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TOWARD A GLOBAL AGRICULTURAL RESEARCH SYSTEM

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We are, during the closing decades of the 20th century, approaching the end of one of the most remarkable transitions in the history of agriculture. Prior to the beginning of this century, almost all increases in agricultural production occurred as a result of increases in the area cultivated. There were only a few exceptions to this generalization. One exception was the wet rice cultivation areas of East Asia. A second major exception was the areas in Western Europe that contributed to the agricultural revolution of the 18th and 19th centuries.

By the end of this century, there will be few significant areas where agricultural production can be expanded by simply adding more land to production. Expansion of agricultural output will have to be obtained almost entirely from more intensive cultivation in areas already used for agricultural production. Increases in food and fibre production will depend to a great extent on continuous advances in agricultural technology. It is imperative that over the next several decades we complete the establishment of agricultural research capacity for each commodity of economic significance in each agroclimatic region of the world.

In this paper I address the task that remains: to design and implement the global agricultural research system that will need to be in place by, at the very latest, the first decade of the 21st century. I will pay particular attention to the special problems of the smaller countries in the emerging global system.

THE INTERNATIONAL AGRICULTURAL RESEARCH SYSTEM

Let me first recall what has been accomplished over the last several decades. The architects of the post-World War II system of global institutions included the problem of meeting world food needs and reducing poverty in rural areas as essential elements in their vision of a world community that could assure all people of freedom from want and insecurity. They sought to achieve this vision by the creation of a set of global bureaucracies, the UN specialized agencies. The establishment of the UN Food and Agriculture Organization was the initial institutional response to this concern (Hambridge).

It was not until the late 1950s and early 1960s that a combination of concern about meeting world food needs, experience in advancing technology in food grain production in the tropics, a more adequate analysis of the role of agriculture, and of advances in agricultural technology in the development process, converged to provide the impetus, on the part of several bilateral and multilateral assistance agencies and national governments, for a major effort to build the research capacity needed to sustain agricultural production in the poor countries of the tropics.

Organization and Impact

One of the most remarkable advancements that emerged out of the efforts of the last two decades has been the establishment of a new system of international agricultural research institutes (Table 1). The first four institutes in the system were the product of the joint efforts of the Ford and Rockefeller Foundations. The system now operates under the aegis of the Consultative Group for International Agricultural Research, and is funded by a consortium of private foundations and bilateral and multilateral assistance agencies. An important innovation in the management of the system is that each institute is governed by an independent board of directors and operates as an autonomous institution. This structure, which combines decentralized decision-making with respect to scientific program, with centralized supervision regarding funding and program direction, is fundamental in accounting for the efficiency of the system. Scientific judgments about programs are made in a decentralized manner, while system design and strategy can be made centrally.

Evidence regarding the productivity of the system is fragmentary and incomplete. Yet there is little doubt that the rate of return to the investment in the system has been high, even by comparison with the more productive developed countries national systems (Table 2). As early as the mid-1970s, evidence developed by Robert Evenson and colleagues, at the University of the Philippines and the International Rice Research Institute, indicated that the supply of rice in all developing countries was approximately 12 per cent higher than it would have been if the same total resources had been devoted to the production of rice using only the varieties that were available prior to the mid-1960s (Evenson, Flores, and Hayami). A recent study by Joseph Nagy suggests that the gains to Pakistan alone, from the wheat research conducted by CIMMYT, would have been more than enough to cover the cost of the entire CIMMYT wheat program from its inception to 1980. Another way of making the same point is that Pakistan could then have afforded to invest in a wheat research program of its own, comparable in extent and cost to the CIMMYT program.

Support for Small Country Systems

The international system is particularly important for enhancing and sustaining the productivity of the smaller national agricultural research systems. I recall in the late 1970s visiting the rice research station at Mopti in Mali. The scientific staff at the station consisted of four young men: a rice breeder, an entomologist, a plant pathologist, and an agronomist who had recently returned from completion of master's level (or equivalent) training abroad. They had access, through the West African Rice Development Authority (WARDA), to the IRRI germplasm collections. Their professional isolation was relieved and their productivity enhanced through participation in WARDA and IRRI workshops and seminars. A decade earlier, they would have had little access to either the genetic resources or the intellectual contact that enabled them, in the late 1970s, to initiate a modest but yet productive research program.

Let me refer to a second example. At the 1984 Agricultural Research Policy Seminar held at the University of Minnesota, a research director from one of the smaller Latin American countries commented to the effect that: "It is very well for those from Mexico or Brazil to talk about the strength of your national systems and how little you gain from the international centers. But without the international centers we would not get anything from you. The international centers are there working with us to make sure we have access to the available technology. The primary factor that limits what we get through the centers is our own capacity to use it."

A Continuing Need for International Support

When the system of international centers was being established by the Ford and Rockefeller Foundations in the early and mid-1960s, there was a general consensus that over a period of several decades the foundations would withdraw and transfer the management and support of the institutes to the host countries. The two foundations have now withdrawn from anything more than token support of the system. But responsibility for supervision and support has been assumed, as noted earlier, by the CGIAR and its member institutions. Yet one still hears comments from both staff members of the developed countries donors and the developing countries national research system that, at some time in the future, the responsibility for the system can be transferred to the developing countries or that the major units of the system (excepting the International Board for Plant Genetic Resources) will eventually be phased out.

I find such discussion unrealistic. The system should be viewed as a permanent component of the global agricultural support system. This should not mean that every unit in the present system should be regarded as permanent. It is not difficult to visualize circumstances that could lead to the de-emphasis of some programs and the initiation of new programs. But the international system should be regarded as permanent. And the funding for the system should become part of the permanent commitment of the more developed countries to the agricultural development of the poorer and smaller countries in the system. In this respect, there is a similarity between the national funding of a system of regional research centers in larger countries such as Brazil, India and the United States, even though the individual states also support state experiment stations.

An Incomplete System

While arguing for a permanent commitment to the support of the international systems, I would like to suggest that the system remains incomplete. I do not, however, argue for any significant expansion of the system of international commodity research institutes. But there is a need to rationalize the management and supervision of a number of international agricultural research centers that have grown outside the CGIAR system (Table 3). And I do see the need for greater capacity to conduct research on some of the difficult resource problems that continue to inhibit the development of agriculture in tropical environments. And it also seems apparent that lack of basic scientific knowledge represents a serious constraint in the

Table 1: Centers Supported by the CGIAR, 1984

Acronym (Year Established)	*Center*	*Location*	*Research Programs*	*Geographic Focus*	*1984 Budget* * ($ million)
IRRI (1960)	International Rice Research Institute	Los Baños, Phillippines	Rice Rice based	Global Asia	22.5
CIMMYT (1966)	Centro Internacional de Mejoramiento de Maíz y Trigo	Mexico City, Mexico	Maize Bread wheat Durum wheat Barley Triticale	Global Global Global Global Global	21.0
IITA (1967)	International Institute of Tropical Agriculture	Ibadan, Nigeria	Farming systems Maize Rice Sweet potato, yams Cassava, Cowpea, Lima bean, Soybean	Tropical Africa Global Tropical Africa	21.2
CIAT (1968)	Centro Internacional de Agricultura Tropical	Cali, Colombia	Cassava Field beans Rice Tropical pastures	Global Global Latin America Latin America	23.1
CIP (1971)	Centro Internacional de la Papa	Lima, Peru	Potato	Global	10.9
WARDA (1971)	West African Rice Development Association	Monrovia, Liberia	Rice	West Africa	2.9
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics	Hyderabad, India	Chickpea Pigeonpea Pearl millet Sorghum Groundnut Farming systems tropics	Global Global Global Global Global Semi-arid	22.1
ILRAD (1973)	International Laboratory for Research on Animal Diseases	Nairobi, Kenya	Trypanosomiasis Theileriosis	Global Global	9.7
IBPGR (1974)	International Board for Plant Genetic Resources	Rome, Italy	Plant genetic resources	Global	3.7
ILCA (1974)	International Livestock Center for Africa	Addis Ababa, Ethiopia	Livestock production systems	Tropical Africa	12.7
IFPRI (1975)	International Food Policy Research Institute	Wash. D.C., U.S.A.	Food policy	Global	4.2
ICARDA (1976)	International Center for Agricultural Research in the Dry Areas	Aleppo, Syria	Farming systems Wheat, Barley, Triticale, Broad bean, Lentil, Chickpea, Forage crops	Dry areas of West Asia and North Africa	20.4
ISNAR (1980)	International Service for National Agricultural Research	The Hague, Netherlands	National agricultural research	Global	3.5

* CGIAR supported core budget, net of capital, at the bottom of the bracket (from 1983 Integrative Report.)

development of viable and sustainable technologies in some areas.

The establishment of an International Fertilizer Development Center at Muscle Shoals, Alabama, USA, in 1974 represented an initial step in the development of an international capacity for research on resource development and management problems. The decision, this past year, by a group of donors to establish an International Irrigation Management Institute (IIMI) in Sri Lanka represented a second significant initiative. There is widespread discussion in forestry circles of the need for greater capacity in the tropics for reseach on the development, management, and utilization of fast growing trees, to sustain the demand for biomass for fuel and other uses.

We have also seen the beginnings of international support for the development of capacity to work on some of the problems where lack of basic knowledge acts as a constraint in technology development. Within the CGIAR system, the International Laboratory for Research on Animal Diseases (ILRAD) has been forced to direct much of its research to basic investigations. The International Centre for Insect Physiology and Ecology (ICIPE), initially established in 1970, has gradually evolved into an institution with very substantial research capacity. The United Nations Industrial Development Organization (UNIDO) has sponsored exploratory studies that are leading to the establishment of an International Centre for Genetic Engineering and Bio-Technology (ICGER). It is doubtful, however, that the ICGER will devote adequate attention to the work in molecular biology that will be most relevant for animal and plant protection in developing countries. There is also, in my judgment, a very strong need for capacity to conduct research to overcome the lack of knowledge about problems of fertility maintenance and enhancement of tropical soils. In many parts of Africa, lack of knowledge about soil fertility represents a serious constraint on the ability to design viable short rotation systems, to replace the more extensive slash-and-burn or other long rotation systems now in use. Finally, there are serious deficiencies in the knowledge needed to develop economically viable technologies for the control of the parasitic diseases that inhibit the development of more intensive systems of agricultural production. In many cases, the relationship between disease and development appears to be symbiotic.

Intensification of agricultural production enhances the environment for parasite disease. And parasite disease reduces the capacity of rural people to pursue more intensive systems of cultivation.

It is not too difficult to obtain agreement, at least in principle, for greater international support for research on problems of resource development and management. But there is considerable scepticism about the need for international support for a series of basic research institutes in the tropics. The argument is frequently made that the basic research can be done in developed countries institutes, particularly in countries such as France, the United Kingdom, and the Netherlands, that have a tradition of tropical research and are now seeing that capacity erode as support adjusts to the disappearance of colonial responsibilities and to budgetary constraints. Part of my answer is that intellectual commitment to the solution of scientific problems is enhanced when scientists working on these problems are located in the environment in which the problems exist. Basic research capacity in the tropics will also facilitate more effective dialogue with the research community of the developed countries.

Considerable thought will also have to be given to the appropriate governance of the emerging system of natural resource and basic science research centers. The present CGIAR system is already approaching the limits of its financial and managerial capacity. Yet it would be a serious mistake if new natural resources and basic science institutes were to continue to emerge on an ad hoc basis. One of the great strengths of the present CGIAR system is its planning and supervising role in welding the set of autonomous institutes into an international research system. It may be necessary to consider the establishment of new supervising bodies, such as a Consultative Group for Natural Resources Research (CGNRR) to govern the new natural resource-based institutes. And it will certainly be necessary to establish a separate governance system for any new system of basic research institutes - a Consultative Group of Biological Sciences for Tropical Agriculture (CGBSTA).

As new internationally supported basic research units are established in the tropics, more attention should be given to their training role, particularly advanced training at the Ph.D. and post-doctoral levels, than was the case when the present international commodity institutes were established.

A Global System

Finally, I would argue that an effort should be made to ensure that the international system becomes a truly global system. The new international system has been effective in building communication among developing countries national research systems. The linkages of the international centers with developed countries research institutions are, however, generally filtered through the bilateral

Table 2: Summary Studies of Agricultural Research Productivity

Study	Country	Commodity	Time Period	Annual Internal Rate of Return (%)
Index Number:				
Griliches, 1958	USA	Hybrid corn	1940–1955	35-40
Griliches, 1958	USA	Hybrid sorghum	1940–1957	20
Peterson, 1967	USA	Poultry	1915–1960	21-25
Evenson, 1969	South Africa	Sugarcane	1945–1962	40
Barletta, 1970	Mexico	Wheat	1943–1963	90
Barletta, 1970	Mexico	Maize	1943–1963	35
Ayer, 1970	Brazil	Cotton	1924–1967	77
Schmitz and Seckler, 1970	USA	Tomato harvester,	1958–1969	
		Tomato harvester, to displaced workers		37-46
		Tomato harvesters, with compensation of displaced workers for 50% of earnings loss		
Ayer and Schuh, 1972	Brazil	Cotton	1924–1967	77-110
Hines, 1972	Peru	Maize	1954–1967	35-40 (a)
				50-55 (b)
Hayami and Akino, 1977	Japan	Rice	1915–1950	25-27
Hayami and Akino, 1977	Japan	Rice	1930–1961	73-75
Hertford, Ardila,	Colombia	Rice	1957–1972	60-82
Rocha, and Trujillo	USA	Soybeans	1960–1971	79-96
1977		Wheat	1953–1973	11-12
		Cotton	1953–1972	none
Pee, 1977	Malaysia	Rubber	1932–1973	24
Peterson and Fitzharris, 1977	USA	Aggregate	1937–1942	50
			1947–1952	51
			1957–1962	49
			1957–1972	34
Wennergren and Whitaker, 1977	Bolivia	Sheep	1966–1975	44
		Wheat	1966–1975	48
Pray, 1978	Punjab (India)	Agricultural research and extension	1906–1956	34-44
	Punjab (Pakistan)	Agricultural research and extension	1948–1963	23-37
Scobie and Posada, 1978	Bolivia	Rice	1957–1964	79-96
Pray, 1980	Bangladesh	Wheat and rice	1961–1977	30-35
Regression Analysis:				
Tang, 1963	Japan	Aggregate	1880–1938	35
Griliches, 1964	USA	Aggregate	1949–1959	35-40
Latimer, 1964	USA	Aggregate	1949–1959	not significant
Peterson, 1967	USA	Poultry	1915–1960	21
Evenson, 1968	USA	Aggregate	1949–1959	47
Evenson, 1969	South Africa	Sugarcane	1945–1958	40
Barletta, 1970	Mexico	Crops	1943–1963	45-93
Duncan, 1972	Australia	Pasture improvement	1948–1969	58-68
Evenson and Jha, 1973	India	Aggregate	1953–1971	40
Cline, 1975	USA	Aggregate	1939–1948	41-50 (c)
(revised by Knutson and Tweeten, 1979)		Research and extension	1949–1958	39-47 (c)
			1959–1968	32-39 (c)
			1969–1972	28-35 (c)
Bredahl and Peterson, 1976	USA	Cash grains	1969	36 (d)
		Poultry	1969	37 (d)
		Dairy	1969	43 (d)
		Livestock	1969	47 (d)
Kahlon, Bal, Saxena, and Jha, 1977	India	Aggregate	1960–1961	63
Evenson and Flores, 1977	Asia – national	Rice	1950–1965	32-39
			1966–1975	73-78
	Asia International	Rice	1966–1975	74-102
Flores, Evenson and Hayami, 1978	Tropics	Rice	1966–1975	46-71
	Philippines	Rice	1966–1975	75
Nagy and Furtan, 1978	Canada	Rapeseed	1960–1975	95-110
Davis, 1979	USA	Aggregate	1949–1959	66-100
			1964–1974	37
Evenson, 1979	USA	Aggregate	1868–1926	65
	USA	Technology oriented	1927–1950	95
	USA	Science oriented	1927–1950	110
	USA	Science oriented	1948–1971	45
	Southern USA	Technology oriented	1948–1971	130
	Northern USA	Technology oriented	1948–1971	93
	Western USA	Technology oriented	1948–1971	95
	USA	Farm management research and agricultural extension	1948–1971	110

Appendix to Table 2

Evenson Robert E., Paul E. Waggoner, and Vernon W. Ruttan, *Economic Benefits from Research: An Example from Agriculture,* Science, 205 (September 14, 1979), pp. 1101-7. Copyright 1979 by the American Association for the Advancement of Science.

Notes:

(a) Returns to maize research only.
(b) Returns to maize research plus cultivation "package".
(c) Lower estimate for 13-, and higher for 16-year time lag between beginning and end of output impact.
(d) Lagged marginal product of 1969 research on output discounted for poultry and dairy, and 7 years for livestock.

Sources for Table 2: The results of many of the studies reported in this table have previously been summarized in the following works:

Arndt Thomas M., Dana G. Dalrymple, and Vernon W. Ruttan, eds., *Resource Allocation and Productivity in National and International Agricultural Research* (Minneapolis: University of Minnesota Press, 1977) p. 6, 7.

Boyce James K. and Robert E. Evenson, *Agricultural Research and Extension Systems* (New York, Agricultural Development Council, 1975), p. 104.

Evenson Robert, Paul E. Waggoner, and Vernon W. Ruttan, *Economic Benefits from Research: An Example from Agriculture,* Science, 205 (September 14, 1979), pp. 1101-7.

Sim Robert J. R. and Richard Gardner, *A Review of Research and Extension Evaluation in Agriculture,* (Moscow, Idaho: University of Idaho, Department of Agricultural Economics Research Series 214, May 1978), pp. 42, 42.

The sources for individual studies are:

Ayer H., *The Costs, Returns and Effects of Agricultural Research in Sao Paulo, Brazil* (Ph.D. dissertation, Purdue University, 1970).

Ayer H. W. and G. E. Schuh, *Social Rates of Return and Other Aspects of Agricultural Research: The Case of Cotton Research in Sao Paulo, Brazil,* American Journal of Agricultural Economics, 54 (November 1972), pp. 557-69.

Barletta Ardito N., *Costs and Social Benefits of Agricultural Research in Mexico* (Ph.D. dissertation, University of Chicago, 1970).

Bredahl M. and W. Peterson, *The Productivity and Allocation of Research: U.S. Agricultural Experiment Stations,* American Journal of Agricultural Economics, 58 (November 1976), pp. 684-92.

Cline Phillip L., *Sources of Productivity Change in United States Agriculture,* (Ph.D. dissertation, Oklahoma State University, 1970).

Davis Jeffrey S., *Stability of the Research Production Coefficient for U.S. Agriculture,* (Ph.D. dissertation, University of Minnesota, 1979)

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Evenson R. E. and P. Flores, *Economic Consequences of New Rice Technology in Asia,* Los Banos, Laguna, Philippines: International Rice Research Institute, 1978.

Evenson R. E. and D. Jha, *The Contribution of Agricultural Research Systems to Agricultural Production in India,* Indian Journal of Agricultural Economics, 28 (1973), pp. 212-30.

Flores P., R. E. Evenson, Y. Hayami, *Social Returns to Rice Research in the Phillipines: Domestic Benefits and Foreign Spillover,* Economic Development and Cultural Change, 26 (April 1978), pp. 591-607.

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Griliches S., *Research Expenditures, Education and the Aggregate Agricultural Production Function,* American Economic Review, 54 (December 1964), pp. 961-74.

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Hines J., *The Utilization of Research for Development: Two Case Studies in Rural Modernization and Agriculture in Peru (PhD. dissertation, Princeton University, 1972).*

Kahlon A. S., H. K. Bal, P. N. Saxena, and D. Jha, Returns to Investment in Research in India, in Resource Allocation and Productivity in National and International Agricultural Research, University of Minnesota Press, 1977), pp. 124-47.

Knutson M. and Luther G. Tweeten, *Toward an Optimal Rate of Growth in Agricultural Production Research and Extension,* American Journal of Agricultural Economics, 61 (February 1979), pp. 70-76.

Latimer R., *Some Economic Aspects of Agricultural Research and Extension in the U.S.* (PhD. dissertation, Purdue University, 1964)

Nagy J. G. and W. H. Furtan, *Economic Costs and Returns from Crop Development Research: The Case of Rapeseed Breeding in Canada,* Canadian Journal of Agricultural Economics 26 (February 1978), pp. 1 - 14

Pee T. Y., *Social Returns from Rubber Research on Peninsular Malaysia* (PhD. dissertation, Michigan State University, 1977).

Peterson W. L., *Return to Poultry Research in the United States,* Journal of Farm Economics, 49 (August 1967), pp. 656-69.

Peterson W. L. and J. C. Fitzharris, *The Organization and Productivity of the Federal State Research System in the United States* in Resource Allocation and Productivity in National and International Agricultural Research, Thomas M. Arndt, Dana G. Dalrymple, and Vernon W. Ruttan, eds. (Minneapolis, University of Minnesota Press, 1977), pp. 60-68.

Pray C. E., *The Economics of Agricultural Research in Bangladesh,* Bangladesh Journal of Agricultural Economics, 2 (December 1978)F, pp. 1-36.

Pray C. E., *The Economics of Agricultural Research in British Punjab and Pakistani Punjab, 1905-1975, (PhD. dissertation, University of Pennsylvania, 1978).*

Schmitz A. and D. Seckler, Mechanized Agriculture and Social Welfare: The Case of the Tomato Harvester, American Journal of Agricultural Economics, 52 (November 1970), pp. 569-77.

Scobie G. M. and R. Posada T., *The Impact of Technical Change on Income Distribution: The Case of Rice in Colombia,* American Journal of Agricultural Economics, 60 (February 1978), pp. 85-92.

Tang A., *Research and Education in Japanese Agricultural Development,* Economic Studies Quarterly, 13 (February-May 1963), pp. 27-41 and 91 - 99.

Wennergen E. B. and M. D. Whitaker, *Social Return to U.S. Technical Assistance in Bolivian Agriculture: The Case of Sheep and Wheat.* American Journal of Agricultural Economics, 59 (August 1977), pp. 565-69.

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Marsden J. S., G. E. Martin, D. J. Parham, T. J. Risdill, and B. G. Johnston, *Returns on Australian Agricultural Research: The Joint Industries Assistance Commission -CSIRO and Benefit-Cost Study of the CSIRO Division of Entomology,* (Canberra: Commonwealth Scientific and Industrial Research Organization, 1980.

Purchase H. Graham, *The Etiology and Control of Marek's Disease of Chickens and the Economic Impact of a Successful Research Program,* in Virology in Agriculture: Beltsville Symposium in Agricultural Research-1, John A. Romberger, ed. (Montclair, N.J.: Allanheid, USMUN, 1977), pp. 63-81.

Table 3: Some International Agricultural Research Activities Outside the CGIAR*

Center	Primary Focus	Location	Year initial operation	Budget US$m	(Year)	No. Senior Staff	Programs
ICIPE	insect physiology and ecology	Nairobi, Kenya	1970	4.77	(1982)	46	Crop borers Livestock ticks Tsetse fly Plant resistance Medical vectors Insect pathology and pest management
AVRDC	tropical vegetables	Shanhua, Taiwan China	1972	3.60	(1983)	32	Tomato Chinese cabbage Sweet potato Soybean, Mungbean
ICLARM	living aquatic resources	Manila, Philippines	1973	1.70	(1983)	14	Aquaculture Traditional fisheries Resources development and management Information services
INTSOY	soybeans	Urbana, Illinois,	1973	0.95	(1983)	8	Soybeans
IFDC	fertilizer	Muscle Shoals, Alabama	1974	6.70	(1982)	60	Nitrogen research Nutrient interaction Phosphate research Sulfur research Potassium research Economics research National programs Technical assistance Training
ICRAF	agroforestry	Nairobi, Kenya	1978	2.20	(1983)	18	Agroforestry systems Agroforestry technology Information Training Collaborative research
IIMI	irrigation management	Kandy, Sri Lanka	1984	5.00	(when operational)	10–12 in HQ 3–4 unit	Collaborative research Training Information dissemination
IBSRAM	soils	not fixed	1985	4.54	(when operating)	5–10	Headquarters Soil management networks
INIBAP	banana and plantains improvement	not fixed	1985	1.75	(initially)	small	Headquarters Regional networks

* Activities currently using CGIAR meetings or in some other way related to CGIAR activities in 1984 (Total approximately $30 million).

development assistance agencies. Direct linkages with the national research systems of the developed countries remain underdeveloped. The linkages among the national research systems of the developed countries are even more rudimentary. It is my impression, for example, that there has not yet emerged any institutional capacity to rationalize or coordinate agricultural research among EEC member countries. There is a modest program of information exchange among OECD countries, but its activities appear to be more ceremonial than substantive. And we have not yet begun to build effective linkages between the international systems, or with agricultural research systems of the socialist countries.

NATIONAL RESEARCH SYSTEMS

The last several decades have witnessed a remarkable expansion in agricultural research capacity in a number of important developing countries. The number of agricultural scientists in the developing countries of Latin America, Africa, and Asia rose from approximately 14,000 in 1959 to 63,000 in 1980 (Table 4).

When one examines individual countries in detail, howev[er] it is clear that most of this growth has occurred in a relatively few countries such as Brazil, the Philippines, India, China, and Nigeria. In 1980, there were only

Table 4: Trends in Numbers of Research Scientists and Extension Workers, 1959 - 1980

	Research Scientists [1]			Extension Workers			Ratio of Extension to Research Scientists		
REGION/SUBREGION	1959	1970[2]	1980	1959	1970[2]	1980[3]	1959	1970	1980
Western Europe	6,251	12,547	19,540	15,988	24,388	27,881	2.56	1.94	1.43
Northern Europe	1,818	4,409	8,027	4,793	5,638	6,241	2.64	1.23	0.78
Central Europe	2,888	5,721	8,827	7,865	13,046	14,421	2.62	2.28	1.63
Southern Europe	1,545	2,417	2,686	3,330	5,704	7,219	2.16	2.36	2.69
Eastern Europe and USSR[4]	17,701	43,709	51,614	29,000	43,000	55,000	1.64	0.98	1.07
Eastern Europe	5,701	16,009	20,220	9,340	15,749	21,546	1.64	0.98	1.07
USSR	12,000	27,700	31,394	19,660	27,251	33,454	1.64	0.98	1.07
North America and Oceania	8,449	11,688	13,607	13,580	15,113	14,966	1.61	1.29	1.10
North America	6,690	8,575	10,305	11,500	12,550	12,235	1.72	1.46	1.19
Oceania	1,759	3,113	3,302	2,080	2,563	2,731	1.18	0.82	0.83
Latin America	1,425	4,880	8,534	3,353	10,782	2,835	2.35	2.21	2.68
Temperate South America	364	1,022	1,527	205	1,056	1,292	0.56	1.03	0.85
Tropical South America	570	2,698	4,840	2,369	7,591	16,038	4.16	2.81	3.32
Caribbean and Central America	470	1,160	2,167	779	2,135	5,505	1.59	1.84	2.54
Asia[4]	11,418	31,837	46,656	86,900	142,500	148,780	8.55[5]	7.28[5]	5.06[5]
West Asia	457	1,606	2,329	7,000	18,800	16,535	15.31	11.71	7.10
South Asia	1,433	2,569	5,691	57,000	74,000	80,958	39.80	28.80	14.23
Southeast Asia	441	1,692	4,102	9,500	30,500	33,987	21.54	18.03	8.29
East Asia	7,837	13,720	17,262	13,400	19,200	17,300	1.71	1.40	1.00
China	1,250	12,250	17,272						
Africa[4]	1,919	3,849	8,088	28,700	58,700	79,875	14.96	15.25	9.88
North Africa	590	1,122	2,340	7,500	14,750	22,453	12.71	13.15	9.60
West Africa	412	952	2,466	9,000	22,000	29,478	21.80	23.11	11.95
East Africa	221	684	1,632	9,000	18,750	24,211	40.72	27.41	14.84
South Africa	696	1,091	1,650	3,200	3,200	3,733	4.60	2.93	2.26
World Total	47,163	108,510	148,039	177,521	294,483	349,337	3.87[5]	3.06[5]	2.67[5]

Source

M. Ann Judd, James K. Boyce, and Robert E. Evenson, *Investing in Agricultural Supply*. Paper presented at Workshop on Agricultural Growth, Economic Growth Center, Yale University, 20-21 June, 1983.

Notes:

(1) Research scientists estimates include only workers with advanced degrees. An attempt has been made to include only research workers engaged in production-related agricultural research. Research on post-harvest technology is, for example, not included in these estimates.

(2) 1970 data are an average of 1968 and 1971.

(3) 1974 data are used when more recent data are not available. In other cases, the 1980 data are averages for 1974-1980.

(4) Data for Extension Workers in Eastern Europe, USSR, Africa, and Asia are estimated.

(5) Excludes China, for which data on extension workers were not reported.

slightly more agricultural research scientists in all of Latin America and Africa combined than in the US federal and state system, and fewer than in the Japanese national and prefectural system. Even in those countries that have made substantial progress, the ratio of research expenditures to the value of production remains low, and it remains lowest for those commodities produced and/or consumed primarily by the poorest farmers and consumers.

During the last several years, I have been involved in a series of studies of agricultural research systems in Asia (Ruttan, 1981). The concerns about the development of national agricultural research systems that have emerged out of my own research and experience have been reinforced by the series of very useful reviews conducted by the World Bank (1983), the US Agency for International Development (1983) and by the UNDP-FAO (1984). Let me list some of these concerns.

1. *I have become concerned about what appears to be excessive investment in research facility development relative to development of scientific staff.* There are too many facilities without programs. Many of the premature facility

Table 5: Estimated Cost of a Minimum Research Module for One Product (in thousands of current US dollars) ([1])

I.	**Direct Research Costs** (60% of total budget)		306
A.	Personnel		245
	1.	4 chief researchers, MS or PhD, 3 persons/year in plant breeding, agronomy and pest and disease control and 1 person/year equivalent in socioeconomics and other specializations, according to requirements (soils, physiology, etc). Total cost per person/year US $30,000([2])	120
	2.	8 specialists, university graduates. Total cost per person/year US $12,500	100
	3.	Training Calculated on the basis of 2 x 1 rate of retention; total rotation every 15 years; cost of US $100,000 per PhD (MS 60%). Total annual cost for a permanent team of 3 PhD and 1 MS (approximately)	25
B.	Services and materials Calculated as 12.5% of direct costs.		38
C.	Equipment Calculated as 7.5% of direct costs.		23
II.	**General Costs and Administration** (40% of total budget) Includes direction, support and services (administration, laboratories, library, communication, field, etc.)		204
A.	Personnel Calculated as 60% of general and administrative costs		122
B.	Services and materials 25% of general and administrative costs.		51
C.	Investments and equipment 15% of general and administrative costs.		31
		Total Budget	510

Percent summary by broad budgetary items (approximate)

A.	Personnel	72.5%
B.	Services and materials	17.5%
C.	Equipment	10.0%

Source

Eduardo J. Trigo and Martin E. Piñeiro, "Funding Agricultural Research" in *Selected Issues in Agricultural Research in Latin America*, eds. Barry Nestel and Eduardo J. Trigo. (International Service for National Agricultural Research, March 1984, The Hague, Netherlands, p. 85).

Notes

(1) The estimates were made using the budgetary structure of the international agricultural research centers as a guideline for determining the percent of each item of expenditure.

(2) US $30,000 was used as an average of the case for the different countries of the region. The sum includes salaries plus benefits. A variation of US $1,000 above or below this average figure implies an increase or decrease of US $4,250 in the total budget.

developments are the direct result of the multilateral and bilateral assistance agency programs that find it easier to invest in facility development than in human capital development or program support. Premature facility investment represents a burden on the research system rather than a source of productivity.

2. *I have become concerned about the excessive administrative burden that stifles both routine investigations and research entrepreneurship*. A major challenge to any national research system is how to achieve consistency between the personal and professional objectives of individual researchers, research teams, research managers, and the social objectives of the research system. In many respects, the individual scientist can appropriately be viewed as an independent contractor who makes his or her services available in return for professional and economic incentives. Bureaucratic efforts to achieve consistency between the objectives of the individual and of the system, or simply fiscal responsibility, is often carried to the point where it becomes an excessive burden on research productivity.

3. *I have become concerned that location decisions for major research facilities, often made with the advice of assistance agency consultants, have frequently failed to give adequate weight to the factors that contribute to a productive research location.* These factors include: location in a community that includes related educational and professional infrastructure; location in an agro-climatic environment that is representative of an important part of the area in which the particular commodity is grown, or which is representative of a major resource (soil, water) problem area; and selection of a site with appropriate resource (soil, water) and infrastructure (electricity, transport, amenity) characteristics.

4. *I have become concerned about the lack of congruence between research budgets and the economic importance of major commodities or commodity groupings.* If new knowledge and new technology were equally easy (or difficult) to come by in each commodity area, a good rule of thumb would be to allocate research resources roughly in proportion to the value (or value added) of commodity output or resource input. It is easy to think of good reasons for departure from such a rule. In a small research system, critical mass (i.e. scale economies) implies the desirability of focusing resources or areas that account for a large share of output (i.e. rice) or on a commodity where very large gains can be made in a short time (i.e. lowland irrigated rice in the 1960s). But extreme lack of congruence often suggests that little careful thought has been given to research resource allocation or that particular interest groups have biased research allocation to their own benefit.

5. *I have become concerned about the lack of information and analysis that goes into establishment of research priorities and thrusts.* In the research planning staffs that have successfully struggled with the research resource allocation problem, it has become increasingly obvious that effective reseach planning requires close collaboration between natural and social scientists and among agronomists, engineers, and planners. This is because any research resource allocation system, regardless of how intuitive or formal the methodology employed, cannot avoid making judgments about two major questions. *One is: what the possibilities are of advancing knowledge or technology if resources are allocated to a particular commodity problem or discipline.* Such questions can only be answered with any degree of authority by scientists who are on the leading edge of the research discipline or problem being considered. The intuitive judgments of research administrators and planners are rarely adequate to answer such questions.
A second question is: what the value would be to society of the new knowledge or the new technology if the research effort is successful. The intuitive insights of research scientists and administrators are no more reliable in answering questions of value than are the intuitive insights of research planners in evaluating scientific or technical potential. Many of the arguments about research resource allocation founder on the failure of the participants to clearly recognize the distinction between these two questions, and the differences in expertise and judgment that must be brought to bear in responding to them (Ruttan, 1982, pp 262-264).

6. *I have become concerned by the apparent presumption in some national systems that agricultural science is possible without scientists.* In too many national research systems, commodity program leaders often have neither the training nor capacity to direct either scientific research or technology development. Salary structures and non-economic incentives are frequently so unattractive, relative to other national and international alternatives, that potential leadership is eroded, research programs become routine, and returns to research investment are low.

7. *I have become concerned about the cycles of development and erosion of capacity that have characterized a number of national agricultural research systems.* There is a disturbing tendency among the systems that have had the longest history of development with substantial external assistance. Periods of rapid development have often been followed by the erosion or collapse of research capacity, when external support has declined. Martin Piñeiro, Eduardo Trigo and their colleagues have documented this pattern most thoroughly in a number of Latin American countries such as Argentina, Peru, and Colombia (Ardila, Trigo and Piñeiro, 1980; Piñeiro and Trigo, 1983). But those of us who have worked in other parts of the world can each find examples familiar to us.

I do not wish to be misinterpreted in suggesting that the perspectives and concerns that I have expressed about agricultural research in developing countries are the exclusive problems of new and growing research systems. Don Hadwiger has provided evidence that in the United States, the "pork barrel" approach to the location of agricultural research facilities resulted in 44 percent of all USDA research facility construction between 1958 and 1977 occurring in states represented by members of the Sub-committee on Agriculture of the Senate Appropriations Committee. He noted that this practice has forced "the federal Agricultural Research Service to operate a 'traveling circus' opening up new locations in current Senate constituencies, while closing some locations in states whose senators are no longer members of the sub-committee."

SMALL COUNTRY AGRICULTURAL RESEARCH SYSTEMS

The concerns I have outlined above, impinge most severely on the development and management of small country agricultural research systems. We are confronted with a remarkable paucity of data and analysis on the relationship between scale (or size) and productivity in agricultural research. And what evidence there is, even in the way of casual observation, often lacks precision as to whether the size-output relationship being referred to relates to the size of the individual research unit (team, laboratory, department), the individual research institution (center, institute, faculty), or the national or international research system. The view that small is better has often been advanced with considerable heat, but with relatively little precision in concept or definition and with even less empirical evidence. The issues that I discuss in this section represent an important opportunity for research to bring better theory, method, and data to bear in order to advance our understanding.

Size and Productivity in Research

What little knowledge we do have suggests that the optimum scale of the research is affected by factors both external and internal to the research process. The optimum level of resources devoted to a commodity research program, as demonstrated rigorously by Binswanger, is positively related to the area planted to a commodity in a particular agroclimatic region. Determining the optimum scale of a research unit or program involves, therefore, balancing the increasing returns associated with the area devoted to the commodity (or problem) on which the research is being conducted, against the possible internal diseconomies of scale of the research process or system.

The data we do have suggests that industrial research and development productivity, measured in terms of patents per engineering or scientific work, is lower in the large laboratories of the largest firms than in the smaller firms in the same industry (Schmookler, Kamien and Schwartz). There is similar evidence for agricultural research by G. S. Pound and P. E. Waggoner. There are also a number of case studies that suggest very high rates of return to individual public, philanthropic, and private research units, often with fewer than 20 scientific or technical staff members per unit (Evenson, 1977; Sehgel, 1977). Many of the smaller "freestanding" agricultural research units are, however, engaged primarily on technology screening, adaptation, and transfer activities that depend only minimally on in-house capacity in such supporting areas as physiology, pathology, chemistry, and even modern genetics.

Evenson also noted that, during the early stages in the development of national research systems, experiment stations tend to be widely diffused, to utilize primarily technical and engineering skills, and to be characterized by a strong commodity orientation. He also pointed to a trend towards hierarchical organization and consolidation into a smaller number of larger units at later stages in the development of agricultural research systems. These centralizing trends are apparently motivated in part to take advantage of economies resulting from research activities in the basic and supporting sciences, and to use economically the laboratory, field, communications, and logistical facilities.

The urge for consolidation can, however, easily be overdone. In the United States, for example, there is now rather strong evidence supporting the value of decentralization even within individual states. For a given level of expenditures, a state system that includes a strong network of branch stations gets more for its research dollar than a state system that is more concentrated. What decentralization gives up in terms of lower costs seems to be compensated for by the relevance of the research and the more rapid diffusion of results. There are, of course, limits to the gains from decentralization. The gains vary among commodities and are influenced by the diversity of agroclimatic conditions and the area devoted to the crop in each agroclimatic region.

A Minimum National System

One of the most difficult issues related to size and productivity in agricultural research is the problem faced by the smaller countries in the development of their agricultural research systems. Most of the smaller countries (those in the 4 to 10 million population range) do have the resources, or access to donors' resources, that would permit them to develop, over a ten to twenty year period, an agricultural research and training capacity capable of staffing the nation's public and private sector agricultural research, education, planning and service institutions. The fifty or so smallest low-income countries must, however, think of research systems that will often be little larger than a strong branch station in a country such as the Netherlands or Denmark, or in a state such as Texas or Minnesota.

But how can the government of a small country decide on the appropriate size and organization of its national agricultural research system? For countries like Sierra Leone or Nepal, even the financial and professional agricultural resources of a small American state or a Japanese prefecture are probably at least a generation ahead. The time required to achieve viable research systems for many of the smaller national systems must realistically be calculated in terms of a generation rather than the five to ten year project cycles used by most development assistance agencies.

One major focus of the research effort in these smaller research systems must be the direct support of agricultural production and rural development programs. This means a primary focus in applied fields such as agronomy, plant breeding, animal production, crop production, farming systems, and agricultural planning and policy. Trigo and Piñeiro have estimated that a minimum research module for one product requires a team consisting of four researchers trained at the MSc. and PhD. levels, complemented by eight specialists with graduate level training, plus a complement of support personnel. They estimate that the total cost of such a program would run in the range of 500,000 US dollars (1984) (see Table 5). For a small country with 6-10 major commodities and several important agro-climatic regions, this implies a research budget of 5.0 - 8.0 million US dollars. When this effort is complemented by the non-commodity oriented research in areas such as soil and water, pest management, cropping systems, and socio-economic aspects of agricultural production marketing and policy, the implications run into the $12 to $15 million range.

The viability of even a small nation's agricultural production also requires capacity for higher education in agriculture, at least up to the master's level, to support national programs of technology in transfer, rural development, and regulatory and service activities. When these activities are aggregated, it is not difficult to arrive at a minimum level of professional capacity, with training at the MSc. and PhD. levels, of around 250, and with budget support somewhere in the $20-$30 million range for even the smaller (but not the smallest) countries. For the very smallest countries, even this investment is not feasible in the foreseeable future. For one of the more serious attempts to suggest a solution to the smallest countries' problems, I refer you to a recent paper by Lawrence A. Wilson, Dean of the Faculty of Agriculture, University of West Indies.

Interdependent Systems

The idea of reducing or eliminating technological dependency generates strong emotional appeal. Yet, even larger countries with advanced agricultural research systems (United States, Soviet Union, Japan, India, and Brazil, for example) are not able to be self-sufficient in agricultural science and technology. An effective national agricultural research system must have the capacity to borrow both knowledge and materials from the entire world. The problem of how to link effectively with an increasingly integrated, and interdependent, global agricultural research system is difficult for the state and provincial research units in the larger national systems. It is even more difficult for the national agricultural research systems in the smaller countries.

One approach to this problem has been to attempt to establish cooperative regional research programs; for example, the West African Rice Development Association (WARDA) and the international crop research networks that are linked to the international agricultural research institutes. Other regional institutions not directly linked to the international (CGIAR) system include the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), the Caribbean Agricultural Research and Development Institute (CARDI), and the Southeast Asian Fisheries Development Center (SEAFDEC). It is hard, however, to find many outstanding success stories amongst these efforts. Program activities and cooperative efforts often appear stronger in the glossy pamphlets issued by the organizations than they do in practice (Venezian, 1984). To my mind, such regional programs can succeed only with the commitment of long-term external support and with the participation of external donors in the governance of such centers. Some of the most effective collaborative regional efforts have been organized around the research programs of the international research centers (Plucknett and Smith, 1984).

The international crop research networks, centered around the international institutes have not, however, been without problems. When the institutes have had confident and effective leadership, they have often played an exceedingly useful role in creating opportunities for productive professional interaction and collaboration. But the institute research networks tend to be selective. At times, they have found it hard to bend institutes priorities to meet national priorities. Collaborative efforts tend to involve the strongest institutions and the leading scientists rather than those who have the greatest need.

A richer institutional infrastructure is necessary to strengthen and sustain the capacity of the smaller national agricultural research systems. In spite of ideological considerations, many small countries have found it advantageous to encourage the transfer and adaptation of technology by the private sector seed supply industry or by the multinational firms engaged in commodity production, processing, and trade. Firms engaged in the production of crops grown under plantation systems, and independent growers producing under contract arrangements with processors, have at times provided their own research and development facilities. In other cases, associations of producers have been willing to tax themselves to support commodity research stations. Such arrangements have often been associated with discredited systems of colonial governance. A strong case can be made for re-examining and strengthening the incentives for private sector research, development and technology dissemination.

The perspectives outlined in this section are highly tentative. Although they are drawn from considerable experience, they should be treated as hypotheses to be tested by further research, rather than as conclusions. Institutions such as the IADs, ISNAR, and CTA should devote a reasonable amount of analytical effort to attempts to understand the problem of developing and sustaining effective agricultural research in the smaller national research systems.

Some Generalizations

In spite of the limited knowledge available, there are a few generalizations about smaller agricultural research systems that can hardly be avoided. One is that the research investment per acre or per hectare will have to be higher in a small system than in a larger system, in order to achieve an equal level of effectiveness. This is because of the cost of developing, for example, a new millet variety that will be grown on a million acres is unlikely to be substantially greater than one that will be grown on half a million acres.

A second generalization is that the cost of developing productive farming systems for a small country with great agroclimatic variations will be greater than for a small country that is more homogeneous. For example, the cost per hectare of developing an effective agricultural research system for Sri Lanka is likely to be much larger than developing one for Uruguay. The issue of guns versus butter in national budgets is also likely to cut more sharply into a small country than in a large country.

Finally, there is no way that a small country can avoid being dependent on others - on the international agricultural research system, on the research systems of large countries in the same region, and on multinational firms - for much of its agricultural technology. Furthermore, a small nation with a strong research program but a limited agricultural or industrial base cannot capture as high a proportion of the benefits from its investment in basic research as can a large nation with a diversified economic base. Much of the benefit will spill over to other countries. If it has a weak agricultural research system, it will lack the knowledge needed to capture the benefits of research in other countries or to choose technological paths consistent with its own resource and cultural endowments. Even a strong agricultural research system cannot assure autonomy. But small countries do need to develop sufficient agricultural science capacity to enable them to draw selectively on an interdependent global agricultural research system. They need to be able to discern what is useful to borrow from other national systems and from the international system.

TOWARDS A REFORM OF AGRICULTURAL RESEARCH SUPPORT

What can be done to alleviate the deficiencies that charaterize assistance for the support of agricultural research, extension, and rural development programs in poor countries? A solution to the problems of "aid effectiveness" in support of research is particularly important at this time. I anticipate that in the next decade there will be a decline in the real flow of aid resources and increasing competition among the several claimants on aid resources.

In my opinion, the basic thrust of the reform that is needed is to move away from primary reliance on narrow project approaches. In supporting agricultural research, the project system should be largely replaced by a "formula funding" or "revenue sharing" approach (Ruttan, 1984). There have been many criticisms of the project approach followed by the major bilateral and multilateral development assistance agencies. The criticism most frequently heard is that the assistance agencies exert undue influence on the content of the national development programs (Faaland, 1982; Salmon, 1983). This criticism is partly correct. It is not too difficult to identify cases where close patron-client bonds have been established between particular officers in the aid agencies and the leadership of favored national program agencies. Such relationships have often appeared to give particular national programs a degree of stability and continuity that would be difficult to achieve in the unstable political environments that characterize many developing countries.

Cycles of development and erosion are inherent in the traditional project approach. The reason for this inherent contradiction is that external assistance provides an alternative to the development of internal political support. National research system directors have frequently found that the generation of external support requires less intensive entrepreneurial effort than the cultivation of domestic political support. Domestic budget support required by donors is often achieved by creative manipulation of budget categories rather than by increments in real program support, particularly when donor representatives are under pressure from assistance agency management to "move resources". Most existing project systems thus have built-in incentives for national research system leadership to direct entrepreneurial effort toward the donor community rather than toward the domestic political system.

Any effective alternative should attempt to reverse the perverse incentives characteristic of the existing development assistance instruments. The system should be reformed to provide incentives for national research system directors to redirect their entrepreneurial efforts toward building domestic political and economic support for agricultural development.

I am increasingly convinced that the long-term viability of agricultural research systems depends on the emergence of organized producer groups who are effective in bringing their interests to bear on legislative and executive budgetary processes. The support of finance and planning ministries for agricultural research is undependable. Their support tends to fluctuate with perceived severity of food crises and foreign exchange demands.

A Formula Funding Model

What alternatives to the existing system are there? I do not want to be interpreted as completely negative with respect to traditional development assistance instruments. Project aid is often quite appropriate for physical infrastructure development projects. Program aid can be an effective way to provide macroeconomic assistance for structural adjustment or for sector development in a country with substantial capacity for macroeconomic policy analysis and program management. But neither the traditional program aid nor project aid instruments are fully effective in countries that have little financial or professional capacity for providing support for long-term institution building efforts. New methods of combining the flexibility of program support, effective technical assistance, and sustained financial support for long-term development efforts must be sought. One innovation that might be effectively used is for the donor community to move towards an approach in which the amount of external support is linked to growth in domestic support (Table 6). This implies the development of a "formula" approach in which the size of donor contribution would be tied to the growth of domestic support. The formula should include a factor that adjusts the ratio of external to domestic support to take into account differences in domestic fiscal capacity.

Country Level Research Support Group

A second alternative might take its lead from the experience now accumulated with the CGIAR model and the various donor consortia that have been organized to coordinate assistance to some of the larger aid recipients. What I am suggesting here is country level Research Assistance Support and Implementation Groups (RASIGs), chaired by the chairman of the National Agricultural Research Council or the director of Agricultural Research. The Support Group will need to have at its disposal relatively long-term program plans for the development and operation of the national agricultural research system. To produce and continuously update this program, the national research system may require external assistance, but in general the program should be the product of indigenous experts in agricultural science and development. Its focus, to help protect the program from the vagaries of political change, would be on long-term agricultural research needs and goals and on the incremental steps required for implementation.

It is expected that the long-term program development and the priority setting would be done through an interactive process with the Support Group. Once the program has been accepted, it is hoped that donor members of the Support Group would collectively agree with the host country to help provide the components essential to the execution of the program as a whole. The host country, in turn, would assume the responsibility for moving its national research program along the agreed-upon development path. Initial commitments might be for three to five years, subject to annual review and course corrections suggested by the analysis and feedback from actual experience.

Use of an institution such as a Support Group has the potential of helping the country involved avoid many of the pitfalls of the project mode whilst retaining several of its desired attributes. Donor identity could be retained by relating grants to components of the agreed-upon overall program. These could even be called projects if, for administrative purposes, it were so desired. The Support Group, like the CGIAR, would likely involve bilateral grants developed in the framework provided by the forum of multiple donors and the host country. The impersonal process of contributing to a common fund is not envisaged. However, this would not preclude "incentive funding" of a formula type. At the same time, this would minimize the danger of a single donor dominating the priority-setting process, or of essential program components being ignored.

The RSG also has several other potential advantages. It would contribute to building a national constituency by focusing from the outset on this essential ingredient for viability. The donors, for example, might agree to increase their contributions by some fraction of the rise that occurred in the real support provided by the nation involved. Or other matching provisions might be agreed upon to provide incentives for nurturing and cultivating national constituencies. It would provide reasonable continuity in support (commitments would be fairly long-term and subject to review and extension well in advance of termination dates) with less risk of the excessive program fragmentation frequently associated with narrowly defined project funding. It would reduce the administrative and management load on the host country through the planning and review process the RSG would follow. Furthermore, it would place donors in a position of genuinely complementing and supplementing one another and the national program, rather than endlessly competing for "good investment opportunities".

The fact that such a support mode is often discussed but little used is evidence that implementation is not a simple, trouble-free task. The method is, however, being used

Table 6: Illustration of a Funding Model for Agricultural Research Support

	Program Support and Assistance Level (in millions of US $)					
	Low		Medium		High	
Nation Fiscal Capacity	National Support	Donor Assistance	National Support	Donor Assistance	National Support	Donor Assistance
Low (40% Assistance)	20	8	50	20	100	40
Medium (20% Assistance)	20	4	50	10	100	20
High (10% Assistance)	20	2	50	5	100	10

successfully in Bangladesh and, somewhat more informally, in several other countries. An important element in its success in Bangladesh is that the Support Group meetings are chaired by the director of the Bangladesh Agricultural Research Council, rather than by a donor representative.

A dialogue on donor assistance to national agricultural research programs was initiated by the World Bank in 1981. The dialogue has been continued by ISNAR in a series of meetings with directors of agricultural research systems. It is imperative that these dialogues be continued. The issue of reform of agricultural assistance should be recognized as one of the most urgent items on the agenda.

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