Consultative Group on International Agricultural Research

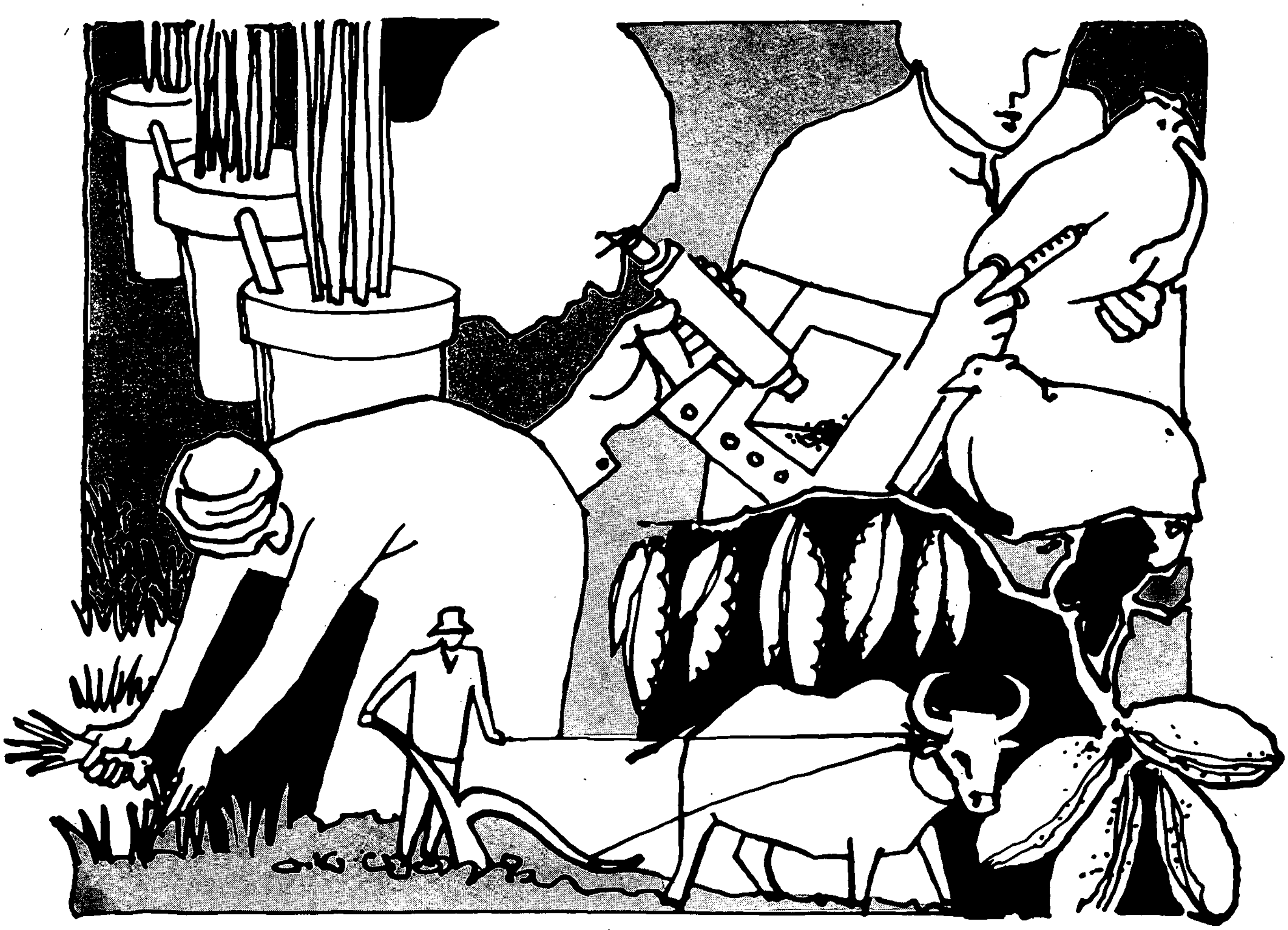
CGIAR

Study Paper Number 15

Philippines and the CGIAR Centers

A Study of Their Collaboration in Agricultural Research

Arturo A. Gomez



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At its annual meeting in November 1983 the Consultative Group on International Agricultural Research (CGIAR) commissioned a wide-ranging impact study of the results of the activities of the international agricultural research oganizations under its sponsorship. An Advisory Committee was appointed to oversee the study and to present the principal findings at the annual meeetings of the CGIAR in October 1985. The impact study director was given responsibility for preparing the main report and commissioning a series of papers on particular research issues and on the work of the centers in selected countries. This paper is one of that series.

The judgments expressed herein are those of the author(s). They do not necessarily reflect the views of the World Bank, of affiliated organizations, including the CGIAR Secretariat, of the international agricultural research centers supported by the CGIAR, of the donors to the CGIAR, or of any individual acting on their behalf. Staff of many national and international organizations provided valued information, but neither they nor their institutions are responsible for the views expressed in this paper. Neither are the views necessarily consistent with those expressed in the main and summary reports, and they should not be attributed to the Advisory Committee or the study director.

This paper has been prepared and published informally in order to share the information with the least possible delay.

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Summary

The main purpose of this paper is to evaluate the effectiveness of the collaboration between the International Agricultural Research Centers (IARCs) and the Philippine National Agricultural Research System (NARS) with respect to improvements in the research capability of the NARS and its impact on productivity in the agricultural sector. Two primary sources of information were used: (1) secondary data on the status of the agricultural sector and (2) interviews of leading researchers and research administrators.

The Agricultural Sector

Philippine agriculture has grown steadily in the past two decades, despite the minimal amount of help and subsidy provided by the government. Rice, the major staple, has been the star performer. Since 1972, production has grown annually by 4.5 percent, outstripping population growth by more than 1.5 percentage points. By the late 1970s, the Philippines became a net exporter of rice, although this status is fluctuating because of the current adverse price structure.

Corn, the next most important crop with about the same harvest area as rice, has been growing at a slower rate, with much of its growth fueled by the expansion of cultivated area. With the development of new hybrids that have much higher yield potential, corn can be expected to be the star performer in the 1980s.

The research and extension system of the Philippines is fairly well developed. The NARS has more than 3,000 professional researchers, 19 percent of whom have MS and 8 percent of whom have PhD degrees. Agricultural research in all institutions is approved and monitored by a central coordinating council that also summarizes and documents research results. The extension

system has enough personnel to cover each of the 34,000 rural communities in the country. It has been strengthened by its participation and leadership in the implementation of a series of national food production programs.

Impact of IARCs on the Philippine NARS

Distribution of improved germplasm, training of research staff and dissemination of new research findings are the three services of the IARCs that are perceived to be the most useful to the NARS. Elite germplasm produced by the IARCs has greatly increased the genetic diversity of breeding materials in the NARS and has contributed substantially to the progress in varietal improvement. New rice varieties developed at IRRI have been directly recommended by the NARS for commercial production. Varieties in corn, sorghum and potatoes developed by CIMMYT, ICRISAT and CIP, respectively, have been tested extensively, with very promising results.

Training of NARS staff by IARCs has been greatly appreciated because of the relevance of the program and the expertise of the training staff.

Research findings that have been applied by the NARS in solving location-specific problems are: (1) properties of submerged paddy soils, (2) research methods for on-farm trials, (3) crop interaction in intensive cropping and (4) breeding methods.

While there is no question about the usefulness of IARCs to the NARS, similar services are also available from other institutions. It is not clear, therefore, if similar progress in the NARS could have been obtained if the IARCs did not exist. Furthermore, the Philippine NARS officials have expressed doubt as to whether the IARC model is cost effective with respect to accelerating the development of the NARS.

Impact of IARCs and NARS Collaboration on Agricultural Productivity

IRRI clearly dominates the contribution of IARCs to increased agricultural production in the Philippines. Rice, the most important food crop, is the recipient of a massive production program that is based mainly on technologies developed at IRRI.

The other IARCs mentioned that have some impact on Philippine programs are CIMMYT, CIP, CIAT, ICRISAT and IBPGR. Relative to the impact of IRRI, however, the impact of these other IARCs on agricultural production is more difficult to trace. Many of the innovations developed by these centers have to go through the NARS before actual adoption by farmers. Consequently, the identity of the IARC technology is often unclear, and in many instances the innovation may be claimed by the NARS.

Effectiveness of the IARC Model

For the commodity-mandated centers, perception of their future usefulness to agricultural research and development in the Philippines is not so optimistic. The prevailing assessment of IRRI, for example, is: (1) that IRRI has been immensely successful in increasing rice production, (2) that IRRI will continue to contribute to agricultural development but its future impact is expected to be much less and (3) that IRRI has had a more modest impact on the NARS and, as the NARS matures, future impact will become even less. The commodity-mandated centers, and IRRI in particular, are seen to be most effective in solving well-defined problems that are common to a large number of countries. As a major problem is solved, many small problems take its place. These secondary problems, which are more diverse and much more location-specific, are not easily solved by IARC research. At this stage, the IARC model becomes less effective and other models may have to take its place. Perhaps the mandate of IARCs can be modified from one of directly conducting research to one of determining research priorities and channeling financial support to the NARS for implementing high-priority research activities.

Contents

Abbreviations and Acronyms

ADB	Asian Development Bank
AIT	Asian Institute of Technology
AVRDC	Asian Vegetable Research and Development Center
BAEcon	Bureau of Agricultural Economics
BAI	Bureau of Animal Science
BIOTROP	Regional Center for Tropical Biology
BPI	Bureau of Plant Industry
CLSU	Central Luzon State University
DANR	Department of Agriculture and Natural Resources
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GNP	Gross National Product
ha	hectare
IARC	International Agricultural Research Center
MAF	Ministry of Agriculture and Food
MNR	Ministry of Natural Resources
MV	Modern Variety
NARS	National Agricultural Research System
NEDA	National Economic and Development Authority
NEP	National Extension Program
NFA	National Food Authority
NSDB	National Science Development Board
P	Philippine peso
PCA	Philippine Coconut Authority
PCARRD	Philippine Council for Agriculture and Resources Research and Development
PSI	Philippine Sugar Institute
PTA	Philippine Tobacco Administration
SEAFDEC	South East Asia Fisheries Development Center
SEARCA	South East Asia Regional Centre for Graduate Study and Research in Agriculture
SMU	Southern Mindanao University
UPLB	University of the Philippines at Los Baños

USAID	United States Agency for International Development
VISCA	Visayas State College of Agriculture

CGIAR-supported centers

CIAT	Centro Internacional de Agricultura Tropical
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CIP	Centro Internacional de la Papa
IBPGR	International Board for Plant Genetic Resources
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILCA	International Livestock Center for Africa
ILRAD	International Laboratory for Research on Animal Diseases
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
WARDA	West Africa Rice Development Association

1 Background

1.1 The country

1.1.1 Natural and political setting

The Philippines is an island country covering a land area of 300,000 square kilometers. Of the approximately 7,100 islands the two largest, Luzon and Mindanao, account for 66 percent of the total land area. The climate is mainly humid tropical, rainfall exceeds 2,000 mm in most parts of the country, and vegetation is lush and green almost all year long.

The country has three distinct levels of government: national, provincial and municipal. An executive officer and a corresponding legislative body is elected at each level. This system had been fairly stable until 1972 when martial law was declared and the President assumed legislative powers. Since then, several amendments to the constitution have added more powers to an already strong president who, even after martial law was lifted, retained the power to legislate.

1.1.2 Population

The estimated population of the country for 1985 is 53.6 million at a projected growth rate of 2.2 percent annually. Luzon has traditionally been the most densely populated island but net migration to Visayas and Mindanao has resulted in a higher rate of growth in these regions. The area and population levels in the 12 regions of the country for 1980 and 1985 are shown in Table 1.1.

1.1.3 The economy

Some indicators of economic performance for the Philippines are shown in Table 1.2. While the GNP has been growing steadily, the terms of trade have been deteriorating and public expenditures have expanded rapidly. Most of the deficit has been funded by foreign loans, estimated at about $25 billion by 1983. At present we are in a severe deflation, with the growth rate expected to hit -6 percent for 1984.

Table 1.1 Area and Population by Region

Region	Land Area (sq. km)	Population (in thousands)[1] 1980	1985
I	21,568.4	3,541	3,877
II	36,403.1	2,215	2,432
III	18,230.8	4,803	5,526
IV	47,560.1	12,045	13,312
V	17,632.5	3,479	3,806
VI	20,223.2	4,526	4,663
VII	14,951.5	3,787	4,069
VIII	21,431.5	2,799	2,931
IX	18,685.1	2,528	2,906
X	38,670.1	2,759	3,329
XI	31,692.9	3,347	4,036
XII	23,293.2	2,271	2,739
Total	300,000.0	48,098	53,626

1 Actual for 1980 and estimated for 1985.

Table 1.2 Some Indicators of the Philippine Economy

Year	GNP[1] (million P)	Per Capita Income[1] (P at 1972 Price)	Balance of Trade[2] (million P)	Annual Budget[3] (in billion P)
1975	114,265	1,308	-8,425.5	20.17
1977	151,958	1,418	-5,645.8	23.76
1979	220,957	1,523	-1,339.9	34.30
1980	265,008	1,534	-14,506.6	37.89
1981	303,160	1,552	-17,443.5	50.32
1982	334,635	1,555	-22,422.4	57.09
1983	377,371	1,530	-27,418.8	61.84

Sources: [1] NEDA, National Income Series.

NEDA, Philippine Statistical Yearbook.

[2] NEDA, Foreign Trade Statistics.

[3] OBM, General Appropriations Act.

Drastic adjustments are now being instituted to bring the country's economy to health again. The peso value was reduced from 1/8 to 1/20 of the U.S. dollar within a 2-year period; lending rates have soared beyond 40 percent; imports have been greatly discouraged; and foreign debts restructured to allow for longer repayment periods. It is expected that the Philippines will be in severe economic difficulty for the next 3 years.

1.2 The agricultural sector

1.2.1 Structure

Agriculture and forestry account for 29 percent of the gross domestic product (GDP) and employ 51 percent of the labor force. Agricultural crops are the most dominant component of agriculture and forestry. The growth rate for crops has been consistently higher than that of the other components, with its share of the GDP for agriculture and forestry increasing from 50 percent in the mid-50s to 65 percent in 1980. Rice and corn are the two most important crops, accounting for a harvest area that exceeds 70 percent of the total cultivated area (Table 1.3). In the industrial and export crops, coconut and sugarcane cover about 29 percent of the cultivated area and provide more than 50 percent of agricultural exports.

Production is primarily in the hands of many small farmers. In 1960 the average farm size was 3.5 ha, with 80 percent and 40 percent of all farm units having an area of less than 5 and 2.2 ha, respectively. With the additional population and traditional inheritance customs, the present average is estimated at 2.7 ha (World Bank, 1984). As a consequence, the intensity of land use is increasing rapidly. Two crops per year are now harvested on about 40 percent of the area on rice and corn farms.

Table 1.3 Harvest Area for the Important Agricultural Crops of the Philippines[1]

Crop	Harvest Area (million ha)	Percent of Total Cultivated Area
Rice	3.5	39.3
Corn and Other Cereals	3.4	38.2
Coconut	2.1	23.6
Sugarcane	0.5	5.6

1 Represent actual area planted for coconut and sugarcane. For rice and corn, some areas are planted more than once a year and actual area used is smaller. Consequently, the sum of all percentage figures exceeds 100.

Source: FAO Yearbook (1978 and 1979).

Traditionally, both production and marketing of agricultural products have been in the hands of private business. Since the mid-70s, however, the public sector has increased its presence, especially on the marketing side. The rice trade has been dominated by the National Food Authority (NFA) which has bought up to 10 percent of the rice harvest during years of excess production and has a monopoly of rice import and export. Coconut has been heavily taxed to fund a replanting program. Through a presidential decree, the sugar trade became a monopoly of the National Sugar Trading Corporation. Unfortunately, government control has had mixed results and the agricultural commodities with major government involvement are presently experiencing severe difficulties. Since early this year, the government has started to dismantle its monopoly and control in the trade of agricultural products.

1.2.2 Infrastructure and institutional support

The infrastructure and institutional support for the agricultural sector have gradually evolved through a series of production and institutional development programs. Some examples of these programs are: (1) the Masagana 99 for rice, initiated during the 1972 rice crisis, which provided rice farmers with more than 500 million pesos of liberalized credit per crop season and added more than 1,000 new extension technicians; (2) the Masagana program for corn, modeled after Masagana 99, which added about 400 agricultural technicians and a modest amount of credit facilities for corn production; (3) the Rainfed Agricultural Development Program for Iloilo, a World Bank-funded program designed to increase land use intensity from 1.3 to 1.8 crops per year in the rainfed paddy rice of the provinces; (4) the National Extension Program (NEP) and the Agricultural Support Services Program (ASSP), both funded by the World Bank, designed to improve the research and extension capability of the Ministry of Agriculture.

There are several public institutions that are mandated to serve the agricultural sector. Some of the most important are: (1) the Ministry of Agriculture serving agriculture in general; (2) the Philippine Sugar Institute and Philippine Sugar Commission serving the sugar industry; (3) the Philippine Coconut Authority serving the coconut industry; (4) the National Food Authority for purchasing rice, corn and other food crops in order to support a floor price; (5) the Ministry of Natural Resources serving the forestry sector; and (6) the Ministry of Agrarian Reform which oversees and promotes the transfer of land ownership to tenant farmers.

Based on quantity alone, institutional and infrastructural support looks adequate. There are roughly two kilometers of road for every square kilometer of cultivated land, a storage capacity that can accommodate 12 percent of the grain harvest, a rural banking network that is present in almost all municipalities, and market outlets for every fair-sized community. The services operated by the government, however, may not come regularly but rather tend to come in intermittent cycles, depending upon availability of financial support.

1.2.3 Pricing

Since the early 70s, the involvement of government in the trade of agricultural products as well as inputs such as fertilizers and pesticides has increased substantially. NFA buys from the farmers up to 10 percent of the total food grains (mainly rice and corn) produced in order to maintain a floor price prescribed by the government. When the prices are too high, NFA releases from its stocks enough of the commodity to defend a prescribed ceiling price. When local stocks are short, NFA is authorized to import.

In export crops, the sugar trade was legislated to be monopolized by a government-operated trading corporation, while coconut products have been taxed heavily at about 20 percent of border prices.

In the early 70s, the government subsidized the price of fertilizer in order to encourage its use. As shown in Table 1.4, the price of nitrogen relative to rice was kept fairly low up to 1973/74. Since then, the subsidy has been gradually reduced, so that the domestic price is now substantially higher than the border price.

Government intervention in the pricing of agricultural products has favored the consumers more than the producers. In rice, for example, many of the benefits from improved productivity have gone to the consumers. This is shown by the declining real price of rice since 1972, the 1982 price of which was only 53 percent of that in 1973 (Table 1.4). In spite of this decline in real price, however, harvest area for rice continued to increase up to 1982. One reason could be that increasing rice yields was more than enough to offset the ill effects of declining rice prices. Another reason could be the increase in areas under irrigation which enables two crops of rice to be harvested in one year. The financial crisis in 1982, however, resulted in major changes in the prices of farm inputs and outputs. Fertilizer became more expensive, investment in irrigation declined considerably, and the harvest area for rice declined. Furthermore, a severe drought hit the country in 1983 and average yield per hectare also decreased. Although yields recovered somewhat in 1984, it is expected that total production will be less than consumption and the Philippines will again be a net rice importer (Alix, 1984).

For agriculture and forestry in general, David (1983) has shown that: (1) while protection rates were favorable in the 60s, the reverse is true in the 80s; (2) except for pork and chicken, almost all agricultural products are net contributors to rather than recipients of government subsidy; and (3) considering that agriculture employs the largest number of low-income families, it seems illogical that this sector should be a net contributor to government subsidies.

Table 1.4 Comparative Prices of Rice and Nitrogen

Year	Real Price of Palay (P/kg)	Real Price of Nitrogen (P/kg)	Nitrogen:Palay Price Ratio
1970	2.72	9.38	3.44
1971	3.61	7.62	2.11
1972	3.64	7.70	2.11
1973	4.14	8.06	1.95
1974	3.49	10.56	3.11
1975	3.38	14.60	4.32
1976	3.28	11.93	3.64
1977	3.17	10.38	3.28
1978	2.94	9.66	3.28
1979	2.50	9.16	3.66
1980	2.27	8.45	3.72
1981	2.28	8.70	3.81
1982	2.18	8.46	3.88
1984*	2.04	8.38	4.10

Source: Philippine Bureau of Agricultural Economics.
* Author's estimate as of October, 1984.

1.2.4 Past and present performance

The agricultural sector has consistently grown through the years (Table 1.5). Relative to the industrial and service sectors, its growth is lower but more constant.

Among the various agricultural commodities, rice is the star performer. Since 1972, the year of extreme rice shortage both locally and worldwide, rice production has been growing at about 4.5 percent per year, exceeding population growth by about 1.5 percentage points. Consequently, the Philippines reached self-sufficiency in 1978 and exported the commodity from 1979 to 1982. At present, the adverse price structure (i.e., low price of grains together with high price of inputs) has resulted in a reduction of actual harvest area of the crop. Thus, the Philippines has again become a rice-deficit country in 1983 and 1984.

White corn is the staple of about 20 percent of the Filipinos, while yellow corn is the primary source of energy in animal feeds. The yellow corn requirement of the country has always exceeded production but, unlike rice, corn has not had any significant increase in yield per unit area. Much of its gain in total production has been due to an expansion in area under cultivation. Recent developments in research, however, have produced very promising technologies in terms of high-yielding hybrids and effective chemical control of downy mildew, a devastating disease of corn. Thus, corn could very well be the crop that could lift agricultural productivity in this decade.

The most suitable cropland in the country is already under cultivation. Further area expansion would mean the use of the uplands or sloping areas which are prone to erosion. It would seem, therefore, that future increases in agricultural productivity will have to come from increasing efficiency of land use. The Philippines is strongly pursuing this avenue through the use of shorter-maturing varieties.

Table 1.5 Distribution and Annual Growth Rates (in parentheses) of Gross Domestic Product by Sector (in percent)

Year	Agriculture/ Fishery/Forestry	Industrial	Service
1970	28.9 (2.2)	29.5 (6.6)	41.6 (4.8)
1971	28.9 (4.9)	30.3 (7.8)	40.8 (2.9)
1972	28.6 (3.8)	31.1 (7.5)	40.3 (3.4)
1973	27.9 (6.1)	32.1 (12.3)	39.9 (7.6)
1974	27.3 (2.6)	32.3 (5.3)	40.4 (6.1)
1975	26.6 (3.7)	33.2 (9.7)	40.2 (6.0)
1976	26.8 (8.0)	33.8 (9.6)	39.4 (5.5)
1977	26.5 (8.0)	35.3 (7.7)	38.2 (5.5)
1978	26.1 (4.1)	35.7 (7.0)	38.2 (6.0)
1979	25.9 (5.3)	36.0 (6.6)	38.1 (5.4)

Source: NEDA, Philippine National Income, series 1967-72, 1971-75; 1975-77; 1977-79.

1.2.5 Policy issues

The farmers in the Philippines are not organized enough to constitute a strong political lobby group. Consequently, existing government policy has not been very favorable to the sector. Some of the policy issues that could encourage growth in the agricultural sector are as follows:

(1) Pricing of food crops. As mentioned previously the controlled prices of food crops, mainly rice and corn, have been designed to reduce the cost to consumers. This seems unfair to the rice and corn farmers who, in fact, constitute one of the poorest sectors of the economy. Should not the producer have the major share of the benefits from increased production? Should there be price control of food crops? Would it be better if this pricing were left to the free market?

(2) Taxation of agricultural products. Taxation laws have recently moved against the agricultural sector. From a state of subsidy, agriculture is now contributing to the subsidy of other sectors. Is this a logical trend considering that the poorest sector of the economy works in agriculture?

(3) Alienable land. Philippine laws clearly prohibit the distribution for private ownership of land exceeding a given slope. However, population pressure has forced many of the landless to illegally cultivate the sloping areas. Since these farmers are in prohibited areas, government services are not provided to them. Consequently, their practices are primitive and very destructive to the natural resources. Should not hilly land farming be legalized? Can government provide the necessary services and technology to make this sector more productive and more conserving of natural resources?

(4) Subsidy of agricultural inputs. For many countries, inputs are heavily subsidized to encourage their use and consequently increase production per unit area of land. In the Philippines such a subsidy has been declining, and has in fact been negative in the last few years, so that input prices are the highest in Asia. Is this a correct direction? Is not our land getting scarce and population rapidly increasing, so that the use of inputs should be encouraged even more?

2 The National Agricultural Research System

2.1 Definition

The National Agricultural Research System (NARS) can be broadly defined to include all institutions conducting agricultural research in a country. There are three distinct groups of institutions that conduct research in the Philippines: (1) public institutions which are organic parts of the Philippine government and are supported primarily by public funds; (2) private institutions (including foundations) that conduct research primarily to answer the needs of their respective private companies, and (3) international centers whose concern transcends country boundaries and whose funds come from international donors. In this paper we limit the coverage of the NARS to include only the public institutions. We do this for two reasons: first, this paper is concerned primarily with the relationship between the IARCs and the NARS, so it is convenient to restrict the identity to these two components; second, the private institutions are not large, and their financial resources and research results are usually not open to public scrutiny.

2.2 Structure

The NARS of the Philippines has had substantial changes in structure and distribution of funds since the establishment of the Philippine Council for Agriculture and Resources Research and Development (PCARRD) in 1972. Consequently, we shall first describe the NARS in the pre-PCARRD period and then outline the major changes initiated by PCARRD in the structure and funding distribution of the NARS.

2.2.1 The NARS before 1972

The organization for agricultural research prior to 1972 was quite loose, and research institutions had proliferated into individual compartments of responsibility (Lantican, 1971).

There were three groups of public institutions conducting most of agricultural research, namely: (1) the Department of Agriculture and Natural Resources (DANR); (2) the National Science Development Board (NSDB); and (3) agricultural colleges and universities. The DANR belongs to the executive branch of the national government and is mandated to conduct research in agriculture and forestry. Its primary research units are: the Bureau of Plant Industry (BPI) for crops, the Bureau of Animal Science (BAI) for livestock and small animals, the Bureau of Soils, the Bureau of Agricultural Economics (BAEcon), the Philippine Sugar Institute (PSI), the Philippine Tobacco Administration (PTA), the Abaca and other Fibers Board, and the Philippine Coconut Authority (PCA).

The NSDB is a national coordinating body for research which also operates its own research units. These research units are: (1) the National Institute of Science and Technology, under which are the Food and Nutrition Research Council and the Agricultural Research Center; (2) the Philippine Atomic Energy Commission, which has an agricultural section; (3) the Philippine Coconut Research Institute; and (4) the Forest Products Industry Development Commission. In terms of research coordination, NSDB has been ineffective since it has not been given the authority to influence the activities of other research agencies and has had a tendency to favor its own research units over other agencies when distributing grants-in-aid money.

The agricultural colleges and universities were established as institutions for higher learning and their primary responsibility is to offer degree programs in agriculture and related fields. However, with the availability of highly trained personnel and the need for research to support teaching, these institutions have participated in agricultural research. Although there are more than fifty agricultural colleges and universities, the University of the Philippines at Los Baños (UPLB) is dominant. By the early 1970s, more than 50 percent of the 246 PhD degree-holders (Table 2.4) were on the staff of UPLB and more than 80 percent of the completed research projects came from this institution.

2.2.2 The NARS after 1972

Due to the ineffectiveness of NSDB as a research coordinating body, PCARRD was created in 1972 and vested with the authority to withhold funds from any public research institution that did not heed its mandate. Since its creation, PCARRD has strongly influenced the NARS in the following ways: (1) reorganized the structure of the NARS such that member institutions have well-defined functions within the following four categories: multi-commodity national centers, single commodity centers, regional centers and cooperating field stations (see Appendix A for more details); (2) developed a listing of research priorities backed by a system of allocating funds that greatly favors the high priority areas; (3) increased the resources for agricultural research from 41.1 million pesos in 1971 to 161.8 million pesos in 1981; (4) funded the training of 130 researchers for advanced degrees and 787 for non-degree courses and in-service training; and (5) funded the infrastructure and research facilities of four multi-commodity research centers (Valmayor and Valera, 1983).

By the early 80s, other agricultural universities and colleges had greatly improved their research capabilities, and the dominance of UPLB had somewhat diminished. The institutions most benefited have been the lead agencies of the three multi-commodity research centers (Table 2.1), namely: Central Luzon State University (CLSU), Visayas State College of Agriculture (VISCA), and Southern Mindanao University (SMU).

2.3 Resources for research

There are three major funding sources for research in the public sector. These are: (1) taxes to fund specific research

Table 2.1 Research Budget of Four Agricultural Universities That are the Lead Institutions of National Commodity Centers (in thousand pesos)

Year	UPLB	CLSU	VISCA	USM
1977	8,541	404	644	122
1979	9,924	1,492	2,918	270
1982	14,161	1,761	4,864	308
1984	17,843	2,478	8,038	1,711

Source: General Appropriations Acts for 1977 and 1979 data and PCARRD Research Inventory for 1982 and 1984 data.

activities, (2) budget allocations, and (3) loans and grants from international sources.

Taxes on trade of some agricultural commodities are used for the research and development activities of that specific commodity. Taxes on the export of sugar, coconut, tobacco and forest products are used to fund the research activities of the Philippine Sugar Institute, the Philippine Coconut Authority, the Philippine Tobacco Administration, and the Forest Product Industry Development Commission, respectively. Another tax that provides a substantial source of research funds is the special science fund which is generated from the registration of motor vehicles. This fund is administered by the NSDB and distributed to various research institutions as grants-in-aid. The bulk of research funds, however, are from budgetary appropriations. Much of the research funding of line agencies of government such as the Ministry of Agriculture and Food (MAF) and the Ministry of Natural Resources (MNR) comes from this source.

In the last 10 years loans and grants from international institutions have become a substantial source of research funds. For example the funds for staff development and infrastructure of the NARS in the late 70s came from the proceeds of a U. S. Agency for International Development (USAID) loan to PCARRD. Other loan funds used for research are discussed further in section 2.5.

The actual amount of resources used for research is not easy to quantify. First, the research, teaching and extension functions in many research institutions are closely linked to each other such that research expenditure is not easy to separate. Second, proceeds of taxes for research are automatically labeled as research money even if they are spent for other purposes. Finally, proceeds from foreign-assisted projects including the government's counterparts are budgeted separately so that research expenditures are not easily separable. Nevertheless, we have secured what we feel are the best estimates of research expenditures from 1960 to 1982 (Table 2.2). These data indicate:

(1) A low priority is given to research. Research appropriations have consistently been less than half a percent of GNP.

(2) There was a continuing increase in research appropriations up to 1981, with a budget in that year of four times that in 1971.

(3) Appropriation of funds to commodities do not match their relative contribution to agricultural products (Table 2.3). In general, crops that have lower harvest area are allocated research funds that are proportionately higher. This is an indication of a buoyant attitude in agricultural research that attaches great optimism to new crops as potential contributors to the agricultural sector.

In terms of distribution of funds to the various research institutions, there is a tendency to allocate more funds to smaller institutions. In the early 70s research funds were concentrated at Los Baños in the U.P. College of Agriculture at Manila where the main offices of the Ministries are. By 1984, however, with the influence of PCARRD, research funds were spread out more evenly to outlying institutions. The most notable gainers are the newly established research centers such as CLSU, VISCA and USM (Table 2.1). The research funds of these institutions have multiplied by 6, 12 and 15 times, respectively, compared to only 2 times for UPLB.

2.4 Research staff

The Philippines NARS has a fairly strong research staff.

Table 2.2 Annual Investment in Agriculture and Natural Resources Research (in real terms using 1972 as base year)

Year	GNP (in million pesos)	Research Appropriation[1] (in thousand pesos)	Percent of GNP
1960	31,367	17,447	.056
1961	32,959	19,843	.060
1962	35,853	20,663	.058
1963	38,508	25,426	.066
1964	38,252	22,723	.059
1965	40,523	24,941	.062
1966	42,624	27,402	.064
1967	45,038	27,108	.060
1968	48,759	31,482	.065
1969	53,048	44,253	.083
1970	55,080	49,666	.090
1971	53,679	94,481	.083
1972	55,526	50,277	.091
1973	61,415	65,697	.107
1974	63,946	57,421	.090
1975	68,463	43,980	.064
1976	72,799	53,072	.073
1977	76,986	55,420	.072
1978	82,822	57,531	.069
1979	88,206	60,837	.069
1980	90,010	82,950	.092
1981	81,581	61,802	.076
1982	90,203	50,785	.056
1983	101,172	47,608	.047

[1] Data from 1960-74 taken from Librero (1983), for 1975-83 from General Appropriations Act. Research allotment includes only direct expenditures of the Government and does not include grants or loans from international sources.

Table 2.3 Area Planted to the Various Commodities and Their Relative Research Appropriations

Commodities	1982 Research Appropriation (in million P)	Area Planted (in million ha)
Rice	4.8	3.5
Corn	4.9	3.4
Coconut	3.4	2.0
Root Crops	4.1	0.2
Vegetables	4.0	0.1

Source: Report of PCARRD review team (1980).

Its distribution according to highest degree obtained, agency of employment and field of specialization is shown in Table 2.4.

The highest concentration of research staff is in the colleges and universities in terms of agency of employment, and in crop science in terms of field specialization. Furthermore, 28 percent of 3,047 research staff have degrees beyond the BS level.

Most of the staff listed in Table 2.4 do not work purely on research. Only 49 percent of the time of university staff is devoted to research, while those in the Ministry of Agriculture spend 77 percent of their time in research. In fact, PhD degree holders are usually given other responsibilities, mainly administration, so that they spend less time on research than those with MS or BS degrees. Reviewing this situation, Leonor et al. (1975) estimated that 119 more MSs and 59 more PhDs will have to be added to the research staff between 1975 and 1980. In a more recent survey conducted by PCARRD, an addition 436 MSs and 122 PhDs are needed to compliment existing personnel (Valmayor and Valera, 1983).

Since 1972, PCARRD has funded the training of 570 MSs and 96 PhDs. In addition, the various educational institutions, notably the UPLB, graduate about 200 MSs and 50 PhDs every year. It does seem that there is an adequate pool of personnel now, and in the coming years, that can support the needs of the Philippine NARS.

2.5 External influences

The international agencies that exert substantial influence on the Philippine NARS can be grouped into three categories, namely: (1) the lending agencies, (2) the fund-granting agencies and (3) the research agencies.

Table 2.4 Distribution of Research Staff by Academic Degree, Agency and Field of Specialization

Category	Academic Degree			
	BSc	MSc	PhD	Total
	Agency of Employment			
Colleges and Universities	811	428	192	1,431
Ministry of Agriculture	484	39	4	527
Ministry of Natural Resources	346	21	1	368
National Science Development Board	113	20	4	137
Other Government Agencies	277	18	4	299
International Agencies	165	64	40	269
Private Agencies	11	3	1	15
Total (%)	2,207(72)	593(20)	246(8)	3,046
	Field of Specialization			
Crop Production	728	160	61	949
Forestry	365	53	27	445
Agricultural Economics	219	58	17	294
Fisheries	245	37	12	294
Rural Sociology	106	102	38	246
Animal Science	117	82	28	227
Agricultural Engineering	174	32	9	215
Soil Science	142	18	18	178
Plant Pathology	65	16	21	102
Entomology	64	17	15	96
Biology	56	28	11	95
Physical Science	70	15	9	94
Food Science	26	15	5	46
Others	29	11	8	48
Total	2,406	644	279	3,329*

Source: Adapted from Librero (1983).

*Some researchers (315) are entered in more than one discipline.

2.5.1 Lending agencies

The lending agencies are those who lend money for development including research. The World Bank, the Asian Development Bank (ADB) and USAID are three of the major lending agencies for the Philippines. Some examples of their loans and the corresponding research components are:

(1) The Rainfed Agriculture Project for the province of Iloilo, funded by the World Bank, designed to increase productivity of rainfed rice paddies, including a research component for adapting technologies developed for Iloilo to seven other provinces.

(2) The Agricultural Support Services Program, funded by the World Bank, designed to improve the institutional services to agriculture, with a research component for technology verification in all 72 provinces in the country.

(3) The Rainfed Research and Development Program, funded by USAID, designed to develop rainfed areas in three of the twelve regions of the country, with a research component for developing new production technologies for rainfed and upland areas.

(4) The Second Laguna Development Project, funded by ADB, designed to develop two agricultural areas in Cavite, with a research component for developing production technologies for upland annual crops, primarily vegetables.

2.5.2 Fund-granting agencies

The fund-granting agencies are government or privately funded international agencies whose primary mandate is to grant funds to the NARSs of developing countries in order to accelerate rural development. They influence research in the Philippines by indicating the types of research they are willing to fund. With such an excellent prospect of financial support, Filipino researchers are motivated to develop project proposals geared towards the specified areas of priority. Some examples of the fund-granting agencies that are presently active in the country are the International Development Research Center, the German Fund for Development, and the United Nations Agencies.

2.5.3 Research institutions

Research institutions funded by international donor agencies are mandated to solve the production problems of major crops in the developing countries. The IARCs dominate this group. Non-IARC institutions such as the Asian Vegetable Research Center and the Tropical Agricultural Research Center are also active in the country. These institutions influence the NARS through their research results, some of which address local problems (see section 3 for the influence of IARCs on NARS).

2.6 Effectiveness and problems

As compared to the NARS of more developed countries, where published papers become an important indicator of research accomplishment, research effectiveness in the Philippines is measured primarily in terms of impact on farm productivity. As a consequence, the number of technical papers published are few, while extension-oriented bulletins are more common. In crop science, for example, where the concentration of researchers is highest, there are only three journals with national reputations that come out regularly, compared to four types of extension bulletins published by PCARRD alone.

Similarly, research findings that solve the most important production constraints are the most likely to get public recognition. Thus, recent research awards have been dominated by (1) breeders who have developed crop varieties that are widely adopted by farmers, (2) those who have developed practical and economical ways of controlling or minimizing pest damage, and

(3) those who have shown successful prototypes of rural development.

A major problem of the NARS is how to achieve a balance between coordination and bureaucracy on the one hand and independence and creativity on the other. The Philippine experience shows that some degree of coordination is necessary for young and inexperienced members of the NARS. A few trained and experienced coordinators at the national level can provide good direction to many developing institutions. As the NARS matures, however, and the staff becomes more experienced, the need for coordination becomes less and the ill effects of bureaucracy become more pervasive. After all, good researchers are expected to be independent, creative and often non-conformist. They are most difficult to coordinate.

The NARS is getting stronger and the number of highly trained and capable staff is increasing. As a result, coordination and central planning will become increasingly more difficult. How PCARRD should react to this reality is a problem. How PCARRD can continue to minimize duplication and effectively direct research priorities without becoming a major bureaucracy is a challenge.

3 Impact of the IARC on the NARS

3.1 Introduction

Impact connotes two essential ingredients: (1) an effect that is measured as a change or improvement in the recipient unit (in our case the NARS) and (2) a cause that is identified, through association with the effect, as due to the activities of the donor unit (in our case an IARC). In the present study, the description and quantification of the effect, i.e., the change and progress in the NARS, is not much of a problem. Improvements in facilities, staff, output and organization of the NARS is not difficult to document. The probable causes of these effects, however, are usually many. Government policy, economic environment, national values, and international organizations are some possible causes. Consequently, it is not easy to trace a cause to a specific effect, and much less to quantify the contribution of a particular cause to a particular effect. To cope with this difficulty, we have relaxed somewhat the requirement of proving causation from a clear association to that of establishing a possible association. That is, any improvement in the NARS that can be associated with, or could have been affected by, any activity of an IARC is immediately considered as part of the impact of that IARC on the NARS. Obviously, this definition can grossly overemphasize the importance of the IARC relative to other causes. We recognize this potential for bias and try to minimize it by including, whenever possible, other causes that could have participated in producing an identified impact.

The impact of the IARCs on the NARS can be grouped into three major categories, namely: (1) improvements in biological materials through the germplasm that the IARC disseminates, (2) staff development primarily associated with the IARCs' training programs, and (3) research findings of the IARCs that become the basis of applied research by the NARS.

3.2 Biological materials

Varietal improvement is a major area of research for most IARCs. For their respective mandate crops they maintain comprehensive sets of genotypes that represent land races from all over the world. Through various methods of recombining genotypes, the IARCs generate large numbers of breeding materials, which they continuously evaluate for outstanding performance.

Any national research system can request any genotype available from any IARC. In addition, the IARCs distribute, through selected national centers, selected genotypes which are most likely to be useful to existing national breeding programs. The IARCs that regularly send breeding materials to the Philippines are shown in Table 3.1.

For most researchers and research administrators interviewed, the collection, generation and distribution of genetic materials (germplasm) is the most important and useful service that the IARCs provide the NARS. This opinion is most pronounced at UPLB, with its fairly strong research staff and relatively good availability of training opportunities. At smaller centers (i.e., Southern Mindanao University, Maligaya Research and Training Center, and Camarines Sur Agricultural College) staff training is perceived to be more important (see section 3.3).

More availability of genetic materials does not by itself improve the NARS. It has, however, the potential for initiating a chain of events that could substantially improve research capability and research output.

3.2.1 Improving research capability

Working cooperatively with the IARCs in evaluating germplasm, two important opportunities are opened for the NARS scientists. First, regular IARC staff visits can expose the

Table 3.1 Approximate Number of Genotypes per Year That Are Sent by IARC to the Philippine NARS

IARC	Crops	Number of Genotypes	Recipient
IRRI	Rice	1,000[1]	BPI
CIMMYT	Corn	50	UPLB/SMARC
ICRISAT	Sorghum	30	UPLB
	Pigeonpea	not regular	UPLB
CIAT	Cassava	not regular	UPLB/VISCA
CIP	Potato	20	MSAC/BPI/UPLB

[1]Includes genotypes evaluated directly by IRRI staff but tested on NARS experiment stations.

local staff to new research findings and open up opportunities for training or attendance at conferences. These contacts are specifically useful to smaller and more remote stations, where opportunities for staff improvement are limited.

Second, these trials are relatively large and are commonly used by the local agency to justify requests for additional funds and research staff. In all five research stations visited where such international nurseries are being tested, special funds are provided for the international nurseries and at least one research assistant considers this activity a major responsibility. Three of the five stations, however, indicated that the additional resources are not enough and the institution has to put up its own counterpart. None of the participating institutions, however, are willing to give up the international nurseries, indicating that the benefits far outweight the disadvantages.

3.2.2 Improving research output

National research institutions, especially the smaller ones in remote areas, have the tendency to operate small breeding programs involving locally available genotypes. The diversity of these materials is usually narrow and the potential for progress is small. The introduction of elite germplasm from the IARCs results in a substantial increase in genetic diversity and a dramatic improvement in yield potential. Such changes greatly broaden the researchers' outlook and improve their perception of achievable goals. For example, corn and sorghum elite lines from CIMMYT and ICRISAT have helped increase the yield expectation of breeders at UPLB and SMU. In cassava, yields exceeding 40 tons are suddenly perceived as achievable where 20 used to be considered excellent. Similar changes have happened with sweet potato, white potato and even the grain legumes. For rice, where breeding programs first started, these upgraded expectations have been translated into better farm yields (see section 4.3).

3.3 Staff development

Staff development is perceived by all research administrators as a continuing concern. Due to staff turnover, training must be instituted just to maintain present strength. For young researchers, a chance to train either locally or abroad is one of the major rewards of a job well done. Thus, training is ranked as either the most important, or the second most important, service of the IARCs. In fact more than 80 percent of those interviewed have either trained or attended conferences in at least one IARC.

There are several features that are desirable about the IARC training. First, training is usually given in areas where the IARCs have the best practical experience. Second, the sponsoring center is familiar with research work in the recipient countries and training is designed to fit local needs. Third, trainees are selected from people already working in areas related to the training program, so that their newly acquired knowledge is readily applicable to their current job.

Research administrators were especially appreciative of the above features and indicated that IARC-trained staff did not need much readjustment on their return. They were, in fact, trained to go back to their old jobs.

The same desirable features, however, have caused difficulties in cases where the trainees are not selected carefully. For example, when trainees are taken from jobs that are not related to the topic of training, or when returning trainees are assigned to new jobs, they feel lost and out of place. The very specificity of the IARC training that is so advantageous when one returns to the correct job makes it difficult to apply to new situations. For example, when trainees are taken from jobs that are not related to the topic of training, or when returning trainees are assigned to new jobs, they feel lost

and out of place. Clearly, it is essential to select the trainees appropriately. Toward this end, PCARRD strongly suggests that the selection of trainees should pass through a national coordinating body which can ensure that only qualified persons who are now holding relevant positions are sent for training.

Training for advanced degrees, most especially for the PhD, is needed from institutions outside of the Philippines. It is necessary that our key researchers be trained, not by a single institution but by several, preferably with divergent environments as well. The general preference is for at least half of the new PhDs to come from non-IARC and non-Philippine institutions. For BS, MS and other degrees the existing NARS and IARCs could supply most of the requirements.

Shown in Table 3.2 are the training needs of the Philippines, and the international institutions that can provide such training. Of the total of 377 people to be trained, only 28 percent are expected to be satisfied by the international centers, CGIAR or non-CGIAR. The majority (78 percent) will be trained by local institutions, primarily the colleges and universities that are members of the NARS.

3.4 Research results

Aside from genetic materials, research results are available to the NARS in the form of published or unpublished manuscripts. Some of the IARC findings have been the basis for applied research that is designed to solve Philippine problems. Some results that have made substantial impact on the activities of the NARS are discussed in this section.

3.4.1 Breeding methods

These are techniques for handling breeding materials that are designed to hasten the rate of genetic improvement. Some examples are:

(1) Techniques for rapid evaluation of (a) breeding materials; (b) disease resistance in sorghum designed at ICRISAT; (c) laboratory culture and multiplication of corn borer designed by CIMMYT; and (d) high lysine in corn designed by CIMMYT;

(2) Population breeding in corn. Population improvement techniques in corn have been widely used and tried in several universities and private companies in the U.S. They have also been widely applied to maize at CIMMYT and to some extent to sorghum at ICRISAT. Because of the close contact of the IARCs to breeding programs in the Philippines, techniques used at the IARCs are also used in the Philippines, and the materials developed by the IARCs are often used as the starting point of materials used by the NARS.

(3) Techniques for simplifying cross-pollination in rice. After experimenting with many techniques for simplifying emasculation in rice, IRRI and Filipino rice breeders are primarily using the spikelet-clipping technique. With this technique a person can easily make 50 crosses in one day. Although IRRI is not the originator of this technique, it has perfected it and demonstrated it to so many local breeders that it is currently the standard emasculation method used in the Philippines.

3.4.2 Farm trials

The use of actual farms instead of research stations for conducting experiments is not new. The centers, most notably IRRI, CIMMYT and CIP, however, have added a new dimension to these trials -- participation of the farmer. These trials are primarily designed to evaluate the performance of new

Table 3.2 Training Needs of the Philippine NARS and the Institutions That Could Provide the Training

Area of Training	Number to be Trained	Int'l Training Institution	
		IARC	Non-IARC
Crops	110	IRRI, CIMMYT IITA, ICRISAT CIP, ICARDA, CIAT	AVRDC, INTSOY BIOTROP, SEARCA AIT, PHRTC
Livestock and Poultry	39	ILCA, CIAT, ICARDA, ILRAD	-
Farming Systems/Soil	21	ICARDA, IRRI ICRISAT, IITA, ILCA	AIT
Fisheries	49	-	SEAFDEC, ICA BIOTROP
Forestry	60	ICARDA, ILOA	BIOTROP
Socioeconomic	51	IRRI	AVRDC, SEARCA, AIT
General	47	IRRI	SEARCA, SEAFDEC

Source: PCARRD (1983).

technologies in actual farm environments. The Philippines has, since 1982, established a network of on-farm trials designed to test in farmers' fields the superiority of newly developed technologies before they are given widespread dissemination.

3.4.3 Other information

Much of the basic research conducted by the IARCs has served as a basis for applied research conducted by the NARS. Some examples are the behavior of submerged paddy soils, the inheritance of resistance to pests and diseases, nitrogen losses, and biological sources of nitrogen and phosphorus.

3.5 Important issues

3.5.1 Effectiveness of the IARC model

If the improvement of the NARS is taken as the measure of the IARCs' success, how cost-effective is the IARC model? Could the same amount of money used by the IARCs have produced more effect if it had been channeled directly to the NARS or through other types of intermediary donor agencies? Many researchers and research administrators expressed the opinion that while the IARCs have made substantial progress in solving the problems of their mandated research areas, their impact on the NARS is far too small relative to the resources used. Some of the bases for this judgment are:

(1) Improving the NARS is not the primary mandate of the IARCs, but is only incidental to solving food production bottlenecks. Some research administrators feel that the benefits they get from the IARCs come more as a by-product than by design.

(2) The IARC model is not efficient in solving location-specific problems. IARC research is designed to address problems commonly faced by a large area or a large number of countries. The NARS, however, deals with more location-

specific problems. In the early years of an IARC, when its establishment is justified by a well-defined problem, its mandate and the local problems being addressed by the NARS are usually similar. Consequently, much benefit is then derived by the NARS from the IARC activities.

(3) As the initial problem gets solved, however, secondary problems take its place. These secondary problems are usually many and vary over geographical areas. Consequently, different NARS have different problems, and the IARC finds it difficult to address many problems simultaneously. In this situation, the IARC is not an efficient model and the benefits derived from it by the NARS are not substantial. Many research administrators and some researchers allude to the fact that IRRI, after developing the short stiff-strawed rice varieties, may have reached the secondary problem stage. Consequently, IRRI's impact on the NARS in the coming years cannot be expected to be as substantial.

3.5.2 Mechanics of channeling service to the NARS

In the Philippines, research activities of the NARS are coordinated, monitored and recorded by PCARRD. PCARRD strongly advises international research institutions, including the IARCs, to use existing mechanisms (in this case PCARRD's coordinating mandate) in determining the best place for its funds and services. PCARRD observes that several international donors go directly to the member institutions of the NARS or even to individual researchers without informing PCARRD. Such activities are alleged to have caused duplication of effort and at times some confusion in the NARS.

On the other hand, some researchers and research administrators in the NARS consider direct negotiations with the IARCs as beneficial. They feel that such direct contact avoids delay and bureaucracy that can stifle initiative in institutions and individuals.

Despite these differences in opinion, it seems logical that any IARC working in the Philippines should consult with PCARRD. Such consultation could prevent duplication of effort or avoid the execution of activities that run against the current attitudes and policies of the NARS.

3.5.3 Complementarity and competitition of research activities

With the similarity of objectives between NARS and IARCs, it is inevitable that a substantial degree of overlap in research activity should occur. How can this overlap be managed to minimize friction and maximize complementarity? Several mechanisms have been tried at Los Baños, the campus where both IRRI and the UPLB are located. Some of these are:

(1) Phase out by the NARS of research activities that clearly duplicate those of the IARCs. With IRRI's strong lowland rice varietal improvement program, UPLB felt that it was not necessary to duplicate the research being done right in the same experiment station. It was deemed more advantageous to allocate resources to other research activities. There were strong objections against this decision then and even stronger objections now. The objectors argue that by weakening the national program on rice breeding, the country has become too dependent on IRRI, an institution whose actions are not within the NARS control.

(2) Allocation of research responsibilities. At about the time the UPLB phased out its lowland rice breeding programs, it was also decided to further intensify research on upland rice. UPLB and IRRI actually agreed to divide the rice research activity into lowland rice and upland rice with each institution taking one as its main focus. This

arrangement has in fact held rather well until recently when IRRI decided to put substantially more emphasis on upland rice as well.

(3) Periodic consultation. IRRI and the MAF have recently implemented a semi-annual technology transfer workshop where IRRI presents its most promising research findings to the MAF. In return, MAF informs IRRI of urgent field problems that could be addressed by IRRI research. These consultations have greatly improved the transfer of technology from IRRI to the NARS and at the same time minimized the potential for miscommunication between the two parties.

Of the three arrangments described above, the third seems to be most satisfactory, while serious doubts have been expressed about the first two. The main apprehension about the first two arrangements is that they do not enhance the strength of (and may even weaken) the NARS in research areas where the IARC is competent. Furthermore, it reduces the potential for cooperation and complementarity between NARS and the IARC, the mechanism through which the IARC delivers some of its services to the NARS.

3.5.4 Personal relationships

Ideally, the relationship between the NARS and the IARC's research staff should be cordial and conducive to cooperative activities. For the Philippines, such a relationship has been elusive. There are several reasons for this. First, the IARC staff have much higher salaries than the NARS staff, a situation that has encouraged feelings of jealousy and sometimes inferiority on the part of the NARS personnel, and a corresponding tendency to feel superior and patronizing on the part of the IARC staff. Second, researchers are by nature individualistic and secretive, and voluntary consultation does not come easily. For IRRI and the NARS, time has been a great mediator and there are an increasing number of cooperative activities. Clearly, the challenge is how to foster such cooperative activities in a much shorter period.

3.5.5 Essentiality of the IARCs

To the question of the IARCs' usefulness, Filipino scientists have no hesitation in giving an affirmative answer. To the question of whether these contributions can only come from the IARCs, the answer is clearly in the negative. Pressed even further as to whether the development of the NARS would have been just as fast without the IARCs, there was no categorical answer. My general assessment is that the IARCs have facilitated and even hastened the development of the NARS, although the same development would have come anyway even if delayed somewhat.

4 Research Impact on Agricultural Production

4.1 Important innovations

An innovation is considered important if it has been adopted by a large number of farmers and has, therefore, made a significant contribution to productivity. We classify these innovations into three groups: (1) improved genotypes, (2) improved management, and (3) increased land-use intensity.

4.1.1 Improved genotypes

The use of improved varieties has been and continues to be one of the most important innovations for increasing farm yield in the Philippines. Rice is the leader in this category.

The traditional varieties were tall and easily lodged, or fell flat on the wet ground soon after flowering, because the long stems were too weak to support the rapidly developing grain. Thus, lodging effectively limited the yield of the traditional varieties, since it becomes more severe as more grain is formed. The newly developed varieties corrected this defect. With short and stiff straws, the yield ceiling due to lodging is effectively removed and higher levels of management, such as fertilization and pest control, can be applied to increase the yield substantially.

Although IR 8, the first short and stiff-strawed variety released by IRRI, is not widely grown in the Philippines, its plant type has been the trademark of all modern varieties. A list of the presently recommended varieties is shown in Appendix B. The origin of these varieties is indicated by their pedigree (names) with IR, UP and BPI indicating IRRI, UPLB and BPI, respectively.

Varietal improvements in corn have not been as successful as in rice. Varieties and hybrids produced by UPLB in the 1960s and

1970s have had only sporadic adoption. Farmer feedback indicates that these varieties are more susceptible to pest attack, most notably downy mildew and corn borer; have inferior milling recovery (corn for food is milled before cooking); and have longer maturity relative to the traditional varieties. Lately, however, several private multinational seed companies have introduced new hybrids that produce substantially higher yields than the existing varieties. Farmers' adoption, although still small, has been increasing rapidly.

Mungbean, the most important grain legume in the country, has also benefited from improved varieties. Pagasa 1 and Pagasa 2 are UPLB-bred varieties that have gained acceptance in farmers' fields.

4.1.2 Improved management

Increased fertilizer application and improved pest management are companion technologies to the new varieties which are more responsive to better management. The Ministry of Agriculture has vigorously promoted fertilizer use by subsidizing its cost and providing farmers, through liberal credit, with the resources to pay for the additional inputs. In rice, the adoption of improved management followed closely that of the adoption of improved varieties. In corn, the gains are more modest. Adoption of new varieties which respond better to additional fertilizer is slow, and the corresponding increase in fertilizer use is not as dramatic as in rice.

A similar trend has been shown for chemical pest control. As the crop becomes productive, farmers are more prone to protect it from damage. However, with the increasing cost of chemicals, and the development of more pest-tolerant varieties, further increase in the use of chemical pest control is not expected. In fact, recent findings show that pre-scheduled applications of chemical spray both for rice and corn is not profitable anymore and farmers are now advised to spray only when pest infestation is prevalent enough to cause substantial crop damage.

4.1.3 Intensification of land use

Since the most suitable land in the country is already under cultivation, government programs have recently emphasized the intensification of land use. Primary emphasis is given to: (a) the planting of an additional crop in the rice paddy, (b) intercropping in corn, and (c) intercropping in coconut.

Additional crop in the rice paddy

There are several new innovations that allow for an additional crop:

(1) development of short-maturing rice varieties that can be harvested in less than 90 days after transplanting;

(2) direct seeding, which allows the planting of rice soon after the first monsoon rain instead of the usual method of transplanting in puddled soils that require 30 to 60 days of rain; and

(3) development of varieties of annual crops that grow well in the rice paddy, thus allowing these crops to be planted after rice, even during the dry months of the year.

With these innovations many rainfed rice areas are now growing two crops per year (Table 4.1). The most common cropping patterns are rice followed by another rice and rice followed by mungbean. In fact, a World Bank-funded program in Iloilo has relied heavily on this technology for improving farm yields in the rainfed rice areas of the province.

Intercropping with corn

Mungbean, peanut and soybean have been shown both at IRRI and at the NARS to intercrop well with corn. These intercropping practices have been observed even in the early 60s primarily in the northern Philippines. With increasing population, however, there has been an increased rate of adoption of this practice. In Mindanao, where corn is grown extensively, soybean is a common intercrop. The Philippines is actively encouraging corn farmers to intercrop with soybeans or other grain legumes.

Intercropping in coconut

Research findings have shown that coconut yield increased significantly with cultivation in between rows. Furthermore, several crop species, such as cacao, coffee, lanzones, pineapple, banana and some grain crops can be grown profitably under coconut, especially during the early and late growth stages when vegetative cover is not so dense (Gomez and Gomez, 1983). In the 70s and 80s there has been a continuous increase of coconut land planted to intercrops. Corn and grain legumes are common crops during the seedling stages, while the perennial fruits such as banana, coffee, cacao and lanzone are commonly grown under mature trees. It is estimated that 20 to 30 percent of the coconut areas are intercropped.

4.2 Adoption of innovation

Agricultural production programs in the Philippines are traditionally commodity-based. That is, each program focuses on one crop or animal at a time and government services such as extension, credit and market assistance are organizaed into specific commodities. In the 70s, rice and corn were the primary beneficiaries of these agricultural programs. Masagana 99, the rice program, is by far the best funded and the most successful. The technical component of this production program consists of high-yielding varieties coupled with higher levels of fertilizer and chemical pest control. The rate of adoption of improved varieties (Table 4.2) was very rapid, reaching a high level of 84 percent last year. The adoption rate is highest in irrigated areas and lowest in upland rice. Furthermore, increased application of fertilizer and insecticides closely followed the increase in areas grown to high-yielding varieties. There is no

Table 4.1 Contribution of Area and Yield Increasing Factors to Rice Production Growth in the Philippines

	1955-65[1]	1965-80[2]
Area	68	19
Yield	32	81
MV		26
Fertilizer		31
Irrigation		24

Source:

[1] World Rice Statistics, IRRI (1982).

[2] Herdt, R. W. and C. Capale (1983), Adaption, Spread and Production - Impact of Modern Rice Varieties in Asia, IRRI.

Table 4.2 Percent Area Planted to Modern Rice Varieties, Philippines, 1965 to 1982

Crop Year	Percent Area Planted to MV			
		Lowland		
	Total	Irrigated	Rainfed	Upland
1965	0	0	0	0
1970	51	61	39	na
1975	65	81	64	na
1980	78	88	78	14
1982	85	93	82	18

Source: Bureau of Agricultural Economics.

Note: Upland area planted to MV are reported only in recent years.

doubt that the new technology in rice has been adopted by a large number of farmers and has been a major contributor to the increasing productivity of rice.

With respect to corn, government investment in new technicians and additional credit is more modest. New varieties developed were mainly open-pollinated, although recently F_1 hybrids have been added. In contrast to rice, adoption of new varieties has never exceeded 15 percent of harvest area. Consequently, the impact of the new technology is much less than that in rice, and improvement in corn productivity is substantially lower.

4.3 Production effects

Shown in Table 4.3 are the harvest area and yields of rice, corn, coconut and sugarcane from the period 1960-82. Although production of all crops increased substantially from 1960 to 1982, much of the increase was due to area expansion for corn, coconut and sugarcane. Only in rice was increase in yield per unit area a major contributor to increased production. Furthermore, irrigated rice had the largest improvement (1.03 t/ha) while corn had the lowest (0.18 t/ha) (Table 4.4). Note further that the improvement in rainfed rice is much lower than that for irrigated rice, giving substance to the fact that much of the new rice technologies in the 70s were developed for irrigated rice culture.

It should be clear, however, that technology is not the only factor that has resulted in rice yield. Other important factors are (1) the increasing areas with irrigation; (2) input-output price structure; and (3) weather. Apparently, the first two factors were fairly favorabe for the rice farmers up to 1982. The financial crunch, however, resulted in substantial reduction in investments in irrigation and a rapid increase in the input cost. Together with a severe drought, both rice hectares and

Table 4.3 Area (in thousand hectares) and Production (in thousand metric tons) for Rice, Corn, Coconut and Sugarcane, 1960-1982

Year	Rice		Corn		Coconut		Sugarcane	
	Area	Production	Area	Production	Area	Production	Area	Production
1960	3,306.5	3,739.5	1,845.5	1,165.3	1,059.4	1,117.3	204.3	1,439.4
1961	3,197.7	3,704.8	2,045.5	1,209.6	1,199.9	1,130.3	208.7	1,353.6
1962	3,179.1	3,910.1	2,016.3	1,266.3	1,283.7	1,418.9	235.2	1,505.8
1963	3,161.3	3,967.0	1,949.5	1,272.8	1,292.3	1,555.7	238.0	1,590.3
1964	3,087.4	3,842.9	1,897.6	1,292.7	1,482.9	1,550.0	248.3	1,689.9
1965	3,199.7	3,992.4	1,922.7	1,311.1	1,604.7	1,535.4	327.7	1,621.0
1966	3,109.2	4,072.6	2,106.1	1,379.8	1,610.9	1,561.3	292.7	1,460.1
1967	3,096.1	4,164.8	2,157.9	1,435.0	1,840.2	1,206.6	286.3	1,621.7
1968	3,303.7	4,560.6	2,247.8	1,618.5	1,800.4	1,592.8	296.6	1,658.4
1969	3,332.1	4,444.7	2,256.0	1,732.7	1,845.4	1,562.2	320.7	1,592.7
1970	3,112.4	4,963.4	2,419.6	2,008.2	1,883.9	1,726.2	344.0	2,118.8
1971	3,112.6	5,342.9	2,392.2	2,005.0	2,048.5	1,678.0	422.6	1,910.1
1972	3,246.4	5,100.1	2,431.7	2,012.6	2,125.5	1,813.4	426.0	1,870.3
1973	3,111.8	4,414.6	2,325.4	1,831.1	2,133.3	1,708.3	--	--
1974	3,436.8	5,594.1	2,763.0	2,288.7	2,206.0	1,964.6	490.7	3,449.7
1975	3,538.8	5,660.0	3,062.4	2,568.4	2,279.5	2,723.1	563.1	3,287.6
1976	3,579.3	6,159.5	3,257.0	2,766.8	2,521.2	3,557.0	572.6	4,070.7
1977	3,547.5	6,456.1	3,320.6	3,843.4	2,728.2	3,844.9	573.1	3,541.1
1978	3,508.9	6,894.9	3,222.9	2,855.2	2,889.8	4,194.8	521.6	3,282.1
1979	3,468.9	7,197.6	3,326.9	3,167.4	2,994.6	4,295.4	451.2	3,198.9
1980	3,636.8	7,835.8	3,101.1	3,122.8	3,125.9	4,570.2	424.6	3,120.8
1981	3,459.1	7,722.7	3,238.7	3,109.7	3,105.3	4,312.1	421.1	3,193.0
1982	3,432.8	8,107.9	3,360.7	3,290.2	3,162.3	3,785.5	470.8	3,402.7

Source: Philippine Bureau of Agricultural Economics.

Table 4.4 Grain Yield (t/ha) for Irrigated Rice, Rainfed Rice and Corn for Crop Years 1969-79

Year	Irrigated Rice	Rainfed Rice	Corn
1969	1.72	1.10	0.77
1970	2.05	1.51	0.83
1971	1.99	1.59	0.84
1972	1.96	1.40	0.83
1973	1.89	1.20	0.79
1974	2.02	1.43	0.83
1975	2.15	1.34	0.84
1976	2.25	1.44	0.85
1977	2.34	1.53	0.86
1978	2.60	1.58	0.89
1979	2.75	1.71	0.95

Source: Bureau of Agricultural Economics.

average yield were significantly reduced in 1983. Although average yield improved again in 1984, harvest area remained low.

4.4 Gender issue

Very little empirical data is available on the effect of the new innovations on the distribution of benefits to males and females. Several papers have alluded to the gender bias of improved technology, citing evidence that the new technology requires more working hours for females. More work, however, is not bad if proper reward is received. For the Filipino household, it is not clear how the benefits from increased production are divided between males and females. Whether much of this new income is turned over to the housewife, as before, or is retained by the husband, is not clear. It seems likely that innovations have not greatly changed the social and cultural practices of the farm household and that, as before, much of the farm income is treated as family property, mainly used to satisfy the basic needs of the family rather than being divided separately to the male and female members.

4.5 Effects on income distribution

A major criticism of the newly developed production technologies is that they greatly favor well-to-do farmers. The main bases of this criticism are:

(1) The new technologies, based mainly on the use of modern varieties that respond better to higher fertilizer applications, require large investments that are not affordable to most small farmers. Thus, the earliest adaptors of the rice technology were mainly farmers with larger farms that have more resources to spare.

(2) The new technologies, developed under ideal conditions of the research stations, were best suited to farms with the

most favorable environment, i.e., good irrigation, and flat areas with good soils. Since these farms usually belong to the richer farmers, the technology has a substantial bias in favor of the well-to-farmers.

(3) Production programs of government, both in rice and in corn, have given high priority to areas with favorable environments, since these areas are perceived to have the highest chance of success. In rice, for example, irrigated areas have received the bulk of investment in credit, fertilizer and technical support.

Economists at IRRI, however, argue that the new technology offers substantial opportunities for increasing the income of the poorest sector of the rural communities. It is argued, for example, that the new rice technology is labor intensive and has provided increased employment and benefits to the landless rural workers, the poorest sector of the rural community.

The question as to whether the richer farmers have benefited more from the new technology relative to their less endowed colleagues is a very difficult issue to resolve. It seems clear, however, that the rural community as a group, both landowners and landless labor, have derived substantial benefits from the new technology. Their share of the benefits has increased substantially relative to the urban sector, thus reducing the large gap between urban and rural incomes.

4.6 Promising innovations

As in section 4.1, we group innovations into three categories: (1) varietal improvements, (2) intensification of land use, and (3) culture and management.

4.6.1 Varietal improvements

Varieties that are shorter in maturity, more resistant to pests and more tolerant to soil deficiency are expected to be developed in the future. Shorter-maturing varieties enhance higher land use intensity. In rice, for example, varieties that mature in less than 90 days will encourage the planting of two crops of rice per year even in areas without irrigation. Thus land use intensity could very well increase from 1.4 to 1.8. The Philippines is looking at this innovation as the primary source of additional rice production in the short term. For corn, the estimated land use intensity is 1.3. If maturity can be shortened to 90 days, land use intensity could very well increase to 1.6.

Resistance to pests is a major consideration in accepting new varieties for commercial production. Up to 25 percent of annual production can be lost to pest damage. With the increasing cost of chemical pest control this damage rate may increase further. With resistant varieties, however, reduction in yield due to lower use of chemicals can be minimized.

Tolerance to adverse soil conditions has been a consistent feature of both IARC and NARS breeding programs. Promising results with respect to salinity and low pH have been obtained. It is expected that these new varieties, if approved for commercial production, would effectively add up to 50,000 ha to the cultivated area.

4.6.2 Intensification of land use

Promising innovations that could be adopted in the Philippines are:

(1) Use of 30 to 45 day old seedlings in order to further shorten the length of time that rice occupies the land. With this innovation, rice can be harvested within 70 days of transplanting. Such a technology could increase land-use intensity from 1 to 2 in rainfed areas and from 2 to 3 in irrigated areas.

(2) Ratooning. Rice and sorghum are the annual grain crops that have good potential for ratooning. With this technology, plowing is eliminated and the turn-around time is effectively reduced to zero. With this innovation, it should be easy to grow three crops of rice or sorghum in one year.

(3) Rice garden. By staggered planting and harvesting of rice in small plots, it is possible to maximize land and labor use while at the same time increasing stability of production. Experiment station data shows that this innovation can increase yield from 10 to 18 tons per hectare per year.

4.6.3 Culture and management

Some of the promising innovations are: zero tillage, deep placement of nitrogen, hedge-row planting and organic fertilization.

(1) Zero tillage. If weeds can be adequately controlled, yield from crops grown without tillage is just as high as under normal culture. With zero tillage up to 1/4 of the cost of production can be saved and turn-around time can be reduced by 10 to 15 days.

(2) Deep placement of nitrogen. Nitrogen is the most easily lost fertilizer. With improper application, actual utilization by crops can be as low as 25 percent. In the rice paddy, it has been shown that by burying nitrogen fertilizer deep into the mud (i.e., 4-5 cm below ground level) losses of nitrogen fertilizer can be reduced to around 30 percent. With the current high price of fertilizer, the extra effort for deep placement may be economically justified and widely adopted by farmers in the near future.

(3) Hedgerow planting. The use of hedgerows across slopes has been shown to greatly reduce soil erosion in sloping areas. Perennial legumes such as Leucaena are effective in the Philippines. With this innovation, a large portion of sloping areas can be cultivated without fear of losing the soil through erosion. It is expected that this innovation will be useful in converting sloping areas to annual crops initially and, finally, into fruits and other perennial trees.

(4) Organic fertilization. In the tropics, where vegetation is very lush, substantial amounts of nutrients can be returned to the soil through organic fertilization. Techniques for economically converting farm waste and by-products to fertilizers are a focus of much ongoing research. It is expected that this effort will produce tangible results very soon, and that a substantial portion of the nutrient requirements of Philippine farms will come from organic fertilization.

(5) Fixation of nutrients from the atmosphere. The nitrogen-fixing bacteria, Myorhisa and other organisms that can fix nutrients from the atmosphere are the focus of intensive research in the Philippines. Current findings indicate the existence of indigenous strains that exhibit a higher rate of fixation. If perfected, this innovation can very well provide Filipino farmers with the cheapest source of fertilizer.

4.7 The contribution of the IARCs

The IARCs have contributed to agricultural productivity either directly, through the development of production techniques that can be applied to the Philippine situation, or indirectly, through the discovery of materials and information that are used as a basis for developing new technologies adapted to the country. IRRI, which is located in the Philippines and conducts many experiments inside the country, has naturally been the leader in developing technologies that are directly applicable to Philippine agriculture. Many of the recommended rice varieties are direct products of the IRRI program. The accompanying management techniques, such as fertilizer level, time of planting and pest management have in many cases been lifted directly from IRRI research results.

Other contributions have been more of the indirect type. CIMMYT, CIP, ICRISAT and CIAT, are all introducing genotypes of their mandated crops to the Philippines. These introductions are further tested and bred for adaptability to local conditions. The same is true for new management practices. Consequently, there is a longer time lag between introduction and farmer adoption. In addition, the identity and uniqueness of the IARCs' contribution is not as clear as that for the case of IRRI. Nevertheless, the genotypes from the IARCs are a consistent component of local improvement programs, and the general expectation is that these genotypes will contribute substantially to the development of better production technologies.

5 Conclusions

5.1 The Philippine research and extension system

The Philippines has a fairly well-organized research and extension system with trained and experienced staff. The NARS has more than 3,000 researchers, 19 percent of which have MS and 8 percent of which have PhD degrees. Research in all institutions is cleared and monitored by a central coordinating council which also summarizes and documents research results.

Although the extension staff has fewer advanced degree holders, it has a series of successful experiences in production programs. There is enough extension personnel to cover each of the 34,000 rural communities in the country. Thus for any new technology developed by the IARCs, the Philippine research and extension system has the capacity to rapidly test and disseminate it.

5.2 The Philippine agricultural sector

Philippine agriculture has steadily grown in the last two decades despite minimum help and subsidy from the government. Rice, the major staple, has been the star performer. Since 1972, production has grown annually by 4.5 percent, outstripping population growth by more than 1.5 percentage points. By the late 1970s, the Philippines had shifted from importing to exporting rice.

Corn, the next most important crop, occupying about the same area as rice, has been growing at a slower pace, with much of its growth fueled by the expansion of the cultivated area. With the development of new hybrids that have much higher yield potential, corn can be expected to be the star performer of the 1980s.

5.3 Impact of the IARCs on the Philippine NARS

Distribution of improved germplasm, training of research staff and dissemination of new research findings are the three services of the IARCs that are perceived to be the most useful to the NARS. Elite germplasm produced by the IARCs has greatly increased the genetic diversity of breeding materials in the NARS and has contributed substantially to the progress in varietal improvement. New rice varieties developed at IRRI have been directly recommended by the NARS for commercial production. Varieties in corn, sorghum and potatoes developed by CIMMYT, ICRISAT and CIP, respectively, have been tested extensively with very promising potential for progress.

Training of NARS staff by the IARCs has been greatly appreciated because of the relevance of the program and the expertise of the training staff.

Research findings that have been applied by the NARS in solving location-specific problems are: (1) properties of submerged paddy soils, (2) research methods for on-farm trials, (3) crop interaction in intensive cropping, and (4) breeding methods.

While there is no question of the usefulness of the IARCs to the NARS, similar services are also available from other institutions. It is not clear, therefore, if similar progress in the NARS could have been obtained if the IARCs did not exist. Furthermore, the Philippine NARS has expressed doubt as to whether the IARC model is cost-effective with respect to accelerating the development of the NARS.

5.4 Impact on agricultural productivity

IRRI clearly dominates the contribution of the IARCs to increased agricultural production in the Philippines. Rice, the most important food crop, is the recipient of a massive production program that is based mainly on technologies developed at IRRI. The impact of other IARCs on agricultural production is more difficult to trace. Many of the innovations developed by these centers have to go through the NARS before actual adoption by farmers. Consequently, the identity of the IARC technology is not clear, and in may instances the innovations may be claimed by the NARS.

5.5 Impact of individual IARCs

IARCs with commodity mandates were the most useful in improving the NARS and agricultural productivity in the Philippines. IRRI, with its headquarters in the country, clearly dominates all other centers. CIMMYT, CIP, CIAT, ICRISAT and IBPGR (in that order) were the only other centers mentioned to have been useful to the Philippine programs.

5.6 Effectiveness of the IARC model

Perception of the future usefulness of the commodity-mandated centers to agricultural research and development in the Philippines is not so optimistic. The prevailing assessment of IRRI, for example, is: (1) that IRRI has been immensely successful in increasing rice production, (2) that IRRI will continue to contribute to agricultural development, but its future impact is expected to be much less, and (3) that IRRI has had a more modest impact on the NARS, and as the NARS matures, the future impact will become even less. The commodity-mandated centers, and IRRI in particular, are seen to be most effective in solving well-defined problems that are common to a large number of countries. As these major problems are solved, many small problems take their place. These secondary problems, which are more diverse and much more location-specific, are not easily solved by IARC research. At this stage, the IARC model becomes less effective and other models may have to take its place. Perhaps the mandate of the IARCs can be modified from one of directly conducting research to one of determining research priorities and channeling financial support to the NARS for implementing high-priority research activities.

Appendix A

The Member Institutions of the Research Network in the Philippines

A. National Research Centers

Multi-Commodity

1. Central Luzon State University (CLSU), Muñoz, Nueva Ecija.
2. University of the Philippines at Los Baños (UPLB) College, Laguna.
3. Visayas State College of Agriculture (VISCA) Baybay, Leyte.
4. University of Southern Mindanao (USM) Kabacan, North Cotabato.

Single-Commodity

1. Forest Research Institute (FORI) College, Laguna.
2. Forest Production Research and Industry Development Commission (FORPRIDECOM) College, Laguna.
3. Philippine Sugar Commission (PHILSUCOM), La Granja, La Carlota City.
4. Philippine Coconut Authority (PCA), Bago Oshiro, Davao City.
5. Philippine Tobacco Research and Training Center (PTRTC), MMSU, Batac, Ilocos Norte.
6. Cotton Research and Development Institute (CRDI), MMSU, Batac, Ilocos Norte.
7. University of the Philippines in the Visayas (UPV) College of Fisheries, Miag-ao and Legaois Iloilo.

B. Regional Research Centers

1. Mariano Marcos State University (MMSU), Batac, Ilocos Norte.
2. Isabela State University (ISU) Cabagan and Echague Campuses, Isabela.
3. Mountain State Agricultural College (MSAC) La Trinidad, Benguet.
4. Palawan National Agricultural College (PNAC), Aborlau, Palawan.
5. Camarines Sur Agricultural College (CSAC), Pili, Camarines Sur.
6. La Granja Experiment Station, Bureau of Plant Industry (BPI), La Granja, La Carlota City.

C. Cooperating Field Stations

130 CFS have been identified.

As of July 1980 there were 10 Research Consortia (Centers). PCARRD is a member agency to all of them.

1. Bicol Agricultural and Resources Research Consortium (BARRC)
   Lead agency: CSAC, 9 members.

2. Central Luzon Agricultural Research Center (CLARC)
   Lead Agency: CLSU, 5 member agencies.

3. Cagayan Valley Integrated Agricultural Research System (CVIARS)
   Lead agency: ISU, 5 member agencies.

4. Highland Agricultural Center (HARC)
   Lead Agency: MSAC, 2 member agencies.

5. Ilocos Agricultural Research Center (ILARC)
   Lead agency: MMSU, 4 member agencies.

6. La Granja Agricultural Research Center (LGARC)
   Lead Agency: BPI, 4 member agencies.

7. Northern and Central Mindanao Coordinated Agriculture Research and Resources Program (NOCEMCARRP)
   Lead Agency: CMU, 2 member agencies.

8. Palawan Agricultural Research Center (PARC)
   Lead agency: PNAC, 2 member agencies.

9. Southern Mindanao Agricultural Research Center (SMARC)
   Lead agency: USM, 2 member agencies.

10. Visayas Coordinated Agricultural Research Program (VICARP)
    Lead agency: VISCA, 5 member agencies.

Appendix B

Rice Varieties Recommended by the Philippine Seed Board

Variety	Pedigree	Year Approved
	Irrigated Lowland	
IR 22	IR 579-160-2	1970
IR 26	IR 1541-102-7-491	1973
BPI-3-2	BPI 3-2	1973
PARC 2-2	PARC 2-2	1973
IR 28	IR 2061-714-3-8-2	1975
IR 29	IR 2061-464-4-14-1	1975
IR 30	IR 2153-159-1-4	1975
IR 32	IR 2070-747-6-3-2	1975
BPI Ri 2	BPI Ri-2	1975
IR 34	IR 261-213-2-17	1976
IR 36	IR 2071-625-1-1-252	1976
IR 38	IR 2070-423-5-6	1976
RPKN-2	K_n-16-361-1-8-6	1976
IR 40	IR 2070-414-3-9	1977
IR 42	IR 2031-585-5-63	1977
UPLRi-1	C 229-1	1977
BPIRi-4	MRC 603-303	1978
IR 44	IR 2863-38-1-2	1978
IR 48	IR 4570-83-3-3-2	1979
BPI Ri-1	MRC 1502-751	1979
IR 50	IR 9224-117-3-3-2	1980
IR 54	IR 5853-162-1-2-3	1980
BPIRi-3	MRC 1240	1981
IR 56	IR 1329-109-2-2-1	1982
UPLRi-4	C 1000-4	1982
BPIRi-10	MRC 2350-2327	1983

(continued)

Appendix B continued

Variety	Pedigree	Year Approved
IR 58	IR 9752-71-3-2	1983
IR 60	IR 13429-299-2-1-3-1	1983
	Rainfed	
C 168	C 168-134	1973
IR 46	IR 2058-78-1-3-2-3	1978
UPLRi-2	C 166-133	1978
IR 52	IR 5853-118-5	1980
	Upland	
C 22	C 22-51	1972
IR 43	IR 1529-430-2	1978
IR 45	IR 2035-242-1	1978
UPLRi-3	C 424-2	1979
BPI Ri-6	MRC 438	1979
UPL Ri-5	C 171-136	1980
UPL Ri-7	C 1060-5	1981

Appendix C

Persons Interviewed and Places Visited

UPLB, Laguna

1. Dr. Basilio B. Mabbayad, Chairman, Department of Agronomy, College of Agriculture.
2. Dr. Ricardo M. Lantican, Director of Research.
3. Dr. Roger Cuyno, Director of Extension.
4. Dr. Fernando C. Sanchez, Director, National Crop Protection Center.
5. Dr. Ruben L. Villareal, Director, Institute of Plant Breeding.
6. Dr. Narciso Deomampo, Chairman, Department of Agricultural Economics, College of Development Economics and Management.
7. Dr. Nicanor Fernandez, Associate Dean, College of Agriculture.
8. Dr. Manual Lantin, Program Leader, Corn Breeding, Institute of Plant Breeding.
9. Dr. Pedro Sandoval, Dean, College of Development Economics and Management.
10. Dr. Obdulia Sison, Professor and former Director of Extension.
11. Dr. Danilo Baldos, Corn Breeder, Institute of Plant Breeding.
12. Dr. Eufemio T. Rasco, Vegetable and Potato Breeder, Institute of Plant Breeding, Chairman, Horticulture Department, College of Agriculture.
13. Dr. Edwin Javier, Rice Breeder, College of Agriculture.
14. Mr. Rodel Revilleza, Research Assistant, Sorghum Breeding Section, Institute of Plant Breeding.
15. Mr. Armando Aquino, Researcher, Corn Breeding Section, Institute of Plant Breeding.
16. Dr. Azucena L. Carpena, Rootcrops Breeder, Institute of Plant Breeding.
17. Dr. Santiago Tilo, Professor, College of Agriculture.

18. Dr. Henry P. Samonte, Professor, College of Agriculture.
19. Dr. Beatriz Mercado, Professor, College of Agriculture.
20. Dr. Diosdado Carandang, Professor, College of Agriculture.
21. Dr. Belen Rejesus, Professor, College of Agriculture.
22. Dr. Delfin Lapiz, Professor, College of Agriculture.

PCARRD

1. Dr. Amado Maglinao, Director, Farming Systems Division.
2. Dr. Ramon Valmayor, Director General.
3. Dr. Dely Gapasin, Director, Crops Division.
4. Dr. Aida Librero, Director, Socioeconomics Division.
5. Dr. Thelma S. Cruz, Director, Communication Division.

Metro Manila

1. Mr. Antonio Mercado, Jr., Corn Breeder, Pioneer Seed Company, Makati.
2. Mr. Jesus Alix, Director, Bureau of Agricultural Economics.
3. Mr. Emiliano Gianzon, Director of Research, Bureau of Plant Industry, Manila.
4. Mr. Manuel Lim, Consultant and former Deputy Minister, MAF.
5. Dr. Edgardo C. Quisumbing, Director, Agricultural Research Office, MAF.
6. Mr. Domingo F. Panganiban, Deputy Minister, MAF.
7. Dr. Orlando Sacay, Deputy Minister, MAF.
8. Mr. Jose Martinez, Legume and Vegetable Section, Field Trial Services, BPI.
9. Mr. Maximo Aglibut, Chief, Cereal Section, Field Trial Services, BPI.
10. Dr. Alfredo Palo, BPI.
11. Mr. Damaso Callo, Jr., Rice Testing Program, NFAC.
12. Mr. Ronduen, BPI.
13. Mr. Seferino Banguid, Chief Root Crop Division, BPI.

14. Mr. Segundo Serrano, Director, Bureau of Agricultural Extension.

Muñoz, Nueva Ecija

1. Mr. Libertito Feliciano, Superintendent, Maligaya Rice Research and Training Center and RIARS Manager, Region III.

2. Mr. Rudy Gallardo, Core staff for crops, RIARS, Region III.

3. Mr. Aguinaldo Bueno, Rice Breeder and Agronomist, Maligaya Rice Research and Training Center (MRRTC), Region III.

4. Dr. Felomena Campos, Director of Research, Central Luzon State University (CLSU).

5. Dr. Fermina Rivera, Chief, Rural Studies Division, CLSU.

6. Dr. Josue Erabagon, Professor of Agronomy, CLSU.

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