities. Thesis work can be integrated with on-going projects. The likelihood that trained scientists will accept and retain assignments within national research organizations upon completion of their degree work may increase. While the exposure to outside ideas gained from training at exogenous institutions will remain useful, if manpower capacities are to keep pace with the growth of national organizations, local universities must accept the bulk of this responsibility.

Private Sector Research

The full research systems in most developing countries consist of multi-organizational combinations of public and private institutions. The distinction between these is not always easily defined. Private investments have supported research in public institutions. Private organizations may be independently managed, but receive government subsidies or tax abatements. This paper has emphasized the discussion of issues affecting institutions under direct government supervision. However, the role of the private research sector should also be considered. This generally represents an increasingly important component of the national research system broadly defined. Unfortunately, the information necessary for this assessment is scarce. In the developing country context, public and private sector relationships have virtually been ignored.

Most agricultural research in the developing countries has been publicly financed both because it serves national needs and because a public good is produced. Once a technology is generated, it is frequently difficult to restrict its distribution in order to capture a large enough proportion of its benefits to pay for the research investment. Even if such restrictions are feasible, they may not be in the public interest. Agricultural development generally involves some public support for the private farmer in order to achieve national economic and social priorities. Improved technologies promote increased production (or decreased production costs) improving the standards of living of both producers and consumers. The aggregate benefits in economic terms are substantial. The noneconomic returns may be even greater.

Private sector involvement in agricultural research has, however, been growing in many countries. The underlying investments have been called forth by the availability of obvious and secure profits. For the most part, such research has emphasized more valuable cash crop commodities, mechanical technologies, and

agricultural inputs. The development of these technologies is often influenced by producer interest groups. The principal clientele have been the better endowed farmers. Those public institutions which have remained involved in these sorts of investigations have tended to have semi-autonomous administrative units. This leaves the purely public sector research institutions responsible for the development of technologies applicable to less valuable commodities and the poorer, small farm sector. These are investments which the private sector is either unwilling or unable to make. Such research is also frequently more difficult.

Two issues hereby arise which demand consideration. First, one must question the appropriate relationship between public and private sector investments. To what extent are public research responsibilities diminished by the growth of private involvement? Insofar as the private sector fails to serve the needs of a large segment of a country's population, the justification for maintaining public support remains clear. Also, if the objectives of privately funded research do not match broadly defined national needs, public research may be required to fill the gap. According to Trigo and Pineiro (1981), these sorts of problems are currently of critical importance in Latin America. They suggest that public support for national research programs has eroded as private sector research firms have gained prominence. The apparent assumption that the second can replace the first has left the small farmer without adequate assistance. What funding remains for public programs has failed to match the large, unmet residual of technological need. It seems that private investments can expand the scope of national commitments. The evolving extent of this support, however, needs to be examined.

The growing competition between these two sectors for scarce scientific and administrative manpower also requires consideration. Higher levels of renumeration and better working conditions in the private firms have attracted manpower trained with public investments. Experience gained working for

government-sponsored organizations has sometimes yielded its greatest returns in private institutions. High manpower turnover limits the productivity of public programs and threatens the stability of future investments. Comparable salary structures and incentive systems now appear necessary. Yet these have been difficult to implement. If the causes and impact of manpower turnover were better understood, the justification for these changes might be clearly evident. Once again, the development of public research organizations cannot be viewed independently of the associated institutions in their environment.

Linkages with the International Research Centers

The International Agricultural Research Centers (IARCs) have provided considerable assistance to developing country research programs by means of a variety of outreach activities. Training programs and in-country technical assistance have strengthened scientific capabilities. The distribution of germ plasm and information about new technologies have expanded the resource base from which research can be conducted. Thus, a complementary relationship has evolved. The international centers provide leadership in commodity or agroecological zone-specific research made possible by unique concentrations of resources and expertise. The developing countries adapt the results of this work to their individual needs. This potential multiplier impact has frequently been cited as one of the great advantages of IARC programs. It furnishes a key justification for the development and continuing support of these institutions.

Questions have been raised, however, regarding the usefulness of expanding support for these centers while developing country capacities to exploit their services remain deficient. This concern provided the chief rationalization for the establishment of ISNAR (ISNAR, 1981, p. 2). Yet it has been voiced ever since the IARCs began receiving strong donor support. Some believed these financial

commitments diverted funding away from the national programs. The prestige of the international centers was also said to draw top-level scientists out of developing country institutions. The organizations meant to be strengthened were instead becoming increasingly dependent on external assistance.

The rapid growth in demand for IARC outreach support in the form of training and technical assistance reinforced these concerns. This justified the further expansion of international research institute capacities. Some questioned, however, whether this was the best means to employ relatively scarce center resources. By 1981, some 200 IARC professionals were working in over 40 national programs (IBRD, 1981, p. 32). Greater benefits might be achieved if much of this expertise was instead concentrated on the development of technological breakthroughs in their home institutions. The assistance of ISNAR and specific donor projects might then aim to ensure these scientific advances were productively employed. While the need to strengthen developing country programs was recognized, the major part of this task was beyond the scope of IARC capabilities.

The comparative advantage of most international centers has always rested with their scientific expertise. This has helped guide the focus of related national investigations. Such leadership has generally served national programs well. In certain cases, however, this de facto authority has contradicted the objectives of their clientele. Some developing country representatives have expressed the concern that the assistance of certain IARCs has been primarily conditioned by the international institutions' own needs and priorities rather than individual country needs and problems. IARC requests for breeding support have been cited as an example. Research administrators have complained that their own country's researchers and research resources have been co-opted to meet IARC requests for assistance in testing improved varieties in diverse agroecological zones. Researchers who have received training at the international centers have been overwhelmed

with requests to locally test new genetic material despite priorities for work elsewhere (Ampuero, 1981, p. 5). Certain training programs have emphasized plant breeding at the expense of necessary assistance in small farmer investigations (Ibid., p. 6). This has tended to bias the problem-solving perspectives of certain staff scientists. Greater IARC accountability to developing country priorities has been called for in response.

Relationships between the international and national programs have also, in some countries, been characterized by a debilitating dependency. The IARCs were established to provide support for national systems. Yet in certain cases this support threatens to replace national commitments. Pray makes this point forcefully in reference to the Pakistani system. He claims "after the Green Revolution farmer support for research seems to have grown rapidly, but government interest in local research has been deflected by the apparent availability of technology from foreign institutions" (1981, p. 21). The success of improved wheat varieties highlighted the tremendous value of the international programs. Recent suggestions of the renewed importance of building strong national systems have cited the failure to apply IARC technologies as a major justification. Yet underinvestment in local capabilities may in part have arisen out of the strength of the international organizations. The evolving orientation of this relationship may be what needs to be questioned.

The reexamination of this linkage requires attention to at least two issues. First, the developing countries must do a better job of making their needs known. Many research systems presently lack an institutional capacity to seek out information about research being carried on elsewhere. This might be viewed as a major cause of the dependent nature of relationships with the IARCs. Rather than search for and take what assistance is required to meet national priorities, many countries have come simply to accept support along with the advice guiding its

employment. The adoption of this subsidiary role reduces the accountability of national programs, and further reduces the justification for strong national commitments.

The international division of research labor also demands reassessment. The responsibilities of each component may require redefinition. National scientists may need to play a greater role in evaluating the IARCs and identifying their objectives (Ampuero, 1981c, pp. 10-11). Collaboration cannot simply be built on the acceptance among the IARCs of responsibility for research the national programs are too weak to accomplish themselves. These institutions were not established to replace national institutions, but to promote their development. This primary goal may need to be reemphasized.

CHAPTER 7

MANPOWER DEVELOPMENT

Manpower development problems are often cited as among the most critical constraints to research system improvement. Few programs are said to have more than a fraction of the scientists necessary for conducting research in more than a few key commodities. Most current manpower planning and related development assistance has accordingly emphasized the growth of scientist numbers and expansion of the range of disciplinary representation. Yet the manpower constraint also requires that attention be focused on a much larger range of variables. Low salaries and professional incentives have brought high manpower turnover threatening what limited research capabilities have been established. The orientation of staff training has not always been congruent with the problem-solving priorities of most smaller programs. The importance of strong managerial and technical support has gone largely unrecognized in relation to concerns regarding the technical training of program scientists. Relatively few programs have well-defined long-term manpower development plans. Even short-term plans have been poorly coordinated with overall investment strategies and research objectives. As a result, staff scientists have been employed without adequate funding to carry out productive research.

These problems have multiplied with the rapid expansion of research system coverage. Facilities have been constructed without the manpower to run them. Program objectives have been broadened with little consideration of the staff resources necessary for their pursuit. The acceptance of each new challenge has

ensured that the concentrated effort of individual scientists remains thinly spread. This has simply reinforced demands for larger numbers of personnel with greater training.

Numbers of Personnel and Levels of Expertise

In 1981, the World Bank estimated the number of agricultural research scientists would have to grow from 20,300 in 1979 to 29,100 in 1984, if a proposed 10-13 percent annual rate of expansion in research expenditures was to be effectively employed (IBRD, 1981, pp. 104-105). According to Oram and Bindlish, this target had already been surpassed in 1980. Technical manpower grew 38 percent in the previous five years to a total of 36,000. But the distribution of these scientists was heavily skewed with over 50 percent found in Asia and less than 8 percent in Africa. The 15 largest national research systems supported 85 percent of the total. In the 32 countries for which information was available (which include most larger programs), 9 percent of the scientists were trained to the Ph.D. level, 27 percent had Master's degrees, and 64 percent had a B.Sc. or the equivalent. This was well below the target of 20 percent Ph.D.s set by the World Bank (Oram and Bindlish, 1981, pp. 2-5).

There is broad agreement among research planners that developing country research programs need greatly increased numbers of skilled manpower. The World Bank has suggested the developing countries should double their research staff by 1990 (IBRD, 1981, p. 26).

In many national research programs, however, these demands need either to be offset by or coordinated with endeavors to ensure that available scientists are better employed. Salaries must be high and consistent enough to retain scientific manpower brought into the system. Recurrent funding levels must be adequate to cover all essential operational expenses. As more than one program has found,

investments in staff and facilities are valueless unless corresponding funding is made available for the conduct of research itself.

Manpower development may accordingly be viewed as both the expansion of staff resources and the improvement in the use made of research and administrative manpower. Substantially larger numbers of scientists, managers, and technicians are required to serve a widening range of research responsibilities. But in order for such resources to be well employed, reforms in the terms and conditions of employment may be essential. Some programs may even derive greater benefit from the fuller exploitation of available resources than the simple expansion of existing endeavors. Clearly, the process of manpower development is more complex than common references to the subject suggest.

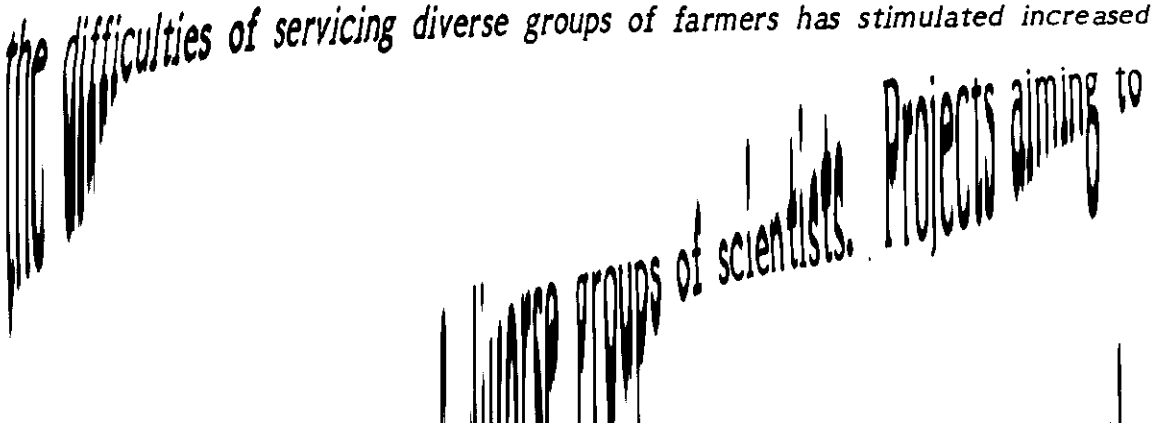
Oram and Bindlish have proposed that current numbers should almost be tripled to meet overall research investment targets of 1 percent of each country's agricultural GDP (Oram and Bindlish, 1981, p. 7). These figures seem to include technical staff who have moved into managerial roles and who, therefore, are less likely to be participating in fieldwork. They do not, however, encompass research technicians. In many countries, these individuals have primary responsibility for the actual implementation of field trials, and may accordingly be viewed as of almost equal importance to the scientists they serve. Oram and Bindlish note that while technician-to-scientist ratios have been improving, most programs still lack even one-to-one coverage (1981, p. 40). Much larger numbers of technicians will be required to provide projected increases in scientific manpower with effective support.

Understaffing inevitably affects the productivity of on-going investigations. While it is difficult to measure the resulting losses, the impact may well be fairly substantial. One of the most commonly cited problems underlying program expansion is the construction of new research facilities and adoption of new

priorities without adequate manpower to employ or pursue them (Moseman et al., 1980, p. 51). The distribution of scientists among a rapidly growing number of institutions and projects leaves each lacking a critical mass of expertise (Cardwell et al., 1981, p. 2). In many cases, while existing facilities are being underutilized, new ones continue to be built. This overwhelming bias toward further expansion also limits the financial support left available to cover operational expenses. Thus, even when manpower is obtainable, the funds necessary for the conduct of research may be deficient.

A number of donor-funded research initiatives have also been plagued by counterpart shortages. The general scarcity of trained manpower, and failure to keep returned trainees working on projects for which they were originally educated, has led to the collapse of these initiatives following the withdrawal of donor support (USAID, 1982a, pp. 37-41). In many cases, manpower has had to be drawn from important on-going endeavors to staff these new projects. But this simply reflects a wider tendency broadly characterizing research system development. Frequent staff transfers from project to project may require a single scientist to work on 3-5 different commodities over a 10-year period. Likewise, one individual may hold responsibility for work on several commodities at once (Moseman, 1970, p. 62). Attention to any particular priority cannot help but suffer.

These issues are complicated by questions raised about disciplinary representation. Suitable mixtures of disciplinary expertise must depend largely on the nature of national research policies and priorities. As the focus of these priorities has expanded, so have demands for a range of personnel. Greater understanding of the difficulties of servicing diverse groups of farmers has stimulated increased



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role in diagnosing complex social and economic constraints. Yet such efforts to understand major farm problems before setting research priorities have also highlighted the need for a broader range of purely technical specialists. As on-farm research leads to the recognition of major gaps in research coverage, manpower numbers may become less important than disciplinary representation.

Manpower planners must seek the greatest range and level of expertise commensurate with the requirements of problem analysis and research implementation while remaining within the bounds of their funding constraints. The evaluation of these requirements is difficult. Employment decisions may be strongly influenced by donor interests in funding new projects which require the training of new manpower to staff them. Ultimate responsibility for manpower planning may rest in the hands of program administrators with little knowledge of the research environment. Administrators who were formerly scientists may be biased by their own disciplinary interests.

The combination of these sorts of pressures leads to employment strategies that are largely ad hoc in nature. While certain disciplines are overstaffed, others remain considerably deficient of personnel. The need for long-term manpower development plans may be proposed. Consistent funding that is closely aligned with well-considered program priorities, however, is necessary for their implementation. Most programs still seem to lack the managerial capabilities necessary to establish firm manpower development programs.

Many questions have also been raised regarding appropriate levels of disciplinary expertise necessary to run an effective national program. Two general observations appear to highlight these concerns. First, some planners have suggested that research systems cannot function effectively without some capacity to perform relatively advanced research. Even systems primarily dependent on the adaptation of technologies developed elsewhere are said to require a high level of

expertise in order to interpret what technologies are appropriate and how they may best be employed. As programs expand, greater numbers of highly trained manpower are necessary to backstop local problem-solving efforts. Moseman suggests an over-reliance on low-level personnel leads to a reliance on second-hand technological support (1970, p. 61). The interpretation of major research needs and the allocation of program resources may likewise remain dependent on the transitory interests of expatriate personnel. World Bank proposals for rapid increases in Ph.D. training represent a response to this type of thinking.

By the same token, however, greater numbers of researchers with relatively low skill levels may be most consistent with aims to spread the benefits of research among a wider population. A larger number of scientists can be employed with limited research resources, and these agents may be more inclined to communicate with rather than at their clients. They may also be less guided by professional disciplinary interests, and more likely to seek involvement in practical problem-solving investigations. Such an orientation may make closer relationships with extension personnel easier to forge.

Advantages entailed in both arguments suggest a tradeoff should be sought. The exact nature of this decision will depend on the resources available to a program and its stage of development. The availability of trained or trainable manpower and existence of adaptable technologies must be considered. Short- and long-term research goals need to be carefully defined and accounted for. Perhaps most importantly, the basis for the resulting decisions should be made explicit.

Training

Investments in the rapid expansion of research personnel necessitate close examination of the content and quality of various training programs. Evidence suggests much degree work can be significantly improved given better coordination

with specific research system needs. Greater understanding of the demands placed upon developing country researchers and administrators has highlighted the limitations of strict reliance on training in the developed countries. The rising expense of these educational opportunities has reinforced growing interest in greater use of home country or regional training institutions. This would allow more scientists to be trained. More importantly, however, it can facilitate greater sensitivity to the problems of a tropical environment and the unique needs of a developing research program. The assessment of these training requirements should take account of several considerations.

First, disciplinary training for research scientists may require adjustment to developing country resource constraints. This would involve some sort of reconciliation between the orientation toward increasingly specialized professional expertise characterizing most university training in the developed countries and the need for greater emphasis on less specialized problem-solving expertise in the developing country context. U.S.-based advanced degree training has been criticized for stressing theoretical issues and narrowly defined investigations using sophisticated equipment. Scientists limited to this kind of instruction may lack both the experience and inclination to carry out field-based problem solving (Moseman, 1970, p. 61). They may also develop a distorted perspective of what problems are important and what means should be employed in seeking their resolution.

The significance of this issue is reinforced by the fact that increasing numbers of young scientists come to research from an urban background. ISNAR found research managers in both Asia and Africa describing the need to give these staff members a more practical orientation (1981a, p. 6; 1981b, p. 6). One suggested means is the integration of more practical fieldwork into degree training programs. For those trained abroad, greater emphasis is now being placed on returning home for thesis work. Alternatively, several years of work experience

might be required before advanced degree training is authorized. A period of strictly problem-solving research could be mandated upon joining or rejoining a particular research institution.

Research planners and administrators have also expressed the concern that the content of disciplinary training programs should be broadened. This would allow at least some degree of familiarization with the wider range of responsibilities research scientists are likely to hold, particularly in programs with limited funding. Useful subsidiary skills might include: an ability to recognize the significance of non-biological variables; an improved ability to communicate with and work among representatives of a number of different disciplines; an understanding of the dynamics of support service operations; a capacity to perform feasibility studies, formulate project priorities, and identify budgetary and logistical requirements; and an ability to evaluate research results in terms of objectives other than the maximization of yields. Asian research managers have particularly called for instruction in equipment use and supply procurement (ISNAR, 1981b, p. 7).

A third major issue underlying the assessment of research-related training has been the need for instruction in administrative and managerial techniques. Researchers receiving advanced degree training abroad often end up in managerial positions within a few years of their return. In some of the smaller research systems, these scientists may move directly into management. At least a small amount of instruction in the necessary skills might, therefore, usefully complement disciplinary training. Where this is not possible, short courses could be utilized to provide this training after they assume managerial positions.

A subsidiary issue frequently overlooked in the review of training needs and opportunities is the value of institutional orientation programs. Scientists, as well as administrative staff, commonly begin working for research programs with little

understanding of the organization's goals, objectives, and procedures. As a result, they may not feel themselves to be representatives of the organization or necessarily committed to its goals. Priorities and funding commitments may change with each new administrator. Scientific investigations, defined according to the interests of individual researchers, may contradict program objectives or mandates. An in-service orientation can help solve these problems by clarifying the justification for an institution's programs, and simply explaining the nature of employee responsibilities and operational procedures.

Professional Incentives

The statistics for research staff turnover in many countries are imposing. ISNAR notes that in some countries staff development and retention have not kept pace with staff attrition (ISNAR, 1982, p. 9). In their calculation of training requirements over the 1980s, Oram and Bindlish have factored in a dropout rate of just over 5 percent (1981, p. 7). The World Bank has estimated training needs based on a 10 percent annual rate of staff replacement and a 30 percent dropout rate (IBRD, 1981, p. 27). Ardila, Trigo, and Pineiro's study of manpower turnover in three Latin American systems found annual rates of attrition since 1975 ranging upward to 16.5 percent (1981, p. 158). The average tenure of national employees in at least one African program is only 2 1/2 years, less than that for the average expatriate (ISNAR, 1981c).

Under those circumstances, manpower development becomes a problem of program maintenance as much as one of program strengthening. This rapid turnover destroys the continuity necessary for technological advancement and draws into question the advisability of expanded investments. If scientists sent abroad for training only begin to become productive a year or two after they return, and if they then leave the research service program, investments are lost.

While these researchers may be usefully employed in ministries or private research programs, the limited resources of the public research organization have still been sacrificed. Losses to private business or the international programs may reduce potential benefits to national agricultural development even further, particularly as these scientists are more likely to be among the best trained personnel. To avoid major commitments required to replace valuable personnel, several issues should be taken into consideration.

The first is staff compensation. Low salaries were cited by scientists in the three Latin American systems studied by Ardila, Trigo, and Pineiro as the major reason for their resignations (1981, p. 162). According to Oram and Bindlish, however, research expenditures per scientist are high in these countries by developing country standards (1981, p. 25). This suggests that it may not be absolute salary levels which are at issue so much as relative levels. The shortage of skilled manpower characterizing many developing countries fosters competition for trained professionals among different sectors of the economy. ISNAR notes on a 10 percent annual rate of staff replacement and a 50 percent dropout rate private organizations commonly receive lower levels of remuneration (1982, p. 32). Staff tenure in the parastatals of one African country has been almost three times as long as the average period of service in the public research system (ISNAR, 1981a, p. 7). Donor projects offering higher staff salaries have tended to attract researchers away from on-going work. This severely disrupts the consistency of such investigations (Ibid., p. 8). Higher salaries have prompted the most highly skilled scientists of many national programs to become administrators despite interest in continuing their fieldwork. In many cases, these incentives have simply turned good researchers into poor administrators.

These losses resulting from manpower turnover and transfer within the system should be compared with the costs of higher compensation. Where program

instability severely compromises research productivity, existing investments may require consolidation before further growth can be sought. If manpower investments are to be protected, competitive salary levels may be necessary. The terms of service of those remaining with a research program should promote the best use of each scientist's relative expertise. Lower turnover rates and higher productivity signal the accomplishment of this goal.

Developing country researchers also commonly lack sufficient employment security. It is generally recognized that effective research requires extended commitments aimed at the resolution of specific problems. Yet the dependence of many research programs on donor support often limits such concentrated efforts. Project funds tend to support relatively short-term contracts, and at times result in situations where researcher employment beyond the term of the project is tenuous. Concerns frequently raised regarding low levels of recurrent funding suggest this problem is widespread.

Changing program priorities may reinforce this uncertainty. Donor funding may require the shifting of commitments every few years. New national objectives or program administrators can similarly lead to the repeated relocation of personnel. Each of these problems demands improved research planning and a stronger commitment to long-term goals.

One important, additional research incentive is the guarantee of opportunities for professional advancement. Two issues are involved here. First, standards of promotion should be explicitly identified and should be structured to promote research productivity. Within many research systems, the advantages of seniority or patronage far outweigh rewards for problem-solving experience and merit. Indonesia has sought to resolve this problem by instituting advancement criteria based upon output of technical publications. India's promotion and career development strategies also stand as a model. Recruitment is based upon scientific merit

displayed in exams. A post-centered system has been replaced by a scientist-centered system allowing pay scales based upon standards of service. Scientists don't need to move from their field of specialization in order to receive higher pay. Researchers may achieve salaries higher than their administrators. Promotion is based upon external evaluations. It is not necessarily tied to the acceptance of higher levels of managerial responsibility. Scientists who do move into management positions are encouraged to return to research after limited appointments. In so doing, their pay need not decline (Gautum, 1981, p. 11). A wide range of base salaries allowing ample opportunity for advancement can provide a similar research incentive.

Opportunities for professional advancement within a community of disciplinary peers extending beyond the national system should also be available. Research resource constraints commonly limit a scientist's opportunities to interact with other representatives in his field. Disciplinary recognition may also be limited by the placement of priorities on applied problem solving rather than specialized work. Yet even this may be of interest to the international community. Recognition fostered through support for publications, and when possible, attendance at scientific meetings should be supported.

Deliberate incentives must also encourage research work at outlying stations and at the farm level. Oftentimes, junior scientists find their relatively low status reinforced by these sorts of appointments. Without adequate motivation to perform this type of work, these researchers may be primarily concerned to change their posting. If professional advancement is largely influenced by relationships with one's superiors who remain at headquarters or in the principle stations, the quality of regional or field-level work may be compromised. If outreach programs are simply viewed as temporary appointments, research continuity may be impossible.

In meetings with ISNAR, research managers in Africa suggested the value of establishing disincentives for working at headquarters and greater salaries for remote positions (ISNAR, 1981a, p. 7). The improvement of research support services at these locations, indicating serious government support for these programs, might also be considered. The construction of strong basic research facilities including laboratories, equipment, a library, housing, transport, water, and electricity, along with the provision of educational opportunities for children, can both attract manpower and enable effective work (CGIAR, 1978, pp. 9-10). Adequate operational resources can prompt motivation based upon opportunities for research success. Without these commitments, such extensions of program coverage may not even be useful to attempt.

Relationship Between Administrative and Technical Personnel

Research administrators are commonly chosen from the upper ranks of research scientists. In some public systems, advancement in the civil service requires that a researcher accept administrative responsibilities. This may cause two problems. First, efforts to gain such appointments may distract scientists from their research endeavors. When the standards for choosing administrators conflict with the requirements of independent scientific inquiry, the overall objectives of a research program may be compromised.

Secondly, evidence suggests that certain top-level scientists simply do not make good administrators. If a strong research staff is to be maintained, the most productive scientists should remain employed in those positions where they are most effective (Cardwell et al., 1981, p. 3). Making these researchers managers may simply be a poor use of limited resources. Such transfers of personnel from one area of need to another could simply shift the location of resource constraints.

One response to these problems is to distinguish between the duties, training, and promotion paths of the two occupational groupings. Each group would then have distinct professional opportunities and standards of evaluation. Administrators, under this strategy, would be chiefly responsible for research coordination and maintenance. They would act as facilitators of the research process. Staff scientists would be responsible for planning and carrying out the research itself. As planners, they could retain principle responsibility for the determination of priorities and guidance of resource flows. Yet substantial time for fieldwork would also be allowed.

Yet there are also strong arguments for the unification of these two groups. One of the most important qualities of administrators is their ability to interrelate with scientists and understand their needs. In order to help coordinate the allocation of resources, they must understand, in rather specific terms, the uses to which they are put. Effective interaction with diverse groups of scientists requires the respect of the entire research community. According to some, the achievement of these skills requires direct research experience.

These positions might be reconciled in two ways. The length of tenure in administrative appointments could be strictly limited except under extreme circumstances. India's system of transferring top scientists in and out of administrative roles may merit close consideration. Alternatively, or perhaps in addition, short-term management training could better prepare researchers called upon to assume administrative positions. When program leadership is poor, relations between research and administrative personnel can deteriorate quickly. When administrative positions are simply sought for their authority and status, the coordination of diverse research interests toward a mutual goal may be difficult. Improved understanding of each group's distinct responsibilities can foster more cooperative, and therefore more productive, relationships.

CHAPTER 8

ORGANIZATIONAL MANAGEMENT

Donor agency commitments to strengthen agricultural research systems have largely emphasized the creation or improvement of physical facilities and the training of scientific manpower. This orientation toward program expansion has broadly characterized most strategies of institutional development. Efforts to improve management operations have, in comparison, received secondary attention. Few planners have firmly confronted the question of whether an expanded system can be effectively administered. Yet this issue has become increasingly important with each stage of system growth.

Management deficiencies have, in fact, been repeatedly identified as major contributing causes of ineffective and inefficient research. Poor program planning, the misallocation of resources, lack of coordination, and personnel management have been described as significant constraints to the productivity of limited research resources. The donors have largely responded by proposing extensive reorganization of national systems or components of national programs. In some cases, they have promoted the establishment of new institutions. In others, they have sought a redistribution of program leadership and research orientation. In most circumstances, these changes have meant structural rather than operational reforms. They have not given much attention to managerial improvement.

The failure to consider how existing management systems function, and why so many of the problems discussed in this paper persist, allows little basis for the identification of meaningful changes. Reforms pursued without the support of the

affected personnel breed conflict and further institutional disorder. Changes sought without attention to the significance of program leadership and requirements often simply remain ill-defined goals. Institution-building is first and foremost a management process. Until the values and objectives of an institution are broadly recognized and the leadership is in place to promote them, research organizations are little more than physical facilities and a collection of individual scientists. This management capability and the procedures underlying it need to be facilitated and nurtured.

The difficulty of many managerial problems results from their complexity, and oftentimes, their political character. Much depends on a government's commitment to promote efficient administration, or its conception of what such efficiency requires. Staffing decisions and administrative procedures may depend as much on political considerations as on institutional objectives. The power of administrative authorities may find its basis in perceptions of status as opposed to structures of responsibility. Almost any kind of change may be viewed primarily as a threat to a manager's status. The maintenance of existing arrangements then becomes a professional priority.

The resolution of management problems requires an analysis of what types of changes are acceptable and likely to be pursued by an institution's leadership. Reforms must be adapted into each system rather than imposed from outside. They must be self-recognized problems in understandable ways. The bureaucratic structures and modes of operation characteristic of organizations in other environments cannot be viewed as universally applicable.

A number of these issues have previously been examined in the analysis above. But several additional management problems directly affecting the conduct of research deserve comment.

Delegation of Responsibility

The clear definition and orderly delegation of research and managerial responsibilities provide an important basis for efficient operations. This involves the delineation of individual roles and responsibilities. Also, attention must be paid to the structure and conduct of professional interrelationships. Each person's duties should match his unique capabilities to ensure the highest possible productivity of his contributions. But the responsibilities of each member of an organization must be coordinated within the guidelines of organizational objectives as well. This is not simply a question of organizational structure. Operational procedures determine the framework of institutional performance. These derive from the interests and concerns of program management. Three views of this process are evident.

Detailed project work plans are said to facilitate the diffusion of research responsibility ensuring all involved recognize who should be doing what, when, where, and how (Cardwell et al., 1981, p. 5). Insofar as each individual understands his particular role and its relationship to the tasks of others, assignments can be coordinated in the mode of teamwork. Each assignment is defined in relation to an agreed upon set of institutional objectives or values.

Carried to an extreme, detailed coordination could lead to the common problem of bureaucratization. In such cases, an institution's management and its participants may be required to conform so closely to specifically outlined administrative procedures that the justification for these guidelines is lost. The flexibility required for response to unexpected contingencies is sacrificed to the objective of accountability. Goals beyond accountability appear secondary.

These problems are most frequently associated with demands for fiscal responsibility. Project or station directors who fear being answerable for the actions of their subordinates may retain authority for more decisions than they can

efficiently handle. Important leadership decisions end up being delayed while time is wasted on activities of lesser administrative importance (Ampuero, 1981, p. 13). It is not uncommon for research personnel to spend so much time writing reports and performing other minor obligations designed to ensure accountability that time for actually conducting fieldwork is limited. Excessive administration becomes a burden stifling even routine investigations. As Schultz puts it, research entrepreneurship is misused by overorganization (1980, p. 9).

At the same time, managerial relationships with scientific manpower may be biased by tendencies toward overpersonalization. In such cases, research-related decisions and the delegation of responsibilities are strongly influenced by interpersonal ties. These may be connections of caste, class, or ethnic grouping. They may also be cemented by relative political or financial power. This problem is most obviously evidenced in systems where professional advancement depends upon patronage. Yet such patterns of decision making similarly affect the determination of research priorities and the allocation of resources making research possible.

This type of program guidance emphasizes the significance of relative authority or status. Structural divisions of responsibility are overlaid by a hierarchy of individual interests. Questions are resolved less in terms of stated organizational objectives than by the views of those responsible for the interpretation of those objectives. The issue of professional survival, mentioned above, rises as a major determinant of managerial decision making.

In both of these cases, the goal of institutional stability may ultimately appear preeminent. Concern for the effectiveness of research, while perhaps remaining important, ends up as secondary. Operational guidelines are necessary for the coordination of diverse personnel holding interdependent responsibilities. Strong leadership is required to supervise the interpretation of these responsibilities. Once an orderly framework of activities is established, however, care must

be taken to maintain the organizational flexibility allowing research to remain a dynamic process. The orientation of research must evolve with experience if it is to be a learning process. Not all decisions can be made beforehand or from the top. Nor, as Schultz suggests, can research be viewed as a routine activity (1980, pp. 10-11). This makes its management difficult. But the combination of managerial guidance and flexibility is what facilitates the productivity of the research process.

Procurement

Research requires a swift and efficient allocation of resources. Delays upset research plans and can compromise investigations already underway. Yet one of the most common complaints scientists in the developing countries express relates to their inability to purchase necessary inputs and equipment or the difficulties caused by its late arrival. The fault often lies with excessively complex procurement procedures. Designed to ensure fiscal accountability, these instead tend to promote the waste of valuable manpower resources. Where the purchase of research supplies must be approved by chains of bureaucrats, some of whom may be preoccupied with other matters, individual managers may be motivated to protect their limited resources rather than promote their application. Sharing across institutional boundaries may be avoided. Corruption may result.

A related concern involves the inadequacy of experiment station budgetary planning. A sudden influx of resources from a foreign assistance project may lead to drastically inflated expenditures in the belief that available funding may soon run dry. Equipment may be sought for which there is no immediate or even apparent need. In normal years, submitted budgets may still be excessive in recognition of the fact that past outlays have never matched funding requests. Yet even when the amount of program money available is well known, it is not

uncommon for this to be used up before the end of a fiscal year. In some cases, record keeping of expenditures is deficient. In others, managers grossly misjudge the requirements of project implementation or station maintenance. These problems are worsened by strict budgetary guidelines which restrict the reallocation of resources once funding requests have been approved (Cardwell et al., 1981, p. 4). The severity of recurrent funding constraints simply augments these difficulties. The research scientist is left to cope the best he can.

Communications

Another common managerial deficiency constraining the performance of research is poor communications. Communication links provide a foundation for institutional coordination. As such, their importance has been observed repeatedly in the discussion of issues above. Communications lie at the heart of research-extension linkages and the alignment of research objectives and national agricultural development policy. They provide the basis for budgetary and research accountability. They promote the efficient allocation of scarce resources and the synergistic payoff of multidisciplinary work. Yet most research system development strategies have done little to improve their effectiveness. The further discussion of four additional, subsidiary issues may increase understanding of the significance of this constraint.

First, research projects must be defined and responsibilities distributed to maximize the productivity of limited manpower resources. Program objectives should be recognized as means to integrate the focus of individual investigations. Scientists lacking this information will carry out independent research corresponding to their own disciplinary interests. This often diverges with the goals of their programs. In some cases, these specialists simply end up duplicating the work of others (Ampuero, 1981c, p. 11).

Research managers in Africa have suggested the need for the more effective induction of new staff into the research system. If they are not to simply continue work initiated in the course of their training, familiarity with program objectives and the priorities guiding on-going work is necessary (ISNAR, 1981a, p. 7). Furthermore, an orientation toward investigatory independence must be overcome. Periodic meetings between researchers working in the same or related fields can foster the coordination of research and the assessment of each scientist's progress toward the fulfillment of common goals. Meetings with representatives of agricultural support organizations including farmers' organizations can help ensure the relevance of on-going work and identify non-technological constraints (Ampuero, 1981c, p. 19). Unfortunately, few systems have institutionalized such links.

Attention must also be directed to the quality of documentation services. At present, developing country research scientists commonly fail to make adequate use of the information created by others. Program libraries are poorly maintained. Little effort is made to keep researchers informed about past findings, generated within or outside their system. Poor documentation of research previously undertaken leads to the needless repetition of particular projects. Lack of information about the types and results of research carried out elsewhere can result in misdirected trials. Even where such information is available, the failure to inform scientists of its existence makes it of little use. Library staff members must take the initiative in publicizing the availability of information resources.

Improved communication strategies are also needed to ensure the proper distribution of research resources. Expensive equipment may only be employed productively if it is shared. This requires that scientists be informed of its existence and availabililty. Similarly, the productivity of individual researchers may be improved if they are held responsible not simply for their own

investigations, but also for backstopping the work of others. Again, recognition of the accessibility of such resources is important. When unexpected difficulties or problems arise, resolution may depend on the capability of research managers to respond quickly. Poor channels of communication may necessitate inordinate amounts of effort simply requesting support. Under each of these sorts of situations, resource limitations can end up being much more constraining than necessary. Opportunities for coordination may well degenerate into the competitive pursuit of scarce assets.

The strength of research system public relations should provide an additional source of concern. The chief responsibility of national research institutions is to serve the public. Given the top-down orientation of technology development and dissemination, this role may not always be apparent. Researchers tend to view their specialized training as a justification for detachment from their clientele. Certain segments of the farm population, particularly small farmers, may perceive the specialized investigations based on the experiment station as irrelevant to their own needs and capabilities. The failure of recommendations to be appropriate to farmers' circumstances reinforces these impressions.

Efforts to foster an awareness of research objectives and the purposes of particular research projects can reduce this division. Farmer field days and technical reports aimed directly at this group can spark public interest in research activities. This can facilitate the dissemination of new technologies as well as the recognition of farm problems. Public interest in research productivity can then be translated into political and financial support.

Public relations aimed directly at national policy makers also provides important payoffs. Research programs are disadvantaged by the lack of prominent returns on development investments. The employment of new technologies may yield production advances. But it may be difficult for government leaders to

recognize the link between program support and production consequences. The long-range nature of the research process magnifies this dilemma.

Consistent and growing funding is critical to research program productivity. Research administrators must, therefore, publicize their accomplishments. They must ensure that public support corresponds with their institution's evolving needs rather than transitory political interests. The stability of institutional development can only be assured if the logic of underlying investments is well understood.

The haphazard pattern characterizing the growth of many national programs suggests this understanding has not been achieved. The reluctance of many governments to allow the establishment of large administrative units may restrict the availability of staff time and funds supporting a public relations effort. However, the strength of government commitments to research itself could depend upon circumventing this limitation. What appears a non-productive investment mobilizes the necessary resources for program development.

Lastly, researchers themselves need public and professional recognition as a source of individual motivation. This can be fostered with newsletters, regular reports of technical accomplishments, and opportunities to publish research results in national and international publications. Managers hold a responsibility to encourage awareness of research success even when this does not result in immediately productive innovations. Such institutional support can help mold a research community. The acknowledgement of each individual's contributions can sustain its productivity.

CHAPTER 9

INSTITUTIONAL EVALUATION

Research system evaluations provide a means to judge the strengths and weaknesses of research operations and requirements for further institutional development. They take a variety of different forms ranging from the analysis of causes underlying a particular problem to general descriptions of broad program characteristics. These appraisals are distinguished by their purpose, range, and depth of focus, methods of assessment employed, and the interests of the group or agency responsible for their execution. They may be designed for implementation once, every few years, or continuously. An evaluation may be internally conducted or require external resources. In each case, however, their usefulness depends upon the degree to which they influence decisions guiding program performance and the allocation of research resources. Evaluations presume an institutional capacity to learn from and adapt to its past mistakes.

For research system assessments to be beneficial, they must be sought by and framed in terms acceptable to the institution reviewed. The criterion of acceptability can be difficult to achieve. Program analysis cannot help but be based upon the unique perceptions of the responsible parties. The perceptions of external reviewers commonly do not match either the concerns of those being evaluated or the objectives underlying historical patterns of institutional development. While the institution's own principal concerns and objectives should be outlined in the terms of reference guiding the evaluation, they may not be clearly articulated by program administrators. Organizational objectives may be

constantly changing. Information necessary for a realistic estimation of problems may not be available. In some cases, only that information promoting a particular point of view is readily supplied. Preconceptions of what should exist can complicate this process further.

While evaluations are generally recognized as necessary, they tend to satisfy few. By nature, the judgements involved are critical, and therefore, controversial. A satisfactory assessment to one person may totally contradict the beliefs of another. While certain values and objectives may be commonly held, their measurement can remain subject to dispute. Two individuals with different disciplinary or ideological backgrounds may well interpret the same event differently. Yet an independent and considered evaluatory perspective still generally provides an important basis for problem diagnosis and the arbitration of conflicting interests. Evaluations can motivate changes which administrators simply do not recognize as necessary. They can rise above intra-institutional politics guiding the distribution of resources between projects with an appraisal of how the sum of resource allocations relates to overall institutionl goals. Even if this assessment does not receive full agreement, it may improve the understanding with which future decisions are made.

The principal issues surrounding questions of evaluation involve efforts to improve their reliability and usefulness. Little cross-comparison of evaluation methodologies has been conducted. Most comments on assessment criteria simply suggest that greater numbers of variables need to be taken into account. A number of planners have noted the need for administrative units which continuously monitor ongoing work. Few have explained how this might operate. Each of these concerns will be discussed below.

Evaluation Methodologies

Perhaps the greatest international publicity has been attached to analyses of research returns. These estimate the quantitative costs and returns to programs and projects in order, primarily, to guide decisions of resource allocation. Most are ex post in nature focusing on the capacity of technologies to increase output. Various techniques calculate resources saved by technology adoption, the growth of consumer and producer surplus, contributions to marginal product, impact on national income, and changes in nutritional status (Shuh and Tollini, 1979, pp. 25-35). Ex ante methods include scoring and simulation models (Ibid., pp. 36-53). Difficulties in identifying and measuring relevant costs and benefits limit the practicality of certain of these approaches and emphasis placed on quantitative variables can restrict the usefulness of conclusions drawn. Socioeconomic and political variables, or those factors which are generally difficult to quantify, have not been well examined. Nor do these studies provide a basis for identifying constraints to institution-building efforts. Their value lies in the justification they provide for expanding research expenditures. Additional information and analysis are required for setting priorities among alternative research investments.

Research project evaluations take the form of preproject appraisals, progress reports, and end-of-term reviews. These generally examine a much broader series of issues including institutional needs and constraints. They tend to emphasize those weaknesses directly relevant to project objectives, particularly those limiting the expansion of research capabilities. Yet in so doing, these assessments can at least draw attention to major requirements of comprehensive institutional development.

Most of these sorts of evaluations, however, supply little depth of analysis. It has been pointed out in an AID assessment of its own research project evaluations that the type of information collected is generally limited to that required to meet

immediate country mission and bureau needs. Project reports and reviews stress project management considerations. The causes underlying frequently identified constraints are seldom examined. Apparent contradictions between donor and host country objectives tend to be neglected (USAID, 1982a).

Impact evaluations assess the consequences of project implementation. Those conducted by AID seek to determine whether institutions which received assistance and researchers who were trained remain active, to appraise their quality and to analyze the impact of technologies developed. Institutional constraints have been examined in most of these evaluations (Murphy, 1982). Yet once again discussion of these difficulties tends to be limited. While problems are identified, the underlying determinants receive little analysis or explanation.

Many of the reports and articles substantiating the analysis presented in this paper represent research system or institution evaluations. Some have been specifically commissioned to review the progress of program development. Others involve comparative institutional analysis of common constraints or descriptions of organizational structure and function. In many cases, however, the citation of research system deficiencies provides little basis for proposing major reforms. The need for closer research-extension links or improved planning strategies may be noted. But few reports suggest specific means to correct these problems. Awareness of institutional constraints marks an important first step toward improved strategies of program development. The translation of this understanding into appropriate reforms, however, remains difficult.

Fault may partly lie with the content of these evaluations. The in-depth discussion of management constraints has been relatively rare. Yet responsibility for strengthening of research systems through institutional consolidation rests largely with the administrators of these programs. The donors may need greater sensitivity to the requirements of program maintenance, but they cannot arbitrate

conflicting political and bureaucratic interests. Often, these must be resolved before many of the issues described above can be treated. Greater evidence explaining the impact of organization and management problems may provoke such reform.

Monitoring Research System Development

Research programs may be monitored by means of regularly scheduled external evaluations or ongoing internal review. External evaluations benefit from the expertise of independent, outside specialists who may be able to employ experience gained from working in a number of different countries. Frequently, team members have also previously worked in the system under study. Internal monitoring capabilities provide warning of the appearance of major operational constraints as these arise.

Both forms of assessment advance the consideration of basic requirements for institutional consolidation. The apparent usefulness of periodic external evaluations can be seen in the impact of these appraisals on the evolution of the Indian research system. The recommendations of expert review teams organized in 1955, 1959, 1962, 1963, 1965, and 1972 provided key assistance guiding the development of this system. Successive teams reviewed progress toward implementation of each previous team's advice and provided additional counsel contingent on changing research conditions and the availability of resources. The Indian government, recognizing the need, was closely involved in the recruitment of these teams and promoted the implementation of their recommendations. Team membership included top Indian scientists who similarly foresaw the value of institutional transformation (Smith, 1981, pp. 19-22). Without this strong backing, the response might have been quite different.

Besides the strong support of government and research system administrators, several additional variables have been cited as necessary for the success of these sorts of efforts. Research program objectives must be clearly stated to provide a standard against which development progress can be measured. The focus of these evaluations should encompass and perhaps emphasize institutional criteria as opposed simply to research priorities and methodologies. Some suggest overall program goals should be reviewed (Ruttan, 1981, pp. 149-151). The objectives and procedures of the review itself should be well understood and agreed upon before work is initiated. Teams should include representatives of several different disciplines. Those primarily composed of foreigners should include at least one host country national.

Each of these requirements helps ensure responsiveness to major institutional needs and the acceptability of team recommendations. Evaluations viewed as imposing the prejudices of outsiders will serve little purpose. Those failing to expose administrative or management deficiencies may highlight constraints without drawing attention to causes. These may simply exacerbate interpersonal tensions within the institution examined (Ibid., pp. 148-149). By the same token, however, major institutional evaluations cannot be relied upon to identify or resolve every managerial problem. These periodic appraisals must be backed by continuous monitoring of program development.

A number of evaluations have called for the establishment of these monitoring capabilities. While many programs regularly review the progress of their research on a commodity basis, relatively few seem to keep track of much more than this. Daniels and Nestel note the failure to reassess, on a periodic basis, program-wide resource allocations. The value of resources committed to various projects and experiment stations is often not known (1981, pp. 9-10). This makes the coordination of planning and resource commitments difficult. Severe resource

constraints may go unrecognized as the distribution of program funding becomes dependent on the relative strength of competitive bureaucratic interests.

Monitoring also provides a means to identify operational constraints. The impact of those affecting several different projects may only become evident when these are viewed together. Project managers might themselves not recognize the significance of certain constraints, or could be reluctant to report them for fear that such problems reflect poorly on their abilities. When the problem is managerial or administrative in origin, independent assessments may provide the only possible channel of response.

In addition, a monitoring unit could play a role in assessing the impact of disseminated technologies. Many research institutions consider their responsibility to end when the technological improvement has been passed on to the extension service. Yet the adoption of new technologies can create new problems or increase the significance of unconsidered constraints. Recommendations may require revision and new research priorities may be established. Where technologies are successful, the monitoring of their impact can provide data useful for justifying strengthened government commitments to institutional development. If they are not successfully adopted, the justification should be carefully examined.

Criteria for Institutional Evaluation

ISNAR has suggested the need for an ideal model providing a basis for the identification of key factors influencing the performance of national research systems (1981, p. 4). This might only provide an idea of the range of factors which should be taken into account when appraising institutional strengths and weaknesses. Yet each program must be examined as an institution which has uniquely evolved in response to the pressures of its environment. It is relatively easy to see the same problem in two different systems and assume the underlying causes and

necessary solution are similar. Yet distinct organizational dynamics or dominant interest groups may require a totally different sort of explanation. Even when the problems are comparable, dissimilar strategies may be required in response. Preconceptions built upon an ideal representation of key factors commonly apparent can obscure the unique character of functional relationships justifying a particular mode of operation.

By the same token, however, evaluation guidelines can play an important role. Evaluation teams need to avoid simply recording what certain administrative authorities want known. Time constraints generally necessitate that the team has a reasonable understanding of what it is looking for before it enters the field. The diverse disciplinary interests of individual team members can lead to different perspectives of what issues are important. If the team includes only technical scientists, a listing of managerial variables likely to be significant may well broaden the evaluative focus. At a minimum, this listing will provide a common frame of reference by which work may be coordinated.

ISNAR has formulated a brief inventory of criteria which includes many of the issues cited in this paper. These include problems of program identification, program planning, program implementation, program evaluation, manpower management, information management, financial management, on-farm research, research-extension linkages, and bilateral, multilateral, and IARC cooperation (1981c, pp. 6-9). Such lists are not difficult to construct. Complications arise in the course of efforts to match apparent constraints with some measure of significance and the need to identify the underlying causes. If recommendations are to be both reasonable and acceptable, the analysis must correspond with the concerns and perceptions of the program's leadership. The practical usefulness of proposed solutions requires their alignment with the availability of institutional resources and managerial capabilities. In most cases, the consolidation of existing

endeavors must take priority over their expansion. Institutions require a firm foundation before their responsibilities can spread too far. This must be built on the basis of each country's individual needs, and primarily constructed with their own resources. Evaluations cannot mandate changes. Where necessary, however, they should help make the need for change understood.

CONCLUSION

The justification for the persistence of many of the problems of administrative management in agricultural research organizations remains unclear. The issues outlined in these chapters have been identified in evaluations of developing country research programs for many years. They have been repeatedly cited by the leaders of research organizations and by the planners of projects calling for organizational reform. Yet progress toward their resolution seems to have remained slow. In some programs, these constraints only seem to be worsening.

Hypotheses explaining the failure of institutional reform, or in some cases, of the institution-building process as a whole, have been almost as varied as the descriptions of the problems themselves. Governments are said to lack commitment to build or maintain strong agricultural research organizations. They are satisfied to rely upon the contributions of international research networks, or dependent on the vicissitudes of donor funding and interest. Research organizations have been unnecessarily confined within the bounds of bureaucratic procedures and civil service codes. These inhibit the entrepreneurship characteristic of scientific enterprise. They distort organizational priorities by emphasizing the importance of one's relative position in the bureaucratic hierarchy rather than the quality or value of one's work. The donor agencies, which by virtue of the relative size of their funding commitments guide the orientation of the development of national programs, have lacked a historical perspective. They have tended to view development as synonomous with the acceptance of new priorities and creation of new programs rather than the maintenance of the old. Reform has most frequently

been interpreted to mean reorganization rather than revision. Similarly, program development has been largely interpreted in terms of the pursuit of technological as opposed to managerial objectives. Organizational development goals call for the release of new varieties and generation of a specified number of new recommendations to serve a predetermined group of farmers. These are often viewed as distinct from the need to ensure that scientists are consistently well-equipped and research results are carefully analyzed and shared. The link between these objectives seldom seems adequately appreciated.

Each of these explanations for the persistence of organization and management problems may be relevant. Yet one additional, and perhaps associated, concern remains largely unexplored despite the fact that it is what ultimately underlies the very definition of most of the constraints described in this paper. This is the failure to recognize, or perhaps simply lay adequate emphasis on, the importance of strong institutional management. The many problems, and in some cases potential reforms, which have been identified in the literature and cited by practitioners in the course of assessments of research program strength, have been essentially issues of management. It is time to place greater emphasis on treating them as such in plans calling for additional organizational funding and development.

The adoption of the goal of improving organizational management implies the need to focus concern on both organizational efficiency and organizational leadership (cf. Selznick, 1957). Greater efficiency in the conduct of standard operating procedures can ensure that research resources are quickly distributed and major allocation constraints are rapidly identified. It can facilitate the flow of both administrative and scientific information within and across organizational boundaries. Efficiency can likewise promote accountability to system-wide objectives.

Many bureaucratic procedures seem to persist more because any change threatens someone's power than because they work well. A large number have probably developed in an ad hoc manner or in response to needs entirely different than those for which they are currently enforced. The failure to implement changes may result, in part, from the failure to recognize the sorts of changes which are possible. Alternatively, the incentives for good management may simply be poor. Institution-building efforts must explicitly tackle such constraints.

In so doing, it should be kept in mind that administrative procedures must be adapted to each organization's own unique needs. These must change as perceptions of managerial needs change. At times, they must be flexibly interpreted. Improvements must be continually pursued. Yet once a well-defined set of standard operating procedures is established, its justification should be widely understood. The procedures can be enforced accordingly.

Organizational leadership is what makes an organization an institution with its own set of values and independent identity. This is at least as important to the managerial process as efficiency. It provides the organization's ability to adapt its priorities or operational procedures in the face of conflict or constraint. By providing an organization with its identity, leadership defines and justifies the institution's position within the development bureaucracy. It provides a point of focus for scientific allegiance. Similarly, it provides a consistent and strengthened source of demand for government resources.

It is similarly important to recognize that substantial returns can be derived from simply strengthening institutional leadership. Rather than undermining a leader's authority by trying to redefine his priorities or stretch his resources too thin, institution-building should be viewed as a means to consolidate the institution's identity and focus. The organization's leadership should direct this effort and be held accountable for it. Only when an institution is firmly established is it

reasonable to consider the extension of its mandate. This expansion must then be sought by an institution's leaders if it is to be successful.

In sum, agricultural research institution-building should first and foremost be viewed as a process of building a firm foundation of organizational management. It should denote efforts to reinforce that management by facilitating the development of its leadership. Once a firm administrative foundation is established, the expansion of an institution's mandate can be self-generated. Only then can these organizations be realistically expected to contribute consistently to a nation's agricultural development objectives.

SELECTED BIBLIOGRAPHY

Ampuero, Enrique. (1981a). "Organization of Agricultural Research for the Benefit of Small Farmers in Latin America." Ithaca, N.Y.: Cornell University, Program in International Agriculture. Mimeograph 85.

_____. (1981b). "Organization and Administration of Experiment Stations in Developing Countries." Ithaca, N.Y.: Cornell University, Program in International Agriculture. Mimeograph 86.

_____. (1981c). "Cooperation Between National Research Organizations and International Centers: Opportunities and Limitations." Ithaca, N.Y.: Cornell University, Program in International Agriculture. Mimeograph 87.

Anderson, Kym. (1981). "Politicoeconomic Factors Affecting Public Agricultural Research Investment in Developing Countries" in Rural Challenge. Edited by M. Bellamy and B. Greenshields. London: Gower.

Anonymous. (1975). "Summary of Presentations: Meetings of the VII Meeting of the Bellagio Group held in Montebello, Quebec, June 1-4, 1975."

Anthonio, Q.B.O. (1979). "Administration of Agricultural Institutions in Developing Countries." Agricultural Administration 6:43-53.

Ardila, Jorge; E. Trigo; and M. Pineiro. (1981). "Human Resources in Agricultural Research: Three Cases in Latin America" in Resource Allocation to Agricultural Research. Edited by D. Daniels and B. Nestel. Ottawa: IDRC.

Arndt, T.M.; D.G. Dalrymple; and W.V. Ruttan (eds.). (1977). Resource Allocation and Productivity in National and International Agricultural Research. Minneapolis: University of Minnesota Press.

Arndt, T.M. and W.V. Ruttan. (1975). "Resource Allocation and Productivity in National and International Agricultural Research." ADC Seminar Report, September 1975.

Bernsten, R.H. and R.W. Herdt. (1981). "Farm Management's Role in Farming Systems Research to Increase Productivity in Small Farms." Mimeograph.

Bonnen, James T. (1981). "Agriculture's System of Developmental Institutions: Reflections on the U.S. Experience." Paper presented for the 1981 Symposium on Rural Economics, October 19-22, 1981.

Boyce, James K. (1980). "Agricultural Research in Indonesia, the Philippines, Bangladesh, South Korea and India: A Documentary History." Asian Agricultural Research Review Project Document.

Cardwell, Vernon, et al. (1981). "Agricultural Research in Indonesia." Economic Development Center Bulletin Number 81-1. Minneapolis: University of Minnesota.

Consultative Group for International Agricultural Research. (1978). "Report of the Task Force on International Assistance for Strengthening National Agricultural Research." Washington, D.C.: CGIAR.

Cummings, Ralph Jr. (1981). "Strengthening Linkages Between Agricultural Research and Farmers." Paper prepared for May OECD/DAC Conference.

Cuyno, Rogelio V. "Effective Management of Agricultural Research Programs." Occasional Paper 5, Research Management Center, U.P. Los Banos, Philippines.

Daniels, D. and B. Nestel (eds.). (1981). Resource Allocation to Agricultural Research. Ottawa: IDRC.

Drilon, J.D. and Aida R. Librero. (1981). "Defining Research Priorities for Agriculture and Natural Resources in the Philippines" in Resource Allocation to Agricultural Research. Edited by D. Daniels and B. Nestel. Ottawa: IDRC.

Galt, Dan. (1981). "Honduras Agricultural Research Project Case Study." Draft.

Gamble, William K. (1981). "National Agricultural Research Systems and the International Service for National Agricultural Research." Paper prepared for Seventh Ministerial Session of the World Food Council, Novi Sad, Yugoslavia.

Gautam, O.P. (1981). "Management of Agricultural Research: Indian Experience." Occasional Paper 4, Research Management Center, U.P. Los Banos, Philippines.

Hayami, Yujiro and V.W. Ruttan. (1971). Agricultural Development: An International Perspective. Baltimore: The Johns Hopkins Press.

Idachaba, Francis S. (1980). "Agricultural Research Policy in Nigeria." IFPRI Research Report 17.

International Agricultural Development Service (IADS). (1979a). Preparing Professional Staff for National Agricultural Research Programs. Report of a Workshop. Bellagio, Italy. February 16-21, 1979.

_____. (1979b). "Senegal Agricultural Research Project Report." July 1979.

International Bank for Reconstruction and Development. (1981). Agricultural Research: Sector Policy Paper. Washington, D.C.: IBRD.

International Food Policy Research Institute. (1977). "Food Needs of Developing Countries: Projections of Production and Consumption to 1990." IFPRI Research Report 3. Washington, D.C.: IFPRI.

International Service for National Agricultural Research. (1981a). Strengthening National Agricultural Research Systems in Africa: Report of a Meeting of Managers of Agricultural Research Systems in 18 African Countries. The Hague: ISNAR.

_____. (1981b). Strengthening National Agricultural Research Systems in Asia: Report of Discussions by Leaders of Agricultural Research Systems in 13 Asian Countries. The Hague: ISNAR.

_____. (1981c). Kenya's National Agricultural Research System. The Hague: ISNAR.

_____. (1982). Annual Report, 1981. The Hague: ISNAR.

Koppel, Bruce. (1979). "The Changing Functions of Research Management: Technology Assessment and the Challenges to Contemporary Agricultural Research Organizations." Agricultural Administration 6:123-139.

Leonard, D. (1977). Reaching the Peasant Farmer: Organization Theory and Practice in Kenya. Chicago: University of Chicago Press.

Lokah, A.K. and I.A. Akinbode. (1981). "Agricultural Research Delivery System in Sierra Leone." Agricultural Administration 8:289-303.

Lowdermilk, M.K. (1981). "Promoting Increased Food Production in the 1980s: Approaches to Agricultural Extension in Different Production Systems." Paper presented at World Bank Symposium, January 5-9, 1981, on Promoting Increased Food Production in the 1980s.

McDermott, J.K. (1981). "Managing the AID Research System." August 28, 1981. Draft.

_____. (1984). "Extension Research Linkage Conceptualization and Management." Draft.

Morawetz, David. (1977). Twenty-Five Years of Economic Development, 1950 to 1975. Washington, D.C.: The World Bank.

Moseman, Albert H. (1970). Building Agricultural Research Systems in the Developing Countries. New York: ADC.

Moseman, A.H., et al. (1980). "Report of the Review Team; Bangladesh Agricultural Research System." July 18, 1980.

Murphy, Josette. (1982). "Agricultural Research and Development." Background paper for Workshop on the Impact of Agricultural Research, July 14-17, 1982. Mimeograph.

Nicholson, Norman L. (1980). "The Political Economy of Agricultural Research in Developing Countries: The Case for Farming Systems Approaches." Paper presented to Farm Structure and Rural Policy Symposium, Iowa State University, Ames, October 20-22, 1980.

Oram, Peter A. (1978). "Current and Projected Agricultural Research Expenditures in Developing Countries." IFPRI Working Paper 30.

_____. (1981). "Recurrent Cost Problems of Agricultural Research and Extension in Developing Countries." Paper presented at the OECD/DAC Workshop on Linkages Between Agricultural Research and Farmers in Developing Countries, 13-14 May 1981, Paris.

Oram, Peter A. and Vishva Bindlish. (1981). Resource Allocations to National Agricultural Research: Trends in the 1970s. The Hague and Washington, D.C.: ISNAR and IFPRI.

Pineiro, M.; E. Trigo; and R. Fiorentino. (1979). "Technical Change in Latin American Agriculture." Food Policy 4:169-177.

Pinstrup, Anderson Per. (1981). "The Political Economy of Technical Change in Latin American Agriculture: A Discussion Note." Paper presented at the Cambio Tecnico en el Agro Latinamericano: Situacion y Perspectives en la Decada de 1980. September 1-3, 1981.

Pray, Carl E. (1981). "Agricultural Research in British and Pakistani Punjab; An Induced Innovation Interpretation." Staff Paper P81-21. Institute of Agriculture, Forestry and Home Economics.

Ruttan, Vernon W. (1981a). "The Asian Agricultural Research Review." Paper presented at the AID Asia Bureau Agriculture/Rural Development Conference, January 13, 1981.

_____. (1981b). Agricultural Research Productivity. Minneapolis: University of Minnesota Press.

Schuh, G.E. and H.T. Tollini. (1979). "Costs and Benefits of Agricultural Research: The State of the Arts." World Bank Staff Working Paper No. 360. Washington, D.C.: IBRD.

Schultz, T.W. (1980). "The Entrepreneurial Function in Agricultural Research." Paper prepared for the Agricultural Research Workshop, Yogyakarta, Indonesia, November 9, 1980.

Selznick, Philip. (1957). Leadership in Administration: A Sociological Interpretation. New York: Harper and Row.

Smith, Grahame. (1981). "A Comparative Study of National Agricultural Research Systems in Selected Countries." Washington, D.C.: Office of Technology Assessment. Mimeograph.

Swedish Agency for Research Cooperation with Developing Countries. (1980a). Strengthening National Agricultural Research, Part 1. Edited by B. Bengtsson and G. Tedla. Stockholm: SAREC.

_____. (1980b). Strengthening National Agricultural Research, Part 2. Edited by B. Bengtsson. Stockholm: SAREC.

Tahir, Saleem M.; G.O.B. Bertilsson; and G.W. Arnott. (1981). "Management of Fertilizer Research in Pakistan and Suggestions for Improvement." Agricultural Administration 8:142-158.

Trigo, Eduardo J. and Martin E. Pineiro. (1981a). "Dynamics of Agricultural Research Organization in Latin America." Food Policy, February 1981.

_____. (1981b). Institutional Aspects of Agricultural Research Organization in Latin America; Problems, Perspectives and Policy Issues. San Jose, Costa Rica: IICA.

United Nations World Food Council. (1982). "Current World Food Situation." Report prepared for Eighth Ministerial Session. WFC/1982/7. Rome: WFC.

U.S. Agency for International Development (USAID). (1980a). "Central America: Small Farmer Cropping Systems." AID Project Impact Evaluation Report No. 14. Washington, D.C.: AID.

_____. (1980b). "Kitale Maize: The Limits of Success." AID Project Impact Evaluation Report No. 2. Washington, D.C.: AID.

_____. (1981a). "Institutions in Agricultural and Rural Development." TPCA Occasional Paper 2. Second Working Draft, January 15, 1981.

_____. (1981b). Senegal Agricultural Research and Planning Project (685-0223).

_____. (1982a). "AID Experience in Agricultural Research: A Review of Project Evaluations." AID Program Evaluation Discussion Paper No. 13. Washington, D.C.: AID.

_____. (1982b). "AID's Strategy to Strengthen National Agricultural Research Systems in Africa." Mimeograph, dated May 5, 1982.

_____. (1982c). "Guatemala: Development of the Institute of Agricultural Science and Technology (ICTA) and Its Impact on Agricultural Research and Farm Productivity." AID Project Impact Evaluation Report No. 30. Washington, D.C.: AID.

_____. (1982d). "Korean Agricultural Research: The Integration of Research and Extension." AID Project Impact Evaluatin No. 27. Washington, D.C.: AID.

U.S. Department of Agriculture (USDA). (1980). "Systematic Procedures for Planning Research." ARM-NE-8. Washington, D.C.: USDA, Science and Education Administration, Agricultural Reviews and Manuals.

Uphoff, Norman. (1981). "Ten Propositions on Agricultural Research, Extension, and Development." Draft.

Whyte, William F. (1981). "Participatory Approaches to Agricultural Research and Development: A State of the Art Paper." Special Series on Agricultural Research and Extension. Ithaca, N.Y.: Cornell University.