AGRICULTURAL RESEARCH AND DEVELOPMENT

THE FINDINGS OF EIGHT IMPACT EVALUATIONS

A Background Paper
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CONTENTS

I. INTRODUCTION 1

Why Evaluate AID-Sponsored Agricultural Research? 1
Purpose of this Paper 1

II. AGRICULTURAL RESEARCH AND DEVELOPMENT 2

The Problem 2
AID's Experience in Agricultural Research 3

III. IMPACT EVALUATIONS OF PROJECTS IN AGRICULTURAL RESEARCH 5

Scope of the Impact Evaluation Series 5
Characteristics of the Projects Evaluated 6

IV. FINDINGS OF THE IMPACT EVALUATIONS 6

Policy and Macro-economic Environment 6
Host government committment to research 7
Macro-level constraints to the use of improved technology 7

Institution Building and Training 8
Affiliation of the research institution 8
Training agricultural researchers 9

Technology Generation and Transfer 9
Planning a research program 9
Adaptation of research to farmers' conditions 10
Dissemination of research results to the farmers 12

Impact on Farming Households 12
Agronomic impact 13
Socio-economic impacts 13

V. FOR FURTHER DISCUSSION 14

Policy and Macro-economic Constraints 15
Strengthening the Scientific Research Capacity of a Host Country 16
Adaptation of a Research Program to Actual Farming Conditions 16
A Word of Caution 17

LITERATURE CITED 19

Annex A. Impact Evaluation Team Members

Annex B. Agricultural Research Documents Published under the AID Impact Evaluation Series

Annex C. Executive Summaries of Impact Evaluation Reports

I. INTRODUCTION

A. Why Evaluate AID-Sponsored Agricultural Research?

Projects to assist the less developed countries in developing their agricultural research capabilities have often been designed according to the following reasoning:

(1) A country that increases its production of food crops achieves a more rapid economic development, its food producers enjoy a higher standard of living, and more and cheaper food is available to its consumers.

(2) Research scientists can find ways to increase food production if they are well trained and receive sufficient funds and adequate facilities.

(3) Therefore, if donor countries provide training and funding for agricultural research, the less developed countries will achieve faster economic growth and their farmers will be better off.

These assumptions may seem oversimplified, and they are rarely stated so bluntly. Yet these assumptions, and the premise that increasing food production is a technical problem that can be solved by agricultural science, have underlaid much of the considerable efforts to promote agricultural development in the less developed countries.

Are these assumptions valid? What are the mechanisms and constraints within each premise and between the premises and the conclusion? Are there constraints other than technical to increasing food production? If so, how can we best address them?

The U.S. Agency for International Development has assisted the development of agricultural research capabilities in the less developed countries for over 30 years, both through financial and technical assistance to national and international institutions, and through training programs. While much has been accomplished in training of Third World agriculturalists and creating or expanding research facilities, the agronomic, economic, and social impacts of these efforts have often been disappointing. Because AID has given priority to increasing food production in the less developed countries for the late 1980's and has reemphasized its interest in supporting agricultural research (AID Food and Agricultural Development Assistance, March 1982), it is important to assess the achievements and difficulties of past development efforts so as to plan and implement future activities most efficiently and to the best advantage of the food producers.

B. Purpose of this Paper

Since November 1979, the office of Evaluation, Studies Division, has been evaluating the impact of the AID's assistance in major development sectors, so that the lessons learned can be incorporated into the AID's policy, planning, and implementation activities.

Agricultural research was among the first sectors designated by senior AID officers for in-depth study. The purpose is to examine critically the impact of completed projects in agricultural research on the research institutions that received assistance and on the food producers of the host country. To achieve this purpose, the Studies Division has completed, or is in the process of completing, the following:

o The entire portfolio of AID's activities in agricultural research has been reviewed, and evaluation documents on a sample of 148 projects have been analyzed. This work is presented in Discussion Paper No. 13.

o Eight projects, in Kenya, Central America, Guatemala, Korea, Nepal, Thailand, West Africa, and Tunisia, were selected for an impact evaluation--an in-country assessment by a multidisciplinary team of the impact of a completed project on the people who were expected to benefit from it. The evaluations have been published as separate reports (see Annexes B and C). Each includes conclusions on the results of the project and specifies "lessons learned" for design and implementation of future projects with similar objectives.

o A workshop will be held near Washington, D.C. in June 1982 to discuss the impact evaluations and the review of AID's portfolio in agricultural research. Participants in the workshop will include AID officers, host country officials and agricultural specialists from other donor and research institutions and from the universities. The workshop participants are expected to research conclusions and make suggestions for incorporating the lessons learned into Agency programming, design and implementation activities, and for future policy in agricultural research.

o A final publication will synthesize the findings and conclusions of all the activities outlined above.

This paper is intended as a background document for use during the workshop. It summarizes the findings of the review of AID's portfolio in agricultural research and of the impact evaluations. It does not prejudge the conclusions and policy suggestions which will be reached by the workshop participants, but does call attention to issues which have been identified in the impact evaluations and in the review of AID's portfolio and which need analysis and discussion.

II. AGRICULTURAL RESEARCH AND DEVELOPMENT

A. The Problem

Fully one quarter of world population suffers from chronic undernutrition. Because the population is growing at a fast rate, it has been estimated that food production must now increase by at least 4 percent per year if consumption needs are to be met by 1990 (IFPRI, 1977 and 1979).

The twentieth century has seen tremendous breakthroughs in agriculture; indeed, the spectacular results of high-yielding wheat and rice have been hailed as miracles. The very real increases in food production and productivity in many less developed countries have been encouraging, yet Bachman and Paulino (1979:13) calculated that the overall rate of increase in food production in the less developed countries from 1961 to 1976 averaged only 2.6 percent per year. In more than half the countries, according to Bachman and Paulino, the increase in food production has not kept pace with population growth, so the situation is in fact worsening. This is especially true in Africa (Table 1).

Such disappointing results are not because of a lack of effort. This century has seen the organization of a systematic attempt to increase food production, first in the developed countries and then in the less developed countries. Despite the many achievements in agricultural research, especially in developed countries, the task of increasing food production in the less developed countries has been found to be much more complex than expected. Demographic, agro-ecological, economic, and political factors combine to make it so. More funds and more technical assistance do not necessarily solve the problem, even if it were feasible to increase the amounts involved.

The world's annual expenditure on agricultural research now stands at $5,000 million, about double what it was in 1975, in constant 1975 terms (World Bank 1981:16), and about $1,600 million of that amount is spent in the less developed countries. Oram and Bindlish (1981:18) computed the amounts and distribution of expenditures on agricultural research in 47 less-developed countries, together with the total number of agricultural scientists in each region (Table 2). They point out that total expenditures seem to have stagnated since 1978-79. The trend begun in the early 1970's may be changing, especially as most donor countries face internal economic difficulties.

Much effort has been directed toward institution building and training, and an effective network of international agricultural research centers has been established. In the context of increased need, a well-established research network and possibly limited financial resources, it behooves agricultural scientists and rural development specialists to learn from past experience so that future financial and human investments in agricultural research are as productive as possible.

B. AID's Experience in Agricultural Research

AID and its predecessor agencies have assisted agricultural research in less-developed countries for more than 30 years. During the 1950's the emphasis was on transfer of Western know-how, characterized by assistance to extension services and training institutions, especially universities. As evidence mounted that Western know-how was not always successful in the agro-economic context of most LDC's, the emphasis shifted, in the 1960's, from extension to assisting national and regional research

Table 1: Agriculture Production Indices per Capita (1969-71 = 100).

	1970	1975	1980
Africa	100	95	89
Latin America	100	103	108
Asia	101	105	107
Near East	98	104	101
World	100	103	104

Source: FAO Production Yearbook 1980.

Table 2: Change in Expenditures on Agricultural Research and Numbers of Agricultural Scientists, 1970-80: 47 Countries

Region[a/]	Expenditures ($ millions (constant 1975 terms))			Change (%)		Scientist Numbers			Change (%)	
	1971	1975	1980	1971/75	1975/80	1971	1975	1980	1971/75	1975/80
South Asia (5)	41.2	73.3	139.7	78	91	2,529	6,120	12,293	42	101
Southeast/East Asia (5)	28.0	46.7	101.0	67	116	2,285	4,400	5,830	95	31
N. Africa/Middle East (5)	21.9	21.9	35.1	-1	60	1,432	1,163	1,375	-21	18
West Africa (6)	41.8	86.5	112.5	107	30	915	3,239	1,897	154	-42
East/Southern Africa (5)	18.0	18.9	27.9	5	47	513	605	861	18	42
Central America/ Caribbean (11)	18.6	22.7	59.9	22	86	967	1,393	1,680	44	21
South America (10)	110.1	160.4	342.8	46	214	4,100	5,291	5,939	29	12
Total (47)	279.8	430.4	818.9	54	90	12,741	22,251	29,875	75	33

a/ Figures in parentheses denote the number of countries in each region.

Source: Oram and Bindlish, 1981.

institutions through training, technical assistance, and by providing these institutions with adequate facilities. During that period, the achievements of the Green Revolution demonstrated that agricultural research focused on commodity improvement (e.g. breeding rice varieties whose yields were highly responsive to nitrogen and water application) could indeed lead to production breakthroughs in the less developed countries.

Since the 1970's, U.S. assistance has focused on the small and near landless farmers. The "New Directions" have been reaffirmed in the 1978 AID Agricultural Development Policy Paper and a March 1982 statement on AID Food and Agricultural Development Assistance. The latter states that increasing the productivity and income of small farmers is a main objective of AID's assistance (p. 3) and includes the generation and adaptation of improved technology among the means to reach that objective. The Foreign Assistance Act specifically requires that AID-assisted agricultural research programs be adapted to the needs of small farmers (Section 103A).

As the objectives of AID assistance have shifted, so have the ways to meet them. The real world is far more complex than any laboratory or experiment station. An improved technology is more likely to be adopted by small farmers if it is adapted to the agronomic, economic, and social dimensions of the farm. To develop such technology, many of the activities of the households need to be taken into account, in addition to the resources (land, water, inputs and labor) available to the farmers. A plant breeder or a soil scientist alone is not able to do this, so multidisciplinary work is a necessity.

The importance of testing and verifying the research output under actual farm conditions also has become evident. A high potential yield under optimal conditions is not an advantage if other requirements, such as early planting, a reliable supply of water, or high levels of fertilization, prevent utilization of the new variety by most farmers.

Given the complexity of the task, no one research institution is likely able to meet the total needs of a country, nor can quick results be expected. Coordination and complementarity between national and international research centers have become a major avenue for increasing the efficiency of national research programs. It also is now recognized that results cannot be expected from a research effort within the usual 4- or 5-year duration of a project, but are more likely to be achieved within 15 or 20 years.

In 1981, USAID allocated about 20 percent of its appropriation for agriculture, rural development, and nutrition to agricultural research (Table 3). The actual expenditure has fluctuated considerably over the last few years, but has ranged between 13 and 19 percent of all appropriations for agriculture. The funds, which include a contribution to the international agricultural research centers, are about equally divided between centrally funded and regional bureau- and mission-funded projects (i.e. projects coordinated directly by the Science and Technology Bureau of AID/Washington, and those coordinated by the regional bureaus).

Table 3: U.S. Agency for International Development, Agricultural Research Appropriations, 1978-1981, By Subcategory[1] ($000)

	FY78 Actual	FY79 Actual	FY80 Actual	FY81 Estimated
Agr. Technology-Research by U.S. Institution[2]				
Africa	-	2,756	-	2,350
Asia	117	1,060	-	-
Latin America and Caribbean	1,100	1,511	700	1,051
Near East	150	1,200	4,032	6,451
Science and Technology	20,244	21,315	19,104	15,058
Totals	21,611	27,822	23,836	24,910
International Centers[3]				
Africa	-	-	-	-
Asia	-	-	-	-
Latin America and Caribbean	10,000	-	-	-
Near East	-	-	-	-
Science and Technology	21,652	29,758	33,800	40,100
Totals	31,652	29,758	33,800	40,100
Agr. Technology-LDC Research[4]				
Africa	15,971	29,827	28,586	39,406
Asia	920	6,042	9,000	30,600
Latin America and Caribbean	8,645	20,569	2,165	8,636
Near East	2,896	1,456	1,115	-
Science and Technology	-	-	-	-
Totals	28,432	57,894	40,866	78,642
Total Agricultural Research				
Africa	15,571	32,583	22,944	35,356
Asia	1,037	7,082	9,000	30,600
Latin America and Caribbean	19,745	22,080	2,865	9,687
Near East	3,014	2,656	5,147	6,451
Science and Technology	45,335	51,073	52,904	55,158
Totals	84,702	115,474	103,502	143,652
Total Aid Appropriation for Agriculture Rural Development and Nutrition				
Africa	147,075	172,449	173,187	200,777
Asia	228,492	286,338	278,989	287,465
Latin America and Caribbean	196,101	129,741	147,365	127,934
Near East	19,814	19,960	14,812	27,855
Science and Technology	63,778	73,664	75,763	77,835
Totals[5]	660,177	689,309	707,938	737,409

1 Source: Agency for International Development, Office of Planning and Budgeting (PPC/P8). Figures as of 7/27/81. Amounts do not include Economic Support Funds ($22,366,000 for agricultural research in FY81).

2 Functional Subcategory "FNDR"--Activities financing direct research in agricultural technology by U.S. institutions.

3 Functional Subcategory "FNIC"--Activities financing international agricultural research centers. Includes appropriations for the International Center for Living Aquatic Resources Management located in the Philippines ($300,000 in 1979, $200,000 in 1980, and $300,000 in 1981).

4 Functional Subcategory "FNDS"--Activities financing direct agricultural research by LDC institutions.

5 Totals may not add because miscellaneous items are omitted.

Projects funded through the Science and Technology Bureau are usually specific research activities in a commodity sector, while projects funded through the regional bureaus and missions usually focus on institution building and human resource development.

Funding levels for the regional bureaus are tending to increase. Currently 24 missions have included agricultural research as an area of particular importance in their Country Development Strategy Statements for 1983, and the Africa and Asia Bureaus have given clear priority to agricultural research for their future programs. The Asia Bureau, which has a long history of agricultural research activities, is currently conducting a review of its past experience in agricultural research (Asian Agricultural Research Review).

III. IMPACT EVALUATIONS OF PROJECTS IN AGRICULTURAL RESEARCH

A. Scope of the Impact Evaluation Series

In order to learn from AID's experience in agricultural research, eight projects were selected for impact evaluations. The decision was made to limit the evaluations, for the time being, to projects funded through AID's missions and regional bureaus: two in Africa, three in Asia, two in Latin America and one in the Near East. The projects provided some form of assistance to a national (five) or regional (three) institution, and all except one (Guatemala) had been completed prior to the impact evaluation. However, AID has continued to assist some of the institutions after the projects evaluated here ended.

Each project was evaluated by an interdisciplinary team (see list in Annex A) during a visit of about 4 weeks. Agriculturalists, economists, social scientists, and development generalists were present, with each team including one or more AID officers. Outside consultants joined the teams where the necessary expertise was not available within AID at the time of the evaluation.

The main goals of each evaluation were as follows:

o To determine whether the institution that had received assistance was functioning and whether the researchers who had received training were active, and to assess the quality of the research program and its applicability in actual farming conditions.

o To determine the extent to which research findings have been adopted by farmers, and how food producers have been affected by the new technology.

While each team was given a list of topics to cover as a framework for its inquiry, team members were free to draw their own priorities for review and conclusions. Each team prepared its own scope of work prior to departure.

In order to assess the impact of the project, each team interviewed a sample of farmers as well as researchers and administrators, spent a minimal time in the capital city, and travelled in rural areas. Every team included members with previous experience in the country and with knowledge of a local language.

B. Characteristics of the Projects Evaluated

The findings of each evaluation are described in Section IV. The basic characteristics of each project (compiled from the impact evaluation reports) are listed in Table 4. For ease of presentation, each project will be referred to by its location.

IV. FINDINGS OF THE IMPACT EVALUATIONS

The institutions assisted by the projects all produced agronomic or other findings of potential value to farmers, but actual adoption of these findings were very unequal. The training component of each project was successful, but the effectiveness and sustainability of the research network have been undermined in several countries by institutional and managerial difficulties. Technical, institutional and policy constraints were found to interact to determine the impact that a research institution has on the farmers and on national development.

The findings of seven impact evaluations (the findings of the Tunisian evaluation are not yet available) can be grouped into four categories: (1) macro-economic and policy environment; (2) institution building and management; (3) technology generation and transfer; and (4) impact on farming households. Findings in each category will be discussed separately. The order in which they are presented has been chosen as a matter of convenience and does not prejudge their relative importance. While each evaluation report touches on all sets of issues, the emphasis varies, so each issue will not be covered in full detail for each evaluation.

A. Policy and Macro-economic Environment

The policy and macro-economic environment in a country determines the long-term effectiveness of a research institution in at least two ways. First, no matter how productive a research station may have been during the implementation of the project, its ability to sustain research activities on its own is a function of the host government commitment to research and its ability to cover recurrent costs. Second, whether farmers use the research results also depends upon government policy. The farm-gate and consumer price of food and other agricultural commodities, prices and distribution of inputs, and efficiency of marketing systems are potential constraints on farmers' actions that are affected by government policy.

Table 4. Characteristics of eight AID projects.

Location	Program Title	Project Funding (in millions)	Implementation Dates	Institutions Assisted	Date of Evaluation	Evaluation Report
Kenya	Crop Production and Research (618-0644, 618-0657)	$2.2	1969-81	East African Community	December 1979	Kitale Maize: The Limits of Success
Central America	Small Farm Cropping Systems (596-0064)	AID grant, $1.633	1975-79	Center for Tropical Agriculture Research and Training (CATIE)	February 1980	Central America: Small Farmer Cropping Systems
Guatemala	Food Productivity and Nutrition Improvement (520-11-130-232)	AID, $1.7 (plus $1.0 in earlier projects)	1975-79	Institute of Agricultural Science and Technology (ICTA)	October 1979	Guatemala: Development of the Institute of Agricultural Science and Technology and its Impact on Agricultural Research and Farm Productivity
Korea	Agricultural Research Project (DLC/P-2014, 489-11-088)	Loan, $5.0 Korean contribution, $3.124	1974-80	Office of Rural Development, Ministry of Agriculture and Fisheries	January 1982	Korean Agricultural Research: The Integration of Research and Extension
Nepal	Food Grain Technology: Agricultural Research in Nepal (367-11-110-054, 367-0054)	about $20.0 total	1957-74	Ministry of Food and Agriculture, with assistance to five research stations	January 1982	Food Grain Technology: Agricultural Research in Nepal
Thailand, Northeast Region	Agricultural Development, Agricultural Research (493-11-190-180.2)	AID, $6.272 Thai Government, $6.8	1966-75	Thai Phra Agricultural Research Center	February 1981	Agricultural Research in Northeastern Thailand
Tunisia	Accelerated Cereals Production (654-0205.1) and related regional projects (698-0173)	$1.715	1967-77	Office of Cereals	April 1982	in preparation
West Africa	West Africa Rice Development Association: Rice Research and Production (698-11-190-382, 698-0382)	AID, $5.166 WARDA, $0.3 (in kind)	1975-80 (first phase)	West Africa Rice Development Association (WARDA)	October 1981	West Africa Rice Research and Production

1. Host Government Commitment to Research. The success of the Korea project is attributable in large degree to the commitment of the government, which gave agricultural research and extension high priority. Research stations existed and were already effective prior to the AID project evaluated here. This program to increase the production of rice and other crops was conducted with the full support of the government, which revised its pricing policy for rice to encourage widespread use of the Tongil variety and to increase the farmers' incomes.

The government in Nepal has also given support to the research centers, and has recently taken measures to ensure greater coordination of research and extension.

In contrast, the lack of government commitment to research and extension greatly undermined the effectiveness of the research center in Northeastern Thailand. The center was created, with AID assistance, but was never given legal recognition. After departure of the AID technical assistants, the center received only a limited budgetary support, and eventually its purpose was switched from research to planning and coordinating development activities.

Government support also seemed weak and somewhat unreliable in Kenya and for some of the countries cooperating in Central America. The team in Guatemala found government interest in ICTA but was uncertain whether support would continue in the future.

At issue here may be the long duration of a program of agricultural research research and the low visibility of research activities, which make research unattractive for a government that depends upon rapid achievement for survival. Yet without assurance of adequate, continuous and timely funding for staff and research facilities, a research program can quickly become ineffective. Recurrent costs can be a burden on public funds, especially when incurred for activities that are not receiving any further external assistance.

2. Macro Level Constraints to the Use of Improved Technology. In deciding whether to adopt a new crop, variety, or farming practice, a farmer does not look solely at its potential productivity. The farmer calculates whether the change is worthwhile in economic terms, taking into account the costs of production, farmgate price, the opportunity cost to the household in time, labor and land, and the risk of failure. High-yielding varieties can reach their production potential only if adequate water and inputs are available. Access to inputs on a timely basis and at a reasonable cost then becomes a key constraint in their adoption, a constraint that is outside the control of either the researcher or farmer.

For example, in Nepal most of the farmers interviewed complained about the unavailability of fertilizer at the right time, and even sometimes about shortages or poor quality of improved seeds, which have limited their use of improved seeds. They also noted that increases in the official producer price of wheat did not keep up with the increased cost of fertilizer.

In Thailand and Kenya, the necessary inputs were often deemed too expensive by the smaller farmers. The Korean project also failed to take into account important issues such as the price of crops other than rice, the cost of labor and of fertilizers.

The research programs evaluated were oriented to the eventual production of a food or cash crop, which depend upon the farmers' access to marketing outlets and transportation. The governments' failure to alter their policies towards pricing and marketing to compensate for the shift from shortage to surplus has also resulted in disincentives and waste, for example in Kenya.

B. Institution Building and Training

All the projects included a component for institution building at either regional or national levels and for training. Whether the research institutions are functioning adequately after the project has ended is a crucial element in determining the sustainability of the project achievements. There are two sets of issues: the location of the institution within a country's administrative system and within the research community, and the staff and resources allocated to the institution.

1. Affiliation of the Research Institution. Three of the projects evaluated were to develop a research institution serving several neighboring countries (WARDA in West Africa, CATIE in Central America, and an East African Community Institution in Kenya). The other projects assisted national institutions, usually affiliated to the ministry of agriculture rather than linked to a university. The institution in East Africa (Kenya) has collapsed, the institutions in Thailand and West Africa are functioning but with difficulties, and those in Guatemala, Korea, Nepal, and Central America have been found effective. Aside from the political changes in East Africa, one key to sustained activity seems to be the ability to establish linkages (vertical and horizontal) among the research institutions, related government agencies, and, eventually, institutions in neighboring nations and international research centers. Indeed, five of the reports state this as a lesson learned.

Effectively linking different parts of a country's administrative system is often difficult. This is especially true when the research institution is attached to the "wrong" line of government, for instance, to the planning ministry if all other agricultural activities are handled through the ministry of rural development. Coordination among research, extension, training, and input supply is difficult at best. It can be close to impossible if three or four ministries are involved. The choice of host-country channels for implementation of an agricultural research program is an important step that should be carefully planned and discussed with the host country at the project design phase.

Overcentralization and rigidity are counterproductive in any development project and they have been cited as problems in several evaluations. In West Africa, none but the simplest decisions can be made by the field stations. Among the projects assisting national institutions, Nepal seems to have reached a practical compromise, with each station preserving its autonomy (budget, programming), but with regular workshops being held for all the stations' research staff, during which the researchers present their work to their peers, discuss each other's programs, and arrange for some common research activities. Both the Thailand and Korea evaluations emphasized the danger of over-centralization and the need for flexibility in the design and implementation of the research program.

2. Training Agricultural Researchers. All the projects included a training component in agricultural disciplines. The basic problems did not lie with training per se--this seems to have been achieved successfully everywhere--but with keeping the returned trainees working in research. Low salaries, poor working conditions, insufficient career incentives are cited in four projects as detrimental to the institutions' effectiveness and sustainability.

While young professionals in less-developed countries are eager for a period of training abroad, steps have to be taken to ensure there will be adequate incentives to keep the trainees at the research institutions upon their return. The evaluations in Kenya, Guatemala, Korea and Thailand cited the lack of salary or career incentives as a problem in retaining researchers at the station.

C. Technology Generation and Transfer

The projects were all expected to generate varieties adapted to local conditions, and all did achieve that result, but with varying success in adoption rates. Many of the difficulties can be traced to poor planning and lack of understanding of farmers' needs.

1. Planning a Research Program. What kind of research does a country need? Is adaptive research sufficient in some countries? Should a country use the resources available for research to concentrate on a few main crops? The type of research capabilities that should be developed is not always clearly defined when plans are made to create or expand a research institution. Yet it is a crucial decision that determines the potential impact of the research.

The projects evaluated varied from a single-commodity focus (rice in West Africa, maize in Kenya), to those focusing on several commodities (Nepal, Korea), to programs focusing on the cropping system of small farmers (Guatemala, Central America).

A commodity focus can use research abilities efficiently if the commodity is indeed one worth encouraging and if the improved varieties and/or practices are suitable for small farmers. Rice in West Africa is

an example. The commodity is essential to the economic development of the countries involved because the demand for rice in the cities is higher than current national production and is likely to continue to increase. Maize in Kenya is also a case of a food staple with a strong demand.

Korea, Nepal and Thailand focused on several commodities. In Nepal, several research stations were created, each specializing in one of the main crops. Over the years, the stations have come to coordinate their work more closely, while still maintaining their basic specialization, and improved varieties of wheat, rice, and maize have been made available.

The two Latin American institutions differ from the others in that they focus not on one crop, but on the cropping systems used by the small farmers, and this seems to have had positive results.

Whether research is to be conducted on one crop or on cropping systems, the problem remains that the potential of any given crop depends greatly upon local agro-climatic conditions. Indeed, this is a major stumbling block in agricultural development as a variety bred under controlled conditions cannot be recommended for adoption without a lengthy period of testing, and perhaps further adaptive research in other locations. A basic decision must be made when attempting to develop a national research institution: can the research center focus exclusively on selecting strains obtained from regional or international centers in similar climates, or is breeding within the country necessary?

It so happens that all the projects evaluated did propose to disseminate improved varieties, obtained either through in-country breeding or selection within imported materials. However, agricultural research need not necessarily be limited to varietal research. In many cases, great benefits can be derived from improvements to existing farming practices such as identifying optimum planting dates and weeding practices, which do not require many changes on the part of the farmers. Indeed, the West Africa team concluded that research on farming practices with rice might be a more useful program at this stage than varietal trials.

2. Adaptation of Research to Farmers' Conditions. Regardless of the of research planned (breeding or selection among imported materials, varietal improvement or research on cultural practices), two steps were found lacking in most projects: (1) obtaining information on current practices before planning the research program, and (2) testing the research outputs under actual farming conditions.

Most evaluation reports indicate that the research program was designed without sufficient information about existing farming systems and an assessment of the needs and constraints of the small farmers. For example, in Korea, the researchers are trying to develop better varieties of wheat and barley, which are grown in winter. While research is under way, the farmers are beginning to grow vegetables during the late winter and are finding this activity to give higher returns than the cultivation

of cereals, as the demand for vegetables is great. Improved varieties of wheat and barley are not likely to be competitive with vegetable production. The two Latin American programs are different. There, an effort was made to identify the existing farming practices and to study how and why they fit together. This was found efficient in both cases.

Even if the program is well adapted to the existing situation, any research is likely to involve some trial and error, so a testing and verification phase is an essential part of the research process. Yet few of the projects included an attempt at systematic feedback from the farmers to the researchers.

When trials were held outside of the research station, they were sometimes supervised so closely by the researchers, who controlled the timing of all farming activities and supplied all necessary inputs, that the farmers only contributed free land and unpaid labor. This is not quite like conditions prevalent on a real farm, where inputs may not be available on time, or where the farmer may not be able to perform some necessary tasks.

The only project which described a systematic feedback from the farmers to the researchers was in Guatemala. In accord with the concept of farming-systems research, the recommended practices were tested by the farmers rather than in research stations or under controlled conditions in farmers' fields. Researchers then evaluated the results and requested the opinions of the farmers before determining whether to disseminate the new practices.

When researchers seek improvements that enhance the productivity of the farm as a whole and not just those improvements that maximize production of any one crop, disciplines other than agronomy become potentially useful. Five of the eight projects did call for multidisciplinary work, at least on paper. The disciplines ranged from soil and agricultural sciences to economics and rural sociology.

Both the Thailand and the Korea projects called for multidisciplinary research but neither was very successful in this area. In Korea, the problem lay in the hierarchical social structure in which the importance given to rank made teamwork difficult. In Thailand, multidisciplinary research was never established because of institutional constraints along with adverse government policies.

However, even when agricultural scientists are convinced of the advantages of multidisciplinary work, they may not be able to obtain the necessary funds and positions. Some of the station directors in Nepal complained that they had requested an agricultural economist for their staffs for years, to no avail.

In Guatemala though, multidisciplinary work proved to be beneficial. Social scientists, economists, entomologists and agronomists worked together

to develop a comprehensive program that takes into account social, agronomic, and economic factors.

3. Dissemination of Research Results to the Farmers. Research results are quite useless if the farmers are not aware of them. Six of the reports indicated that research and extension need to be linked. This may seem obvious, since there is no point in developing improved technology for farmers' use if there is no coherent effort to inform them of its existence and how to use it. Yet, making research results available to farmers is not always easy, especially when there is little cooperation--or outright rivalry--between the research institutions and the extension service of a country. However, if a new technology is worth using, the first farmers who learn of it will pass on the word and the adoption rate will likely be high and fast, with or without further intervention by extension. This was clearly shown in Kenya.

The eight projects vary greatly in their approach to dissemination. In Korea, the extension service was effective and comprehensive and played a major role in the successful, rapid spread of the Tongil rice variety. The team cited "the integration of research and extension" as a key to the project's wide impact. Extension activities included the monitoring of farm trials, training programs, and demonstration plots.

In Thailand, formal extension channels were found ineffective, but radio programs and a mobile information unit were useful in providing information to the farmers.

In Nepal, the focus of development activities in the project being evaluated sh.fted from extension to research in the 1960's, but now there is a concerted effort on the part of the extension and research people to coordinate their efforts, with a renewed emphasis on extension.

In Central America, extension had not been included in the first phase of the project, and this has been found to hamper dissemination of research results. The situation in Guatemala was different; there, research findings were disseminated to the farmers by a specialized extension unit attached to the researchers, circumventing the existing extension agency. This has been cause for conflicts between the research and extension agencies.

The private sector has contributed to the rapid dissemination of research results in at least two projects, Kenya and Guatemala, through its involvement in seed multiplication and distribution activities.

D. Impact on Farming Households

The adoption of new agricultural technologies and practices affect farming and rural households in many ways, both economic and social, and these changes in turn affect the economic development of the country. For ease of presentation, the agronomic and socio-economic impacts of the seven projects evaluated will be discussed separately.

1. Agronomic impact. A change in farming activities for one crop is likely to affect the production of other crops, and indeed may require changes in the household's other activities. These changes in turn influence productivity, food supply, income and pattern of land use. There will be consequences both at the household and at the community level.

Kenya is a clear example of a technical improvement, a high-yielding hybrid maize, which was quickly accepted by the farmers because it fitted easily within the traditional practices and did not change the schedule of farming activities. Simply switching to the hybrid resulted in higher yields. Many Kenyan farmers promptly adopted the hybrid seeds, even though new seeds had to be bought each year. The evaluation team hypothesized that the farmers could assign less land to maize, their staple food crop, and still assure an adequate food supply for the household. That left land that could then be used for a cash crop. The introduction of hybrid maize enabled Kenya to become self-sufficient in that crop for the first time.

But the situation differs in Nepal for both wheat and maize. The high-yielding wheat varieties, which perform best if planted in early November, can conflict with a last harvest of rice, and their production potential can be realized only with adequate irrigation and high levels of fertilizer. The improved varieties of maize yield more than the local strains, and the farmers know it, but the ears do not keep as well. Many producers are compromising by planting part of their land to improved maize for immediate sale, as a source of cash income, and the rest to local maize for household consumption.

In Korea, the Tongil variety of rice produced more than previous varieties under farmers' conditions and its widespread use led to a decrease in cultivation of other crops. This was also because of a higher official farmgate price for rice. While these were positive economic results for the Korean farmers, the use of Tongil rice also made them more dependent upon that one source of income and therefore more vulnerable. Since 1977 the profitability of Tongil has decreased as yields declined because of the occurence of rice blast disease and several years of unfavorable cold weather.

The agronomic impact of the project in Guatemala is different, because the project sought to improve the entire cropping systems rather than focus on one or a few crops. The impact of the project is reported as very favorable, with increased yields despite a decrease in fertilizer use.

2. Socio-economic Impacts. The socio-economic impact of a project was to be evaluated both at the level of individual farms and at the community level. Within the time frame of an impact evaluation, it has been difficult to obtain quantitative information on the incomes of the

families interviewed, but it was often possible to ask the families whether they considered themselves better off than before, and why or why not. It was also possible to understand how the project may have a different impact on families with varying access to farming resources such as land, irrigation, or credit.

The question of equity, i.e. giving all farmers equal access to benefits from the project, is a very difficult one for several reasons. Governments often place a higher priority on assuring the food supply of the urban populations than on bettering the income distribution among farmers. It is also a difficult question from a technical viewpoint because many new or improved farming technologies simply are not efficient on a very small scale, or demand a level of investment in tools, inputs, water, or labor beyond the reach of the smaller farmers, especially those who are tenants.

In Nepal, farmers with some irrigated land have had immediate advantage over those with only rainfed land in using the improved varieties of wheat and maize. Farmers who were better off in the first place were more likely to be able to finance the necessary inputs. Tenant farmers were disadvantaged because they did not qualify for credit to buy inputs, and probably had less incentive to invest in the land.

Even in Kenya, where the overall output of maize was greatly increased as a result of research, the impact on equity within the country was probably negative. Disparity increased between the large and small farmers because the smallest farmers were reluctant to adopt the hybrid. Their main concern was to minimize the risk of crop failure (which the hybrid maize did not do) rather than to increase production. In addition, they were not able to finance inputs; even the need to buy new seeds each year was a problem.

In contrast, the project in Korea contributed positively to equity among farmers because of the price subsidies provided by the government and relatively equitable land distribution.

These evaluations did not look specifically at the projects' impact on consumers. However, the projects may have influenced the food price structure through increased production and also through changes in cropping systems. A shift in land use towards a crop (e.g. rice) or a variety that is especially in demand in urban areas, is likely to benefit the urban consumers, although not necessarily the poorer ones.

V. FOR FURTHER DISCUSSION

Firm conclusions and suggestions for future policy will be advanced only at the end of the 4-day workshop on the impact of agricultural research. The findings of the seven impact evaluations of agricultural research projects described in this paper already point out some key factors that seem to affect the impact of agricultural research on food producers and should be further discussed.

The projects have been successful in training host-country agriculturalists and in implementing productive research activities. However, these achievements have sometimes fallen short of having the expected impacts on the long-term research capacity of the host countries and on the farmers' productions and income. Three sets of problems have hampered the effectiveness of training and research activities: (a) lack of government commitment and unfavorable economic environment; (b) organizational and administrative difficulties, and (c) lack of adaptation of the research program to actual farming conditions and the needs of rural households. Only the third set of problems is technically within the realm of expertise of agriculturalists; the first two are problems of management and policy not specific to agricultural research. A project that addresses only the third set or problems is likely to fail in countries where the policy, administrative, and economic environments are not favorable.

A. Policy and Macro-economic Constraints

Research institutions in several projects have been found ineffective because of a combination of the following problems:

o Lack of commitment on the part of the host government, as evidenced by a lack of continuity in programming and funding. This may be a question of timing: research is a long-term process while government decisions are often made on a short-term basis. It may also reflect a lack of understanding on the part of policy makers of the potential contribution of research to economic development.

o Lack of coordination between the research institution and policy makers and planners in the host government, other host-government institutions that control activities linked to agricultural development, such as extension, marketing, pricing and subsidies, and agricultural inputs.

o Research projects of insufficient duration.

In the 1960's, it became understood that a simple transfer of agricultural know-how from developed to developing countries would not be sufficient to systematically increase food production. An apparent solution was to transfer the knowledge of how to conduct research (in technical terms) rather than a direct transfer of research results. The impact evaluations have found this to be helpful but not sufficient. Planning research programs adapted to the administrative, policy, and economic environments is as important as designing technically effective research programs. To do this, the interactions between changes in agricultural production and the rest of the economy must be understood.

In the Western world, these interactions were often taken into account as a matter of course when research programs were planned at the request of farmers, or by private enterprises for commercial purposes. A host

government establishing a research infrastructure is likely to need assistance in planning and management, as well as technical assistance in agricultural science. The deputy minister of agriculture in one of the countries evaluated, himself an agriculturalist trained under the AID agricultural research project, stated that AID technical and financial assistance to the agricultural research centers would have been more effective on the long term if assistance had also been available for planning and policy decisions regarding the place and role of the research networks within the host government.

B. Strengthening the Scientific Research Capacity of a Host Country

The training of agricultural researchers has been achieved according to plans in most projects, but the actual benefits from training have sometimes been disappointing. This is because the financial or career incentives offered to researchers in less-developed countries are often insufficient to keep them on the job for which they were trained.

In the U.S., research activities are closely linked with the universities. This is not always the case in less-developed countries where a research institution may be part of the government ministry, and where universities are likely to be controlled by the government. Whether agricultural research positions are given civil service status will influence the salary level and career opportunities available to the trainees. It will also determine how much flexibility the researchers have in planning their research programs and controlling research funds.

Other factors contributing to low productivity and eventual loss of trained professionals are inadequate support of research programs and inefficient administration of support services.

Scientific exchanges between the host country researcher and those in other national and international research institutions have been found effective as personal and professional rewards.

C. Adaptation of a Research Program to Actual Farming Conditions

The impact evaluations have found that a research program is more likely to result in improved technology that the farmers find useful if it takes the following into consideration. First, the existing farming practices and the agro-ecological environment in which they are used should be known. Assessing the existing cropping and farming systems rather than isolated commodities has been found effective. Second, the socio-economic constraints that bear on the farm household should be understood. These range from the availability of production resources (land, water, labor, inputs, credit) to felt needs and priorities of the food producers and their families.

Probably as a result of the complexity of the problems addressed by research institutions, programs which maximize linkages between the research activities and related activities have been found most successful. This included establishing maximum contacts among researchers, farmers, and extension services, conducting on-farm trials of varieties and practices, and establishing a systematic feedback from farmers to researchers.

Such programs could not be implemented by agricultural scientists alone, but call for multidisciplinary activities.

D. A WORD OF CAUTION

The U.S. Agency for International Development has reaffirmed its objectives to "enable countries to become self-reliant in food," with "an emphasis on effectively increasing the productivity, incomes and market participation of small producers." (AID Food and Agricultural Development Policy, March 1982, pp. 3 and 6, emphasis in text).

The emphasis on food production and the well-being of small producers will be kept as a central focus throughout the Workshop on Impact of Agricultural Research. The following questions are in order, even though they are not specificially discussed in all the impact evaluations.

Is it enough to increase food production? There is evidence that an increase in food production does not necessarily lead to an increase in net income of the farm household. The additional costs of inputs and opportunity costs of added labor or non-farming activities can counterbalance the increased production. Few of the reports discussed this problem, but the Nepal impact evaluation showed that some farms could have a negative rate of return for high-yield varieties. The assumption "increased production equals increased income" may be incorrect, and this could explain why farmers cannot always be convinced to adopt innovations that are technically valid.

Who benefits from a higher income? The impact of improved technology in agriculture among rural households is also complex. The diffusion of improved technology can have both negative and positive impacts over time or on different sections of the population. Improved technology can open better opportunities for those food producers with a larger resource base (land, water labor, access to credit), therefore widening the gap between the poorer and better-off farmers.

In addition, a high household income does not necessarily benefit all household members. While most development projects take the household as the smallest target unit, it is not so in reality. In most cultures, there is a clear division of labor obligations and of rights to production and income among household members, and especially between the male head of household and his wife or wives. Improved technology can increase the

overall farm production or income while leaving some household members--typically the women--worse off than before. There is little opportunity within the time frame of an impact evaluation to go down to such a level of detail. Nevertheless, it is well to keep in mind that an increase in farm income does not always mean that everyone in the household is better off than before.

Finally, the potential impact of agricultural research on consumers (both rural and urban) should be considered in terms of type, quantity, reliability of the food supply, and market prices.

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Annex A

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Kitale Maize: The Limits of Success	Charles W. Johnson, Team Leader (Bureau for Asia) Keith M. Byergo, Agronomist (Bureau for Development Support) Patrick Fleuret, Anthropologist (Bureau for Program and Policy Coordination) Emmy Simmons, Agricultural Economist (Bureau for Program and Policy Coordination) Gary Wasserman, Political Scientist (Administrator's Office)
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AGRICULTURAL RESEARCH DOCUMENTS

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Project Impact Evaluations

No. 2: Kitale Maize: The Limits of Success (May 1980) PN-AAH-768

No. 14: Central America: Small Farmer Cropping Systems (December 1980) PN-AAH-977

No. 27: Korean Agricultural Research: The Integration of Research and Extension

No. 30: Guatemala: Development of the Institute of Agricultural Science and Technology (ICTA) and its Impact on Agricultural Research and Farm Productivity

in progress: Thailand: Agricultural Research in Northeastern Thailand

in progress: Nepal: Food Grain Technology: Agricultural Research in Nepal

in progress: WARDA: West Africa Rice Research and Production

in progress: Tunisia: Regional Wheat Development and Accelerated Cereals Projects Impact Evaluation

Discussion Paper

13: A.I.D. Experience in Agricultural Research: A Review of Project Evaluations

Annex C

EXECUTIVE SUMMARIES OF IMPACT EVALUATION REPORTS

KITALE MAIZE: THE LIMITS OF SUCCESS

A.I.D. first became involved with hybrid maize research in Kenya in 1963, through the Organization of African Unity and the East African Community. By 1970, the yield of the original hybrids had been successfully improved by 25 percent under research station conditions. The breeding program was continuously followed with similarly positive results until the EAC broke up in 1977. Other aspects of the A.I.D. program were less rewarding. Research to improve maize protein quality and to develop varieties for low rainfall areas did not succeed. Nor did the attempt to train Kenyans and integrate them into the research operation succeed. When the last American scientist left almost 15 years after the first A.I.D. project began, the effort was not sustained by Kenya.

In 1964, the first hybrid maize seeds were released for commercial production. Hybrids produced a remarkable 40 percent increase in yield over local seed and proved appropriate to the environment of the high potential areas of Kenya, with their fertile soils, abundant rainfall, and moderate temperatures. At the time, it was assumed that African farmers would continue to use the local improved variety rather than the new hybrid--it was less prone to crop failure and it could be re-used year after year whereas hybrid seed had to be re-purchased each year. But the hybrid was clearly superior in yield, enjoyed the status of a crop used by large farmers, and small farmers soon demanded it. By 1977, the majority of smallholders in high potential Central, Rift Valley and Western Provinces grew hybrid maize and their production far surpassed large farmer output.

An aggressive private firm, the Kenya Seed Company, reproduced the seed, distributed it, and promoted it throughout the country via a network of private shopkeepers. Extension agents demonstrated the use of improved cultivation techniques. The government-supported official prices and marketing system provided incentives, particularly for large farmers, to adopt and profit by the hybrid technology.

Innovations are usually unfair in the sense they reward those who have the means to benefit from them. Consequently, it is not surprising that hybrid maize was of greater value to those farmers with sufficient land, labor and capital to fully utilize the innovation. More surprising is the large number of smallholders who did gain access to the hybrid maize technology and who have improved their food security as a result. The overall impact of the increased maize production attributable to the use of hybrid seed is that Kenya has continued to be more or less self-sufficient in maize, the country's staple food. As a result, Kenya, despite a very high rate of population growth, has not had to face some food policy problems which have confronted other developing countries. Without hybrid maize, population pressure would likely have led to a demand for more land for food crops and a reduction in less essential export crops. Hybrid maize helped to keep the price of food down in the cities, thus muting the pay demands of urban workers and keeping Kenya attractive for foreign investment.

There is a question, however, whether the government saw the increased production of maize as more of a problem than an opportunity. The

government continued a pricing and marketing system more suited to dealing with the problems of scarcity than those of abundance. The Maize and Produce Marketing Board responded to an obvious need for increased storage capacity, for example, with too little, too late. Nor did the government take adequate measures to ensure the continued success of hybrids by: guarding the flow of critical inputs, including sufficient credit and chemical fertilizers; and being supportive of the research facilities which made the hybrids possible. The loss of the incremental benefits which the A.I.D. project demonstrated were possible by improving hybrid seed year to year, cannot be calculated--but based upon the benefits derived from the program in early years, the loss is substantial.

Smallholders have not yet exerted policy influence on the government (as did the European-dominated large farm sector prior to Independence) by forming effective organizations of their own. If government policy toward maize is to become more effective, it will require not only better long range planning but wider popular participation, especially among smallholders, in its formulation.

From the experience of hybrid maize in Kenya and from the observations of Kenyan maize growers and consumers, an A.I.D. evaluation team drew seven key lessons:

1. Simplicity and viability were the decisive factors in the success of hybrid maize.

2. The private sector was crucial in the rapid diffusion of hybrid maize.

3. Perfect equity cannot be expected even from the most successful technology.

4. The long-term continuity of foreign experts was basic o the success of the breeding program.

5. Foreign advisors and finance do not automatically create institutional capacity to perform agricultural research.

6. Pragmatism and skepticism should surround A.I.D. support for regionalism.

7. Too many lessons should not be drawn from a unique experience in one African country.

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For additional information contact the Administrative Assistant, PPC/E, Room 2839, Agency for International Development, Washington, DC 20523.

CENTRAL AMERICA: SMALL-FARMER CROPPING SYSTEMS

The small-farmer cropping systems research project in Central America was selected for evaluation as part of A.I.D.'s effort to assess the impact of its activities in several development sectors. Field work for the evaluation was done in Costa Rica, Guatemala, Honduras and Nicaragua by a six-person team in February, 1980. The findings and interpretations are those of the team and pertain only to this project. However, they will contribute to a forthcoming analytical report for the agricultural research sector as a whole.

In 1975, A.I.D.'s Regional Office for Central American Programs (ROCAP) began support to the Center for Tropical Agricultural Research and Training (CATIE), located in Turrialba, Costa Rica, to develop and test "a coordinated regional research approach for improving the cropping systems of small farmer, in Central America." CATIE agreed to negotiate working arrangements with the principal agricultural research institutions of the five Central American republics. These arrangements were to provide for CATIE and national scientists to collect survey data on the cropping practices and crop yields of the peasant farmers as well as data on their socio-economic environments. Then the scientists were to work with representative farmers by setting up experimental plots designed to test and evaluate alternative crop combinations for their potential in increasing production and income.

ROCAP undertook this project with the expectation that CATIE would develop and demonstrate an innovative multidisciplinary methodology for doing research on the cropping systems of the small farmers of Central America. It hoped to mobilize a permanent regional institutional capacity and commitment for on-farm research and training addressed to the needs of this vital sector of rural society. It also expected to see CATIE produce, through the project, improved cropping systems alternatives for different ecological zones of the region that might be suitable to rapid verification and dissemination by the national institutions. Its longer-term goal was that as farmers adopted these proven, improved systems the total yields from small farms would significantly increase and family incomes would rise.

By the end of the project in 1979, CATIE had made working arrangements and had carried them out in varied ecological zones of all five of the Central American republics. Twelve agricultural scientists from CATIE had been engaged full-time in on-the-farm research. They had developed and demonstrated a cropping systems research methodology working on the farms of seventy-five small holders. Impressive production gains and potential economic benefits had been documented for the ten major cropping systems alternatives elaborated by the project staff. But these alternatives were yet to be verified through extensive field trials in the region. However, one highly promising alternative crop mix of sorghum and beans, which did undergo limited verification, had been adopted by Nicaraguan agricultural officials for widespread dissemination among peasant farmers.

During this five year period, CATIE increased its graduate training on small-farm systems and generated a five-fold increase in its budget, largely from international donors and almost exclusively for small-farmer oriented agricultural research activities using the "systems" approach. CATIE's institutional commitment to improving small farmer production had become well established as had its ability to work with national institutions in the region.

Although the project had achieved most of its stated objectives, the beneficial impact of the emergent research methodology and of the expanded institutional capacity at CATIE on large numbers of small farmers was yet to be demonstrated. There was no wide-scale adoption of the newly tested cropping systems alternatives developed from the on-farm experiments. In spite of this and partly because of it, some lessons were learned from the project evaluation.

Doing agricultural research on the farms of small holders, as opposed to research done on far-removed experimental stations, holds much promise for the development of truly appropriate production technologies and their more rapid adoption and dissemination. But for that potential to be realized, the projects should be designed to include the full cycle of research through both verification and dissemination. Donors sponsoring such research should provide the time and resources necessary, perhaps eight- to ten-year authorizations, to allow for validated technologies to reach numbers of small producers. International or regional research institutions, like CATIE, must be prepared to maintain their collaboration with the national agencies, not only to support the verification and dissemination phases as they come on line, but to capture important findings during these phases for improving subsequent research work.

Agricultural institutions undertaking on-farm systems research must give adequate attention to non-agronomic issues--such as input constraints, market analysis, and household and area labor availabilities by season--in the planning of the research, the analysis of constraints to production, and the implementation of research, verification, and dissemination programs. To do so requires that the institution have adequate staff skills in the social sciences and in farm management within the multidisciplinary teams undertaking each phase of the research effort.

Scientists need to be aware of the difference between doing research on small farms and doing research with the active interest and participation of small farmers. The former may well inform the agricultural scientist about agronomic issues, but only the latter is likely to educate both the scientist about how the small-farmer household economy works and the farmer about new agricultural options that will fit with the economy. Several of CATIE's field staff demonstrated that being a scientist and an involved participant, or even change agent, are not mutually exclusive roles.

* * *

Copies of the complete report can be obtained from the Editor, ARDA, DS/DIU/DI, Room 813 SA-18, Agency for International Development, Washington, DC 20523. The Office of Evaluation welcomes comments on the report.

FOOD GRAIN TECHNOLOGY:
AGRICULTURAL RESEARCH IN NEPAL

SUMMARY

In 1957, the U.S. Overseas Mission initiated support for a broad-ranging agricultural development effort in Nepal. This project continued without pause for seventeen years, largely in pursuit of the objective of increasing Nepal's foodgrain production capacity by enabling and encouraging Nepali farmers to apply the techniques of modern science. While the U.S. provision of financial and technical assistance was continuous, the emphasis, the pace, and the amount of Nepali involvement were altered considerably during the course of project implementation. The project began as a "General Agriculture" initiative and gradually evolved to its concluding emphasis on the development and dissemination of "Food Grain Technology."

The project successfully contributed to the establishment of the agricultural research and extension systems by training almost 600 Nepalis to the B.S., M.S., and Ph.D. levels and by constructing facilities for research at five stations in the Tarai -- at Nepalgunj, Bhairawa, Parwanipur, Janakpur, and Rampur. With the assistance of the extension service, improved wheat, rice, and maize varieties tested on the research stations were spread to farmers across the Tarai. Some of the selected improved varieties proved widely adapted to Nepal's enormous range of agrecological conditions and spread to Hill and Mountain farms as well. Other parts of the "technology packages" -- which included recommendations for fertilizer, time of planting, spacing, and irrigation -- were not so widely adopted.

In trying to assess more precisely the differences which could be attributed to the implementation of the Food Grain Technology project, we first examined statistical fact sheets and research reports. Farmers' yields have not reflected the potential of the improved varieties and the country as a whole has not experienced the rapid agricultural development envisioned at the outset of the project. We then talked with agricultural leaders (many of whom had apparently taken advantage of training opportunities offered under the project) and with agricultural producers. We took a long view in these dialogues, trying to comprehend the pattern of changes which had occurred in the agricultural sector over the past two decades. While looking at reports of experimental trials and at growing fields of wheat and mustard, we discussed not only what had happened, but what might not have occurred had the project never been implemented.

Our examination provides both a sense of solid accomplishment and a basis for some disquieting fears: On the positive side, we found that:

- a functioning research system exists;
- farmers are immensely aware of the need for and the problems with "krishi bikash" -- agricultural development; and
- extension and research services can, at times, work together in complementary, mutually-reinforcing activities which result in new knowledge in the countryside.

On the negative side, we found that:

- researchers and farmers are not in complete agreement on which questions need to be addressed and how, nor are the channels for communication as open as they might be;

- the "green revolution" as it has occurred in Nepal has not resulted in long-term security and economic independence as expected but has contributed to economic and environmental destabilization; and

- the productivity of farmers, extension workers, researchers, and those agencies charged with input supply distribution is far from optimal.

Thus, researchers articulate the need to continue the search for new varieties which are higher yielding, more disease resistant, and produce grain with acceptable qualities of taste and good marketability. Farmers agree that variety development is important, but recommend that increasing reliability of water and fertilizer supplies are more important for handling their problems of deteriorating soil fertility and declining farm sizes, of low yields and high risks. The role of agricultural research and extension is not in question; at stake is the issue of priorities.

The fact that farmers have adopted components of the technology packages at all may reflect less the persuasive rhetoric of research and extension than the farmers' response to the increasing pressure of population and to their families' requirements for food and monetary income. Nevertheless, without the technology packages, it is unlikely that Nepal's farmers of twenty years ago would be as productive as they are today.

Guatemala: Development of the Institute of Agricultural Science and Technology (ICTA) and its Impact on Agricultural Research and Farm Productivity

During the decade of the sixties, food production in Guatemala barely kept pace with the demands of a growing population. In 1970, the Government of Guatemala initiated a restructuring of public agencies to provide coordinated service to small food-producing farms. An innovative organization, the Institute of Agricultural Science and Technology (ICTA), emerged from this restructuring with responsibilities for generating and promoting the use of improved technologies in basic food crops. AID supported this restructuring with a series of loan and grant projects beginning in 1970.

In 1975, AID approved the Food Productivity and Nutrition Project. Its purpose was to increase the production and nutritive quality of basic food crops in Guatemala and to strengthen and develop ICTA as an institution. Of $1.73 million allocated for the project, $1.2 million was for expatriate technical assistance, including plant breeding experts and other technicians who staffed ICTA while project-sponsored Guatemalans were being trained to assume positions within the new Institute.

Three crops, maize, beans, and sorghum, were targeted for increased production. Working with experts from international agricultural research centers, ICTA personnel developed new varieties and tested them under small farm conditions by collaborating with farmers. With the assistance of the Inter-American Development Bank, a seed service was organized to process seed and help maintain genetic quality.

New varieties of both maize and beans were introduced and increased yields have been recorded. Using improved seed and other technologies recommended by ICTA, collaborators have obtained increased yields. Gains in maize have been primarily in lowland varieties, but one new highland variety is promising. The impact of new seed on maize production is expected to increase as the amount of seed produced increases.

New varieties of beans may reduce or eliminate the need for costly programs to control Golden Mosaic. New varieties of sorghum were not released until 1980 and thus could not be evaluated. However, they appear markedly superior to previously available varieties.

In addition to developing and recommending improved seed, ICTA developed and recommended other farming practices related to increased yields, such as planting distances, seed densities, fertilizer applications, and weed and insect control. Indices of acceptance developed by ICTA indicate that increasing numbers of farmers who have collaborated in the field testing of such new technologies are adopting ICTA recommendations. Interviews with ICTA personnel and with individual farmers support this impression.

The AID project facilitated and hastened the strengthening of ICTA as an institution. The number of ICTA staff increased and staff qualifications improved. Expatriates facilitated the research work of ICTA and its growth as an organization. With project support, 10 Guatemalans received advanced

training and by 1979 and 1980, they were returning to ICTA to replace expatriates.

However, high attrition rates among personnel with advanced degrees are a serious problem for ICTA. Rigid salary schedules are apparently responsible, but ICTA managers have been unsuccessful in efforts to obtain the authority to revise these schedules. With the departure of expatriate advisors, these high attrition rates may make sustaining and expanding the present ICTA system more difficult.

Some confusion remains regarding the respective roles of ICTA and DIGESA, the extension service of the Ministry of Agriculture, particularly as ICTA's approach to research draws on some techniques of traditional extension methodology. ICTA and DIGESA are working on this problem, and it seems likely that new patterns of relationships will develop.

ICTA has come to represent a new model for agricultural research that planners and researchers in other countries are studying and attempting to replicate. If there is continued and increased support from the Government of Guatemala, it will be able to sustain and expand its present activities.

Korean Agricultural Research: The Integration of Research and Extension

A profound change occurred in the early 1970s that transformed the Korean Government's rural development strategy. From one emphasizing industrial exports, the costs of which were largely borne by the Korean farmers, the strategy evolved into one devoted to improving rural Korean life. The genesis of this approach was both political and economic: a hardening of PL 480 terms and the results of the 1971 election that amply demonstrated that government support had eroded in the countryside. The Korean government responded with a rice pricing policy advantageous to the farmers, the strengthening of the extension service, the formation of the Sae-maul ("New Village") Movement, and a rapid increase in rural infrastructure.

The origins of AID's support to agricultural research are found in the Korean Agricultural Sector Survey (1972) and succeeding documents that advocated a strengthening of research as a primary need. The project, proposed in 1973 and implemented in 1974, provided $5 million for a tripartite program to strengthen the capacity of the Office of Rural Development of the Ministry of Agriculture and Fisheries. It included training of Korean researchers overseas, equipment (including a computer and library materials), and both resident and short-term expatriate advisory services. At the close of the project in 1980, 21 Ph.D. students and 7 M.S. students were trained overseas, while an additional 94 received short-term training and 106 participated in observation tours.

Although there were problems with the English language competence of prospective students, the training aspects of the project were universally regarded as the most successful part of the program. Of notable, but secondary, importance was the provision of equipment and supplies, especially the computer and the library materials. Lagging far behind was the value of resident expatriate assistance, which was of marginal use to the project but was more significant in terms of relieving the AID Mission from continuous monitoring of the project than in providing help to the Koreans. Of greater importance was shorter-term foreign technical advice.

The inchoate goal, from a Korean perspective, was probably rice self-sufficiency--a strategic, political, and economic objective. The project purposes, however, were specified in considerable detail outlining exact yield increases on agricultural experimental stations over a ten-year period in the areas of rice, barley, wheat, and soybeans as well as generalized improvement in potato production and in the cropping systems. Specific increases were also proposed for farm fields for the same time. Since the decade of crop improvement is to end in 1984, this evaluation must be somewhat circumscribed.

The project paper suffered from spurious specificity regarding experimental station crop increases. Before the project began, experimental yields were higher than those indicated in the paper, often by considerable amounts. The research breakthroughs that the project

anticipated were generally made prior to the project. Farmer yields may well reach their objectives by 1984, but the AID project was only a beneficial increment to Korean agricultural research. It supplemented an existing, competent system, but offered little that was innovative.

The concentration on rice led to a lack of emphasis on other crops, an inattention caused by national concerns as well as social and economic factors the project ignored. Although there have been increases in crop yields, hectarage of the other crops has consistently been falling, even before the project began. Thus, national targets will not be met even if a relatively few farmers benefit. The choice of some of the crops covered by the project such as wheat, soybeans and potatoes seems questionable, as does the emphasis on increased fertilizer responsiveness.

Critical to a developmentally effective agricultural research program is the transference of experimental results to the farmers. Through a widespread extension service, a farmer training program that includes almost all families annually, demonstration plots, and the Sae-maul Movement, Korea has developed an authoritarian but effective means of disseminating research results.

Thus, beginning in 1972 the spread of the high-yielding varieties of rice was pushed with alacrity by the Korean bureaucracy in response to a national command structure. The effort was effective, making Korea self-sufficient in rice by 1975. Yet there were two inherent problems in this comprehensive effort: these varieties were sensitive to cold, and new races of the fungal disease called blast normally develop after a few years if large areas are planted to a single variety.

The crisis developed first in 1979 with a drop in production caused by blast followed by a disastrous 1980 crop due to cold temperatures. The rice crop fell by one-third, creating a crisis of confidence in the government and in the guidance service.

Ironically, the failures of 1979 and 1980 can be attributed to the strengths of the Korean guidance service. Thus its weakness is based on the omnipresent bureaucratic hierarchy that, in contrast to most developing societies, can transform research into production. In singleminded pursuit of its political goals, it neglected elemental precautions that might have avoided the problems of the last two years.

Agricultural research was an appropriate intervention for AID at the time. It assisted a well-established, agricultural research network, but did not materially transform it. It created no new institutions.

Agricultural research will continue in Korea but replication abroad will be difficult. Any successful adaptive agricultural research project will be dependent upon a positive pricing policy, an effective extension service, rural infrastructure, and continuous contact with international research centers, among other factors. Political will is required for its success, but too strong an emphasis on political objectives can undercut its effectiveness.

AID EXPERIENCE IN AGRICULTURAL RESEARCH:

A Review of Project Evaluations

This study reviews the experience of the U.S. Agency for International Development (AID) in the area of agricultural research. It was completed by Development Alternatives, Inc. (DAI) at the request of AID's Office of Evaluation, Bureau for Program and Policy Coordination (PPC/E). The study's objectives were:

- To review historical trends in agricultural research, especially of AID's expenditure in that sector;
- To identify the set of projects comprising AID's agricultural research portfolio; and
- To identify major issues affecting the design and implementation of agricultural research projects by reviewing evaluations of a sample of those projects.

A review of the literature and interviews with various professionals identified several recent trends in agricultural research. These include an increasing attempt by researchers to develop technology applicable to the needs of farmers under adverse environmental conditions and in resource poor regions of the world. Moreover, in an attempt to better align research with farmer needs, a broader array of production constraints (both agronomic and socioeconomic) is now being examined in the technology generation process than in the past. This has entailed more emphasis on on-farm research, the use of multidisciplinary teams and a more holistic approach to research, as well as greater participation by the farmers themselves in the technology generation process. Additional issues receiving increased attention are the importance of strong national research systems and the amount of time necessary for agricultural research projects to produce useful results.

AID support to agricultural research has been increasing in recent years. Historically, however, the sector has received relatively little attention from the Agency. According to the interviews and literature review conducted during this study, one reason for this lack of attention was the belief, prevalent in the early 1950s, that the technology necessary to improve agricultural productivity in the developing countries already existed. Limitations during the 1960s included Congressionally imposed restrictions on the amount and type of research that AID could undertake together with decreases in the Agency's in-house technical expertise in agriculture. Finally, the New Directions legislation passed in the early 1970s, while contributing to important changes in the nature and focus of AID's agricultural research, emphasized other development strategies such as rural development and food production projects, or the delivery of services to meet basic human needs.

AID's increasing interest in agricultural research in recent years has partly resulted from a realization that a lack of appropriate agricultural technology is a serious constraint to food production increases. Moreover, the success of the green revolution technology developed by the international agricultural research centers (IARCs) in increasing production levels of selected crops in certain regions of the world has furthered this realization.

Between 1978 and 1981 AID funds going to agricultural research increased by almost 70 percent, from $84.7 million to $143.7 million. In relative terms, AID's investment in this sector rose from 12.8 to 19.5 percent of the agriculture, rural development and nutrition appropriation (excluding economic support funded appropriations). Most of this increase came from projects funded by AID field missions. On the other hand, the proportion of AID support going to the IARCs and centrally funded bilateral research has increased only slightly. However, the passage of Title XII and the creation of the Board for International Food and Agriculture Development (BIFAD) may provide a basis for greater activity in this area.

Aside from reviewing historical trends in agricultural research, the study examined issues affecting projects in the sector based on a review of 131 evaluations of 48 agricultural research projects (39 regionally and mission-funded and 9 centrally funded). It found that the evaluation documentation provides only an imperfect picture of any project's overall performance. The evaluations were most often focused on the the provision inputs and the achievement of outputs. Attempts to measure project impact (to determine the effect of project activities on the beneficiaries' welfare) were limited to the four Impact Evaluations included in the sample (part of a series of in-depth, ex post evaluations currently being undertaken by AID). The standard evaluations did not provide the basic information (such as project characteristics and standardized performance indicators) necessary to permit a comparative analysis of the projects in this sample.

Using the evaluation documents it was possible to identify several recurrent issues common to projects in the agricultural research sector. For regionally and mission-funded projects these included:

- Operational problems entailed in doing on-farm, farming systems-type research, and involving farmers in the research process;

- The quality of the research conducted and the setting of research priorities;

- The phasing of activities, especially construction delays which impeded planned research, as well as the amount of time allowed to achieve the research objectives;
- The adequacy of AID's research project supervision, given a lack of technical expertise and high staff turnover in the missions;
- Weaknesses in the links between research and extension, as well as inadequacies in complementary services (inputs, credit, marketing, and so forth);
- Host government support for the projects;
- The lack of qualified counterpart personnel to work with expatriate technicians, together with low salaries for host country researchers which makes it difficult to maintain competent staff;
- Inadequate participant training programs;
- Delays in procurement; and
- The delays or inability of AID and its contractors to provide qualified technical assistance.

For the nine centrally funded projects in the sample (each of which involved overseas research), the issues discussed in the evaluations included: the creation of linkages with host country institutions; the performance of long-term staff; the project's scope and funding; and the quality of the research conducted. Issues not fully treated by the evaluations of these projects included: the problems entailed in simply conducting research within developing countries and in conjunction with local institutions and researchers; the feasibility or necessity of conducting more research away from the research station; and the dissemination of the research findings.

In conclusion, this review of past AID evaluations identified and documented a set of issues or problems that were more or less familiar to development professionals knowledgeable about the sector. The study also identified significant gaps in the evaluation data base that was analyzed. In terms of producing information that might influence overall policy within the sector and feed into the design of future projects, this study highlighted the need for investigations outside the Agency's system of regularly scheduled evaluations in assessing its project implementation experience.