THE CONTRIBUTION OF INTERNATIONAL AGRICULTURAL RESEARCH TO WORLD AGRICULTURE*

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The system of international agricultural research centers has played a facilitating role in promoting a diversity of biological and institutional innovations in the Third World. These include germplasm collections and enhancements, new varieties of crops, changed agricultural and farming systems practices, and improved policies and institutional arrangements affecting agricultural sectors and their research infrastructures. As these centers work in collaboration with national research systems, perhaps the most important induced effect has been in enhancing the human capital of people working in these systems in the developing countries.

Key words: international agricultural research centers, CGIAR, modern varieties, national collaboration, capability and human capital.

Following the early successes of the green revolution there has been rapidly accelerating investment in agricultural research both by national governments and through a variety of international initiatives. Of the latter, a prominent component is the system of International Agricultural Research Centers (IARCs) sponsored by the Consultative Group on International Agricultural Research (CGIAR or "CG") since 1971.

The CG was formed to extend the early successful (US Foundation) models of research on rice (IRRI) and wheat (CIMMYT) to other crops, regions and mandate ecosystems, and through the 1970s facilitated the

establishment and coordination of several new centers, to reach the present systems of 13 research institutions that are directly supported, namely, (using their acronyms for brevity), CIAT, CIMMYT, CIP, IBPGR, ICARDA, ICRISAT, IFPRI, IITA, ILCA, ILRAD, IRRI, ISNAR and WARDA. Subsets of the same 40 or so donor governments and agencies that are members of the CG also support another dozen or so international and multi-nation regional institutions outside the CG that are conducting research on agricultural and related industries.

The international centers operate collaboratively with their partners in development, the national agricultural research systems, in discovery and dissemination of improved technologies (materials and methods), institutions and policies. Thus IARCs do not release new varieties to farmers, or recommend policies to governments directly, for example, but rather work collaboratively with appropriate elements of national institutions which do any releasing of innovations that they judge to be useful.

In 1983, some donors of the CG decided that it would be useful to attempt a stocktaking of what had been achieved through the institutions that had been created. The intention was to cast a deliberately broad net over the range of activities of the centers and, where possible, to measure just what changes had been accomplished through their existence. This raises an immediate difficulty of attribution, given the collaborative mode of working. It was decided that imputation of credit for particular aspects of the work with which the centers have been associated was in general neither feasible nor useful. Accordingly, the stance was taken that measurement would be addressed to the fruits or

otherwise of the broader collaborative activities of the centers, which thus necessarily includes a considerable amount of work conducted in and by partner institutions.

Another intention imposed at the outset of the study (to be reported in full in October 1985) was to give emphasis to perceptions that are held about the CG system among partner countries and institutions. A novel documentation of these would represent a unique record of what the partners thought. Within each country, personnel from a cross-section of relevant research, administrative and policy making institutions were interviewed to seek their opinions on the modes of operation, and impressions about the success or otherwise of the collaboration. Attempts were also made to document the more countable aspects of center-related activities. Obviously, this included the spread of new varieties that have some association with the centers' plant breeding activities, and of other agricultural technologies, policies, etc. that can be regarded as the product of the joint research activities. As well as documenting the spread, attempts were made to quantify productivity differentials associated with such new technologies. As always with such work, there are considerable difficulties with the counterfactual situation of what would have been achieved in the absence of this form of international endeavor.

Institutional Arrangements for Agricultural Research

By the mid 1960s, it was becoming increasingly clear that agricultural growth and productivity improvement was not simply a matter of transferring technology to developing countries. Progress would only come through the generation and diffusion of technologies relevant to the

ecological and economic circumstances of the latter. The centers were conceived as a mechanism to draw on the global stock of knowledge, scientific talent and plant material, in order focus on the needs of the developing countries. In fact, while some attention was devoted to understanding those needs and circumstances, the early years and successes of the centers were characterized by the generation of widely adapted varieties of rice and wheat with a minimum of tailoring to local conditions.

The contact with national research programs was built principally on training and germplasm collection and improvement. Collaborative research was not a central feature. In many cases this was justified on the grounds that the national systems were so poorly staffed, equipped and funded as to preclude productive collaboration. Where such conditions did not so patently apply, there were undoubtedly some overtones of scientific imperialism.

The evolution of the CG system has seen the inclusion of more crops, a wider range of environmental conditions with attention to the climatic, soil and disease conditions of specific localities, and greater realization that local adaptation to those conditions is necessary. This has required the centers to establish much closer working relations with their national counterparts. At the same time, the circumstances of many national programs have changed as the stock of human capital has grown through training, as the networks of alumni of the centers have grown, and as the levels of funding of the national programs have expanded. Both the need and the opportunity for closer ties emerged in the late 1970s.

Interfaces with the Social Sciences

Reflecting the professional structure of agricultural science in general, and the influence of the Ford Foundation and other concerned donors in particular, there is a considerable investment in social science research in the centers. Briefly, eight centers concentrate on research to improve crop productivity through plant breeding and allied areas. Two centers are focused on increasing small-holder animal productivity in Africa, while two of the crop centers also have programs aimed at increasing the productivity of forage or potential pastureland. One center is devoted solely to assisting countries in their collection, conservation, preservation and utilization of plant genetic resources. Two CG centers are not biological research institutions: ISNAR provides advice to governments on how they might best organize their agricultural research systems; IFPRI is devoted to food policy research.

The CG centers currently have about 750 senior research staff, of whom about 10 percent are social scientists, distributed unevenly across the centers. IBPGR and ILRAD have no social scientists; IFPRI has nearly all economists, and ISNAR has a few. Among the crop research centers, three organizational modes for social science research can be discerned: ICRISAT, IRRI, CIMMYT and CIP have specialized programs or departments dealing with the social sciences; IITA, ICARDA, and ILCA have social scientists in their farming systems programs, CIAT and WARDA have social scientists in crop improvement programs.

Perceptions in the Third World

Great importance was attached within this study to the views held by concerned individuals in the national organizations with which the

centers have collaborated. The sheer numbers of such individuals necessitated a case study approach, first in terms of the 28 countries that were selected for study and, within these, the limited cross-section of individuals for whom the resources were available to make contact. Knowledge of the centers and the products varies greatly from person to person reflecting naturally the experiences of individuals but, whether it reflected close knowledge of the workings of a particular center on a particular crop in a given country, or more general understanding of the whole system, most people contacted expressed high regard for the arrangements. Enthusiasm for different products varied with individual knowledge, experience, discipline and job responsibility.

The approach taken, while being novel and, within the context of this study, a most significant part of the effort, is subject to inherent limitations of the subjectivity of all the individuals involved, both those expressing their opinions and those collecting such data, and the partiality in terms of incomplete coverage, both between and within countries. The perceptions gathered are reported in detail in the reports of the country case studies to be published separately. Overwhelmingly, they were positive and supportive of the centers' work in helping their partners to be more productive. Rather than elaborate them in our limited space, some related aspects relevant to interpreting perceptions are noted.

The contributions that international centers make to developing countries depends to a great extent on the capacities of the countries. Countries with well developed research systems are able effectively to

take and use the products of the centers and even to make requests of centers for materials, training, publications and other services. Countries with embryonic research systems are less likely to be able to test technologies effectively for their suitability under local conditions. Many countries with intermediate levels of capability are able to interact to a greater or lesser extent with center researchers but to a considerable extent they remain in the role of receivers from the centers. The centers must thus tailor their approaches to different countries at different stages of development, in some being more normative about what needed research and what materials or methods may work, and in others responding to the expressed needs and desires of established researchers. Over the 25 years that IRRI and CIMMYT have been operating, several research systems have grown from being quite dependent on them to being full partners in crop improvement.

Research Resource Allocation

Questions relating to the allocation of scarce resources to different research tasks are inherently difficult everywhere, for the well-documented reasons of uncertainty as to success and as to the temporal pattern of costs and, especially, any benefits, and are even more difficult over a global domain. The difficulties are exacerbated in dealing with research on basic food production of concern to producers and consumers who are at the impoverished end of the income distributions of the world.

Only a few of these many important and challenging questions could be addressed in the present study which was conducted in parallel with a major review of research priorities by the Technical Advisory Committee

of the CG which will be reported at the same forum. Accordingly, just a sample of issues is presently addressed.

The adjustments of research allocations of national and international systems toward a greater degree of congruence between research expenditures and value of crop output has probably had a positive impact on research productivity. However, economists seemingly should go much further in this regard. Research resources ought to be allocated to equate the ratio of the expected social MVP of each research activity to its expected cost across all alternative activities.

The major impact of the international centers to date has been in what one are sometimes referred to as "favorable" environments -- where rainfall is adequate to grow wheat or rice well, or where irrigation is available. A review of adoption studies and data shows that the principal distinguishing feature of farmers who have not adopted modern wheats and rices is their lack of the basic land and water resources under which these are more productive than existing varieties rather than their farm size and tenure, or their social status.

The IARCs as yet have little claim to having produced improved technologies for "less favorable" environments, but not because of a lack of attention to them. ICRISAT research is entirely aimed at the seasonally dry tropics of Africa, Asia and Latin America; ICARDA research is concentrated on the dry cropping areas of the Middle East and North Africa. The high-rainfall tropics of Africa contain many environments that are unfavorable for food crop production in the sense that production methods that are sustainable at a level significantly more productive than present systems are yet unknown. To date, the bush-

fallow system is still perceived as best by farmers, but it will not long continue to support the rapidly increasing populations of tropical Africa. IITA is addressing this problem with a significant fraction of its resources. Livestock production is the largest income source for many subsistence farmers of the Sahel and other parts of Sub-Saharan Africa. ILCA is concentrating on finding ways to increase livestock productivity in these areas. CIAT is seeking methods to increase the productivity of the acid rangelands in the Llanos of South America.

While a probable majority of the world's farmers are female, this aspect of reality has not been translated into research infrastructures and priorities, and especially into appropriately staffed extension services. Such issues are, in principle, the subject of farming systems research work, in which the centers have played an important role in fostering. Much yet remains to be done to sensitize research workers to potential gender-specific positive and negative impacts of technological innovations. Several such impacts were explored in the study.

Major Findings

The products of the CG centers and their partner institutions in development are diverse and complex. Beyond the attitudinal information already mentioned, a few of the key dimensions of impact findings about some of these products are now noted.

Modern Crop Varieties and Main Impacts

The major visible impacts of the CG system on world food production to date have come from semi-dwarf wheat and rice which by 1983 had spread to 125 million ha in developing countries. Three distinct advantages have been built into the new varieties for the adopting farmers who farm

over 38.6 percent of the wheat area and over 58.9 percent of the rice area in the developing world. The first and most dramatic feature incorporated is the stature; the new varieties convert more of their dry matter to grain rather than straw and they are shorter and have sturdy stems they are less likely to fall over when fertilized. Second, they are not sensitive to day-length and hence mature after a relatively fixed time from planting, unlike varieties in which flowering is triggered by a given length of day. This means that farmers can plant them at any time, thereby enabling a higher intensity of land use where other factors are not limiting. Subsequent to the first generations of non-sensitive varieties, newer ones were developed that matured faster, and this also stimulated intensified cropping. Third, the later versions of the new varieties incorporate genetic resistance to many of the most important plant diseases and insect pests. Farmers have been quick to recognize the advantages of these innovations, and modern rice and wheat varieties with these three characteristics make up the majority of the area planted to modern varieties today.

There are successes with other crops also. Maize research has been slower to make an impact, but it is estimated that, by 1984, over 6 million ha of maize in the developing countries were planted to maize varieties that had been derived from or related to CG maize research. This includes an estimated 25 percent of the lowland tropical maize in Africa.

Improved varieties of other crops related to or derived from the work of the centers are starting to be grown by farmers. In most cases these are of such recent vintage that there are few data on which to base

estimates of impact. There is evidence that from 40 to 60 percent of the area planted to field beans in Guatemala, Costa Rica, Cuba and the important bean growing provinces of Argentina are planted to CIAT-related bean varieties, many of them "Dorado" varieties which are resistant to the devastating Bean Golden Mosaic virus. These countries are among the 18 in Latin America that have named over 90 varieties of beans related to CG research through mid-1984. Six other countries have named similar varieties.

Twenty-three countries have named 63 potato varieties that they obtained through CIP's efforts in sharing improved and disease-free germplasm. Other techniques, like storing potatoes in diffused natural light, which increase productivity and food availability, are also spreading through CIP's efforts. Sixteen countries, including several in Africa, have released over 60 varieties of cassava. Six countries have released over 15 varieties of center-related sorghum; 6 varieties of center-related pearl millet varieties have been released and another 15 are in the final stages of testing, 21 varieties of cowpeas have been released by 7 countries. Release of a variety by a country by no means guarantees that it will result in greater productivity, but it does indicate that it is judged by the authorities to have a good chance to be an improvement over farmers' existing varieties.

Early studies clearly showed large-scale farmers adopting modern varieties much more readily; later work has shown that small-scale farmers caught up, often leaving the larger scale ones, however, with innovators' rents. As for tenure, owner-farmers do not adopt more than tenants, unless tenants get less of more costly credit per unit crop

area. Small-scale farmers may adopt later because they avoid risk until they have seen their wealthier neighbors succeeding with modern varieties; or because they cannot get scarce inputs at first. Small-scale farmers ultimately adopt as much and as intensively as others. Having more family labor per hectare, they may get higher yields. There is no general link of modern-variety adoption or yield to largeness or owner-occupancy.

Areas that have not much used modern varieties have done badly. Poor non-adopting farmers and their employees lose absolutely when burgeoning output depresses prices. Yet, in non-modern-variety areas with poor soils, initial poverty is worse, and less unequal so that the chances of fairly shared gains would be better, if modern varieties do take off. The double cropping facilitated by low photo-period sensitivity gives smoother flows of food through the year; the poor thus stand to gain much, since they can seldom save or borrow against lean seasons.

Modern varieties raise labor-demand per hectare, especially around harvest, pushing up employment. But ample, mobile and growing labor supply keeps real wage-rates from rising much. Modern varieties raise demand for land by less - but usually land-supply cannot respond much, so rents and land values rise.

In low-income countries, the poorest 20 percent of people spend 60-75 percent of income on food. Its demand and hence price is pushed up by growth of population and of income per head. Modern varieties have moderated this price rise. Poor consumers, including semi-subsistence producers, gain most if modern varieties affect "inferior goods" like

producers, gain most if modern varieties affect "inferior goods" like cassava in regions where they are important foods.

Investigators in the study became aware of many, often subtle, institutional influences that the centers were either responsible for or closely involved in. These ranged over such things as: the "hands on" work ethic induced in most trainees; the new professional respectability perceived for working on "humble" non-export crops; research organizational formats modeled on some of the centers' structures; and many other small and large changes to procedures, priorities and commitments of resources.

Conclusion

If the present CG system didn't exist, something like it would have had to be invented to fill the gaps in global agricultural research to help to feed the world more effectively and to realize some of the opportunities for high returns to public technological investigation.

Technological advance, while of critical importance for development of agriculture and beyond, is clearly a partial instrument and a poor one for solving many perceived societal ills such as maldistribution of resources. The remarkable thing about the effects of adoption of modern varieties that have been associated with the centers is that the beneficial impacts have been so widely distributed in societies, including to many of those in greatest need.

Working alone is seldom easy. The collaborative arrangements between centers and research workers is demonstrably productive in many ways, but it is profoundly appreciated in developing countries for bringing workers into the global knowledge system, and into a community

of committed research scholars, with consequent impact on the productivity of all concerned.

Problems of agriculture created by policies that are inimical to the progress of productivity are also now receiving attention in the CG system (e.g., at IFPRI) but, given the transcending importance of the issues, still in trifling amounts. The issues are intrinsically political, as well as economic, and the system must confront them more overtly if progress more generally is to be accelerated.

Taking the simplistic view that the system is essentially a major plant-breeding enterprise with decentralized management, it does a fair job of responding to the many, often inconsistent, forces that operate. It may, however, be too conventional and myopic, paying insufficient attention both to fundamental germplasm issues such as wild relatives of crops, and to the risky business of biotechnology.

The human dimensions of technological advance were earlier rather overlooked. The recent considerable investment in farming systems research has gone some way to correcting initial problems but there are still areas of neglect, e.g., the problems of female farmers in a male dominated society and research infrastructure.

Even though returns to research are generally high, small countries, and especially those with diverse agricultural zones, cannot mount productive research programs on all fronts. The centers play a critical role of assisting such countries with biological, material and scientific resources - a role which will be needed well into the future, and probably on a wider range of crops and livestock than presently serviced.

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Table 2.3 Approximate proportion (percent) by center of senior internationally recruited staff members with primary responsibilities in four major categories of activities, 1984

Center	Strategic research	Crop-improvement applied research	Other applied research	Training, research support and administration
CIAT	13	47	23	17
CIP	15	30	28	27
CIMMYT	14	45	24	17
IBPGR		83		17
ICARDA	11	33	10	45
ICRISAT	13	40	21	26
IFPRI			93	7
IITA	11	34	27	27
ILCA	6		59	34
ILRAD	83		6	11
IRRI	10	26	35	28
ISNAR			16	84
WARDA		10	34	56

Table 2.5 Principal food sources in the developing countries, their daily energy and protein contribution and CGIAR centers conducting research on each

Commodity	Energy kCal/day	Energy %	Protein g/day	Protein %	CGIAR centers responsible[a]
Cereals	1412	60.1	15.8	54.5	
Wheat	411	17.5	5.2	17.9	CIMMYT, ICARDA(R)
Rice	688	29.3	7.3	25.2	IRRI, IITA(R), CIAT(R), WARDA(R)
Maize	178	7.6	1.6	5.5	CIMMYT, IITA(R)
Millet	54	2.3	.5	1.7	ICRISAT
Sorghum	61	2.6	.6	2.1	ICRISAT
Barley	19	0.8	.2	0.7	ICARDA, CIMMYT(R)
Roots, tubers, etc.	213	9.1	.8	2.8	
Cassava	61	2.6	-[b]	-	CIAT, IITA(R)
Potato[c]	33	1.4	.5	1.7	CIP
Sweet potato[c]	73	2.1	.4	1.4	IITA
Yam	12	0.5	-	-	IITA
Cocoyam	2	0.1	-	-	IITA
Others	2	0.1	-	-	
Plantain	24	1.0	-	-	IITA
Pulses	87	3.7	2.3	7.9	
Chickpea	14	0.6	.4	1.4	ICRISAT, ICARDA(R)
Cowpea	2	0.1	-	-	IITA
Faba bean	9	0.4	.3	1.0	ICARDA
Field bean	26	1.1	.7	2.4	CIAT
Groundnut	14	0.6	.4	1.4	ICRISAT
Lentil	2	0.1	-	-	ICARDA
Pigeonpea	5	0.2	-	-	ICRISAT
Soybean	14	0.6	.5	1.7	IITA
Livestock and products[d]	146	6.2	5.5	19.0	
Beef and buffalo	23	1.0	1.4	4.8	ILCA, ILRAD
Sheep and goats	2	0.1	-	-	ILCA, ILRAD
Milk	40	1.7	1.2	4.1	ILCA, ILRAD
Pork, poultry, eggs	80	3.4	3.0	10.3	none
Vegetables	35	1.5	.9	2.1	none
Oilseeds	68	2.9	-	-	
Coconut	94	4.0	-	-	none
Oilpalm	16	0.7	-	-	none
Other oilseeds	42	1.8	-	-	
Sugars and honey	150	6.4	.1	0.3	none
Fish and seafood	15	0.6	2.5	8.6	none
Alcoholic beverages	30	1.3	.2	0.7	none
Other foods[e]	193	8.2	.9	2.1	
Total	2349		29.0		

a (R) indicates a regional responsibility.
b Less than 0.1 g/day.
c Adjusted to reflect latest information showing 50 Mt of potato and 95.7 Mt of sweet potato production annually in China.
d CIAT works on tropical pastures for acid soils, principally in Latin America.
e Fruit, nuts, animal oils and fats, stimulants and spices.

Source: TAC (1985) and FAO (1984).

Table 2.6 Approximate annual allocation of CGIAR centers expenditures (1983$m) to major activities and to continental regions expected to derive the principal impact of such activities (1984-86 average, using budgeted levels for 1985 and 1986)

Program area	Total	Africa	Asia	Latin America	Middle East North Africa
Crop improvement	33.0	8.8	15.6	5.3	3.3
Cereals[a]	8.2	2.9	0.7	4.1	0.5
Roots and tubers[b]	10.1	2.4	2.5	2.7	2.5
Food legumes[c]					
Livestock	11.6	6.7	0	3.4	1.5
Production systems	4.1	4.1	0	0	0
Disease control					
Food policy	2.4	1.0	0.8	0.3	0.3
Farming systems	7.7	3.9	1.7	0	2.1
Genetic resources conservation	14.2	0.9	1.1	11.0	1.2
Research support	21.1	9.4	2.9	6.0	2.8
Strengthening national capacities	13.8	4.7	4.8	3.1	1.2
Training and conferences	9.8	4.0	2.2	2.3	1.3
Information and communications	2.6	0.5	0.7	0.5	0.9
Technical assistance					
Research management	20.4	7.3	4.9	4.6	3.6
Administration and management	23.4	10.8	5.3	4.4	2.9
General operations					
Total operations	182.4	67.4	43.2	37.7	24.1

a Rice - 41%, wheat 18%, maize 14%, sorghum 6%, millet 7%, other 14%.
b Cassava 23%, potatoes 48%, others 29%.
c Field beans 30%, groundnut 15%, other food legumes 55%.

Source: CGIAR Secretariat.

Table 2.2 Numbers of CGIAR center staff posted outside their center's host country, including staff on special projects, 1984

Center	Number of staff posted						
		Outside host country in					
	In host country	Asia	N. Africa, Middle East	Latin America	West Africa	E. and S. Africa	Total
CIAT	50	1		11		3	65
CIMMYT[a]	62	12	2	9	5	6	96
CIP[b]	47	6	4	2		3	62
IBPGR	7	4	2	1	1	1	16
ICARDA	57		4				61
ICRISAT	48	1	2	2	20	7	80
IFPRI	28	2			1		31[c]
IITA[d]	73	1		3	27	2	106
ILCA	34				11	14	59
ILRAD	30						30
IRRI	80	12	3	1	1	2	99
ISNAR	26			1			27
WARDA[e]	34				34		68
Subtotal	576	39	17	30	100	38	800
At centers in developing regions[f]		128	57	159	107	64	515
Outposted and at centers in developing regions[g]		167	74	189	207	102	739

a CIMMYT expects to have 15 staff members in Africa by the end of 1985.
b CIP expects to have 25 staff members in Africa by the end of 1985.
c Of the 31 IFPRI staff in 1984, only 17 were supported by core budget.
d 1983 data are shown; IITA expects to have 68 staff members in Africa outside their Nigerian headquarters by the end of 1985.
e 1983 data shown.
f Excludes 61 IBPGR, IFPRI and ISNAR staff in host country not allocated to regional totals.
g Scientists were located in 38 countries without CGIAR centers; all centers in developing countries had members of other centers posted with them.

Table 2.7 Approximate current number of participants in four major types of training programs at centers (to end 1984)

Center	Number of participants in			
	Individual research training	Degree related[a]	Group courses	Post doctoral programs
CIAT	135	25	180	15
CIMMYT	70	5	130	15
CIP	50	10	540[b]	
IBPGR	5	10	130	
ICARDA	10	10	40	5
ICRISAT	15	30	90	20
IFPRI	5			10
IITA	25	65	500	10
ILCA	15		110	5
ILRAD		15	25	10
IRRI	100	150	240	20
ISNAR			180	
WARDA		20	120	
Totals	430	340	2285	110

a Scholars who are taking advanced degrees at universities and conducting degree research at the center specified, except in the case of WARDA which shows numbers taking advanced training abroad.

b Includes participants attending courses conducted by CIP regional staff outside CIP headquarters.

Table 2.8. Global expenditures on official development assistance (ODA) to developing countries, national expenditures on agricultural research, and CGIAR expenditures

	1970	1980	1982
	(1981 billion $ constant)		
I. Official development assistance[a]	21,310	36,210	34,980
Bilateral	18,450	28,650	27,370
Multilateral	2,860	7,560	7,610
Grants by PVAs	2,220	2,240	2,360
II. ODA commitments by purpose			
Total [b]			32,060
Allocable by sector			16,680
of which technical cooperation			6,690
of which agriculture			1,000
Not allocable by sector			15,380
of which food aid			2,640
III. National agricultural research, world	5,350	7,380	n.a.
N. America, Oceania, W. Europe	2,400	3,210	n.a.
USSR and E. Europe	1,280	1,490	n.a.
Developing Countries	1,670	2,680	n.a.
IV. CGIAR expenditures	20	140	140

a From "DAC" countries (OECD) + OPEC + Socialist + Multilateral.
b "DAC" and multilateral.

Source: OECD Development Cooperation (1983) and Judd, Boyce and Evenson (1985).

Table 6.1 Number of CGIAR center related varieties released by national authorities in developing countries through 1983[a]

Crop	Number of varieties named by countries in				
	Africa	Asia	Latin America	Middle East & North Africa	Total
Barley	0	2	0	8	10
Beans, field	4	2	90	0	96
Cassava	26	5	32	0	63
Chickpeas	0	1	0	2	3
Cowpeas	14	2	12	1	29
Maize	61	49	126	2	238
Pasture species	0	0	12	0	12
Pearl millet	5	3	0	0	8
Pigeonpea	5	2	0	0	7
Potatoes	31	16	12	2	61
Rice	31	140	128	2	299
Sorghum	8	18	5	0	31
Sweet potatoes	6	0	0	0	6
Triticale	2	2	7	0	11
Wheat, bread	40	44	114	66	264
Wheat, durum	5	3	13	20	41

a Excludes varieties developed from crosses made by national programs from sources similar to those used by the centers.

Table 6.2. Area Under Semi-Dwarf Wheat, 1970 and 1983

Country	1970		1983	
	'000 ha	%	'000 ha	%
China	14.7	0.1	5126.0	17.8
India	6480.0	39.0	18550.0	80.1
Other Developing Asia	3458.6	40.1	7797.1	68.8
Afghanistan	232.0	10.5	400.0	13.3
Bangladesh			498.0	96.0
Nepal	98.3	49.2	377.6	92.1
Pakistan	3128.3	50.3	6521.5	88.2
Sub-Saharan Africa	69.8	5.0	556.3	52.1
Ethiopia	60.4	5.7	384.0	51.2
Kenya	7.9	5.3	83.8	72.9
Nigeria	1.0	33.3	10.0	71.4
Sudan		0.0	46.5	35.8
Tanzania		0.0	10.0	43.5
Zimbabwe	0.5	4.2	22.0	62.9
Latin America	794.5	10.8	8878.0	82.5
Argentina		0.0	6490.4	95.0
Bolivia	1.9	2.5	6.0	9.2
Brazil	56.1	3.1	826.5	43.0
Chile	61.2	8.3	329.7	70.0
Colombia	9.2	21.9	42.8	95.0
Ecuador		0.0	8.0	36.4
Guatemala	11.9	29.8	39.9	95.0
Mexico	651.9	88.1	942.5	95.2
Paraguay	2.1	6.6	6.0	8.0
Uruguay	0.2	.0	186.2	62.1
Middle East/ North Africa	1144.4	5.0	7690.3	33.8
Algeria	140.0	6.1	400.0	30.8
Egypt	0.0	0.0	306.2	53.7
Iran	63.0	1.3	891.7	14.7
Iraq	125.0	6.1	600.0	50.0
Libya	4.8	2.9	97.3	34.8
Morocco	90.0	4.6	721.6	36.5
Saudi Arabia		0.0	288.0	100.0
Syria	28.6	2.1	601.5	46.6
Tunisia	53.0	4.8	344.0	37.0
Turkey	640.0	7.4	3440.0	38.9
All Developing Countries	11962.0	14.0	48597.7	49.7

Source: Adapted from Dalrymple(1985).

Figure 6.3
Area under semi-dwarf wheat, 1970-1983

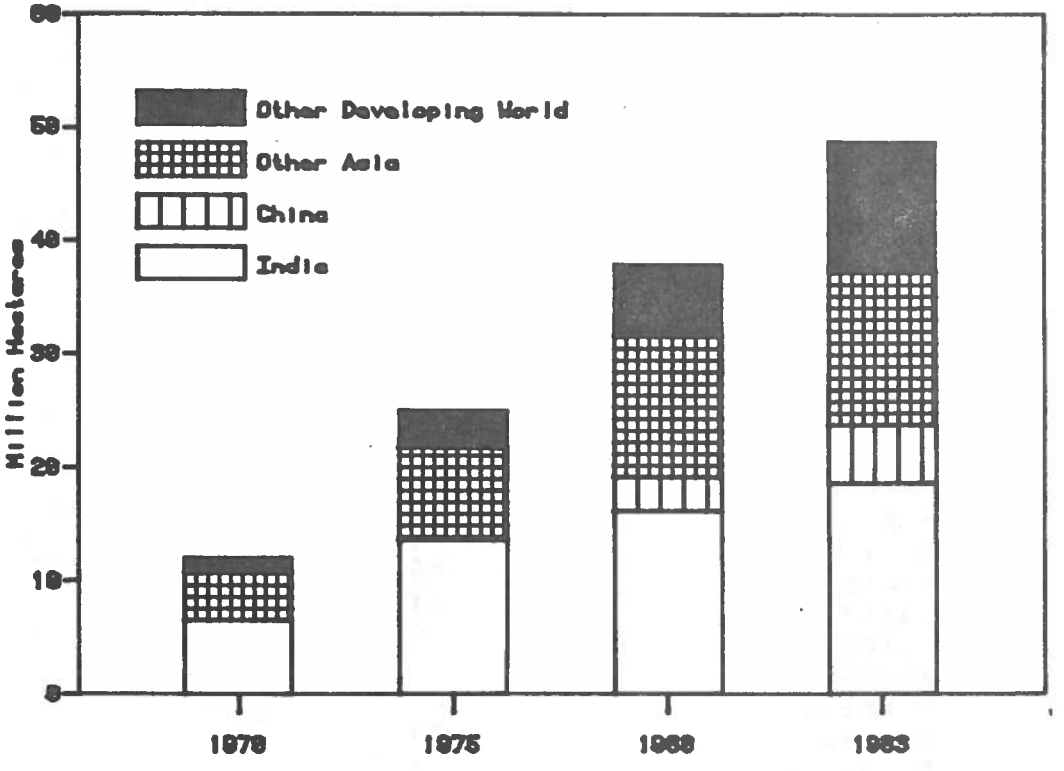

Table 6.3. Area Under Semi-Dwarf Rice, 1970 and 1983.

COUNTRY	1970 '000 HA	1970 %	1983 '000 HA	1983 %
China	26848.0	77.3	32265.2	95.0
India	5588.0	14.8	22180.0	54.1
Other Developing Asia	4281.5	10.0	19734.1	42.4
Bangladesh			2628.5	24.8
Burma	200.0	4.2	2370.1	50.4
Indonesia	1072.2	13.0	6626.9	72.8
Laos	53.6	6.0	9.7	1.4
Malaysia	164.6	23.3	254.8	36.4
Nepal	67.4	5.6	478.9	37.1
Pakistan	550.0	4.6	915.7	45.3
Philippines	1565.4	49.3	2757.0	83.5
S. Korea	2.7	0.2	418.6	34.1
Sri Lanka	73.6	11.2	749.7	81.0
Thailand	30.0	0.4	1200.0	12.8
Vietnam	502.0	20.1	1324.2	50.0
Sub-Saharan Africa	40.9	4.1	241.9	14.8
Camaroon			7.9	35.9
Ghana	36.8	89.8	35.0	43.8
Ivory Coast	2.1	0.7	32.7	7.1
Nigeria	1.0	0.4	60.0	10.0
Senegal	1.0	1.1	72.4	96.5
Sierra Leone			33.9	8.5
Latin America	252.4	4.2	1831.7	27.8
Argentina			27.3	33.7
Brazil			729.1	14.3
Colombia	41.0	17.4	364.3	91.8
Ecuador	15.7	10.5	40.3	53.1
Guatemala			3.5	29.2
Guyana			43.5	59.5
Haiti			11.0	22.0
Honduras	0.9	4.7	21.4	89.2
Mexico	123.3	66.6	154.2	83.4
Nicaragua	9.1	33.7	37.1	78.9
Panama	40.6	31.2	55.2	69.0
Paraguay	0.2	1.5	21.9	64.4
Peru	16.9	12.8	140.7	74.1
Surinam	4.7	13.1	48.7	69.6
Venezuela			133.5	79.9
Middle East/ North Africa	2.1	0.3	80.7	11.0
Egypt	2.1	0.4	20.7	4.9
Iran			60.0	19.2
All Developing Countries	37012.9	30.1	76333.6	58.5

Source: Adapted from Dalrymple(1985).

Figure 6.4
Area under semi-dwarf rice, 1970-1983

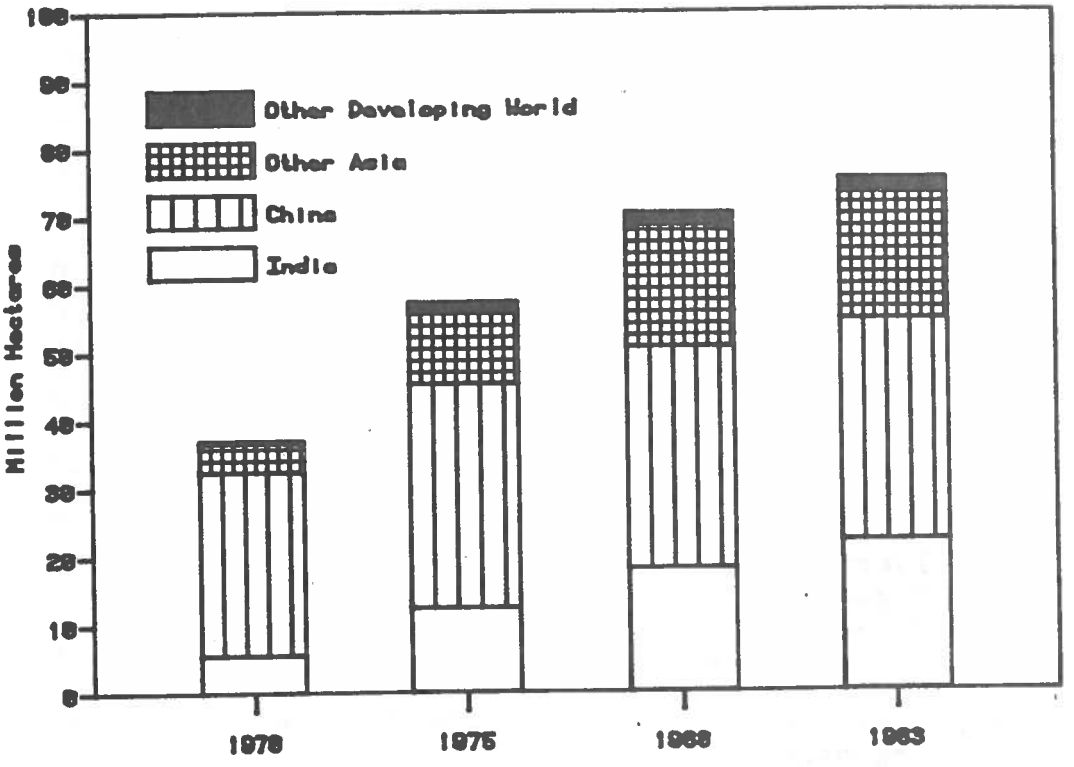

Table 7.2 Changes in cropping intensity associated with collaborative research

Location	Period	Multiple-cropping Index Start	Finish
	Rice Based Systems		
Bangladesh, National	1972/73 to 1981/82	1.45	1.54
North Subang village Java, Indonesia	1968/71 to 1978/79	1.50	2.00
Iloilo Outreach site Philippines	1974/75 to 1978/79	1.18	1.84
Dhobini village Nepal	1977/78 to 1980/81	1.59	1.68
	Semi-arid Tropics		
Taddanpally Watershed AP, India	1980/81 to 1982/83	1.06	1.39
Sultanpur Watershed AP, India	1981/82 to 1982/83	1.06	1.72
Farhatabad village Karnataka, India	1981/82 to 1982/83	1.29	1.67

Table 8.2 Impact of a 10 percent decrease in the price of food on real income of low and high income population groups

Country	Percent increase in real income		Source
	Lowest 10% per capita income	Highest 10% per capita income	
Sri Lanka	8.5	4.1	Sahn (1985)
Thailand	6.0	2.0	Trairatvarakul (1984)
Egypt	5.6	1.0	Alderman and von Braum (1984)
India	7.3	2.9	Murty (1983)
Funtua, Nigeria	7.7	6.5	Pinstrup-Andersen and Uy (1985)
Gusau, Nigeria	9.0	5.7	Pinstrup-Andersen and Uy (1985)
India[a]	5.5[b]	1.2[c]	Mellor (1978)

Source: IFPRI Consumption and Nutrition Program

a Foodgrains only.
b For the lowest 20 percent.
c For the highest 5 percent.

Table 10.4 Some international agricultural research networks with center participation

Network	Center participant/ coordinator	Region	Countries	Year started
Proyecto Adino Cooperativo de Investigacion en Papa	CIP	Andean	5	1982
Programme Regional d'Amelioration de la Culture de la Pomme de Terre en Centrale Afrique	CIP	Central Africa	3	1983
Programa Regional Cooperativo de Papa	CIP	Central America and Caribbean	8	1978
South Asia Program for Potato Research and Development	CIP	South Asia	5	1982
Programa Cooperativo Investigacion en Papa	CIP	Latin America	4	
Asian Farming Systems Networks	IRRI	Asia	15	1974
International Network on Soil Fertility and Fertilizer Evaluation on Rice	IRRI	Asia, Africa	20	1976
Africa Research Network on Agricultural Byproducts	ILCA	Africa	18	1980
Trypanotolerance Network	ILCA/ILRAD	Africa	9	1983
CIMMYT Eastern Africa Regional Economics Program	CIMMYT	E. Africa	14	1976
West African Farming Systems Research Network	IITA/ICRISAT	W. Africa	17	1982
West Afican Regional Cooperation for Research on Plantain	IITA	W. Africa	9	1981
International Network for the Improvement of Banana and Plantain (INIBAP)	IDRC/IITA/IFAD	Worldwide	-	1984
African Association for Biological Nitrogen Fixation	IITA	Africa	31	1982
On-Farm Research Network	IITA	Africa	7	1983
Rice Policies in S.E. Asia	IFPRI/IRRI IFDC	Asia	4	1978

Table 10.4 (cont.) Some international agricultural research networks with center participation

Network	Center participant/ coordinator	Region	Countries	Year started
Income and Nutrition Effects of Increasing Commercialization of Semi-Subsistance Agriculture	IFPRI	Africa, Asia, S. Pacific Latin America and Caribbean	13	1984
Red Internacional de Evaluacion de Pastos Tropicales	CIAT	Latin America	22	1978
International Rice Testing Program	IRRI	Asia	16	1978
	IRRI/CIAT	Latin America and Caribbean	19	1978
	IRRI/IITA/ WARDA	Africa	16	1978