TRAINING SERIES No 1

MANAGEMENT PERSPECTIVES FOR AGRICULTURAL RESEARCH

Edward L. Felton Jr.
and
S. Huntington Hobbs IV

isnar

International Service for National Agricultural Research

The International Service for National Agricultural Research (ISNAR) began operating at its headquarters in The Hague, Netherlands, on September 1, 1980. It was established by the Consultative Group on International Agricultural Research (CGIAR), on the basis of recommendations from an international task force, for the purpose of assisting governments of developing countries to strengthen their agricultural research. It is a non-profit autonomous agency, international in character, and non-political in management, staffing, and operations.

Of the thirteen centers in the CGIAR network, ISNAR is the only one that focuses primarily on national agricultural research issues. It provides advice to governments, upon request, on research policy, organization, and management issues, thus complementing the activities of other assistance agencies.

ISNAR has active advisory service, research, and training programs.

ISNAR is supported by a number of the members of CGIAR, an informal group of approximately 43 donors, including countries, development banks, international organizations, and foundations.

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MANAGEMENT PERSPECTIVES FOR AGRICULTURAL RESEARCH

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International Service for National Agricultural Research

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FOREWORD

The mandate of the International Service for National Agricultural Research (ISNAR) is to help strengthen national agricultural research systems in developing countries. One of the ways in which ISNAR seeks to meet this mandate is by helping to provide, with management, reinforcement opportunities to agricultural research managers. To this end, ISNAR has worked with agricultural research managers to develop management training materials relevant to the specific challenges confronted by agricultural research managers in developing countries. This volume is an outgrowth of these activities.

The first step taken by ISNAR to initiate management strengthening activities was to survey agricultural research managers and others, in order to identify major management problems in the agricultural research community. Representative management problems were then carefully documented in collaboration with research managers. Existing management training materials were reviewed. Where necessary, new materials were developed in the form of management case studies. Each case dealt with actual problems which a manager had to face. These materials were initially tested in agricultural research management training seminars. They were then revised to improve their accuracy, focus, and training effectiveness. After revision, the case studies were used widely in training settings.

Management cases found to bear most directly on the kinds of contemporary challenges faced by agricultural research managers have been brought together in this volume. These include materials developed at ISNAR and elsewhere. Thus, Management Perspectives to Agricultural Research is not solely an ISNAR venture but rather the product of the interest, commitment, and endeavors of scores of agricultural research managers who have openly shared their concerns with case researchers, freely permitted the documentation of their problems in case form, and candidly discussed and commented on the cases, especially in management improvement seminars.

This volume has been prepared to stimulate the sharing of management ideas and to facilitate strengthening the management of agricultural research in developing countries. It has four specific objectives:

1. to provide a format for the wider dissemination of field-tested management training materials for agricultural research managers in developing countries;

2. to provide a self-standing book that can be used for management improvement by agricultural research managers and training institutions in developing countries;

3. to contribute to advancing the discipline of agricultural research management, in particular by developing concepts of managerial perspectives appropriate for agricultural research managers;

4. to promote the discussion of critical issues and problems in the management of agricultural research in developing countries.

Management Perspectives in Agricultural Research has been developed for three principal groups: senior managers of agricultural research organizations; scientists with administrative responsibilities in agricultural research stations and centers; and agricultural policymakers and members of the boards of research organizations whose work affects agricultural research policies, objectives, and practices. In addition, three other groups will find the volume useful: professionals in management and agricultural training institutions; professionals involved in the design and implementation of agricultural development programs; and other practitioners, government officials, non profit organizations, donor representatives, consultants, and academics with responsibilities or interests in agricultural development.

The management of agricultural research in developing countries is a complex, difficult, and challenging task. ISNAR publishes this book as a part of its ongoing concern with the performance of national agricultural research systems. Management decision making is a continuous process: organizations change; the challenges change; the requirements of management change. ISNAR, firmly committed to strengthening the management of agricultural research in developing countries, will continue to produce and distribute publications designed to further this goal.

Alexander von der Osten
Director General
ISNAR

ACKNOWLEDGMENTS

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We wish to express our appreciation to William K. Gamble, former Director General of ISNAR, for his active support of this initiative at ISNAR and for his efforts on behalf of management improvement activities for agricultural research managers. We also wish to thank Alexander von der Osten, the present Director General of ISNAR, who has continued ISNAR's strong commitment to making management improvement opportunities available to agricultural research managers in developing countries. We are also indebted to Howard Elliott, Deputy Director General for Research and Training of ISNAR.

This book is the product of the efforts and commitment of many persons. The editors gratefully acknowledge the contributions of all who helped develop the management case studies collected in this volume. Particular thanks must be given to Donald Winkelmann, under whose leadership case writing was initiated at the International Center for Maize and Wheat Improvement (CIMMYT) as a tool for strengthening the management of agricultural research leaders. The editors also wish to thank the President and Fellows of Harvard College for granting permission to use "CIAT: The Cassava Program (Colombia)". Funding for many of the case studies appearing in this volume was provided by the United Nations Development Programme, the United States Agency for International Development, and the Overseas Development Administration of the United Kingdom.

Although this volume was developed under ISNAR's auspices, the perspectives and judgments expressed are those of the individual authors and the editors and do not necessarily reflect the views of ISNAR or its officers. The editors readily accept responsibility for any deficiencies in this work and share the credit for its strengths with the contributors and authors. The work is presented in the hope that it will prove useful to managers and others who are concerned about agricultural research.

Edward L. Felton Jr.
S. Huntington Hobbs IV

HOW TO USE THIS BOOK

The purpose of this book is to strengthen the managerial capabilities of agricultural research managers in developing countries. It features a series of management problems that are common in agricultural research settings in developing countries. It presents management concepts that are useful in dealing with these problems. Agricultural research managers who have been exposed to the materials in this book have considered themselves better prepared to analyze and to deal effectively with management problems.

The book has four principal sections, plus an introduction and a final overview. Each of the four main sections presents a different managerial perspective identified by the editors. Original contributions have been edited in order to highlight points which illustrate this particular perspective. Each perspective is an analytical tool for managerial decision making. These managerial perspectives are:

Section One	--	A Marketing Perspective: Targeting the Consumers of Agricultural Research
Section Two	--	A Partnership Perspective: Maximizing Public- and Private-Sector Linkages
Section Three	--	A Systems Perspective: Meeting the Challenges of a Changing Environment
Section Four	--	Integrating New Perspectives: The Challenge of Implementation.

Each section begins with a chapter about the managerial perspective on which the section focuses. The chapter describes the perspective, discusses how to use the perspective, and illustrates the relevance of the perspective to the challenges being faced by agricultural research managers in developing countries. The guiding chapter is followed by three agricultural research case studies, each of which deals with management situations in which the perspective has proven to be a valuable tool. A short introduction precedes each management case study, designed to help the reader identify key issues in the case.

The book also includes an introductory section and a final overview section. The opening section offers an introduction to the use of management perspectives in agricultural research management and consists of a guiding chapter and a management case study. The final section is an overview of management perspectives on agricultural research and contains a case and two chapters. The first of these chapters focuses on the application of management perspectives to agricultural research management. The second identifies emerging trends and challenges that agricultural research managers will be facing in the future. The management perspectives presented in the book are related to these trends, showing that they are useful not only in dealing with contemporary management problems, but also in helping the agricultural research manager begin to prepare today for the challenges of tomorrow.

This book presents fourteen agricultural research management case studies. Each case describes critical issues and problems actually faced today by agricultural research managers in developing countries. Each management case study is the documentation of a real-life situation that required a managerial decision or series of decisions. Because management case studies focus on actual problems, occasionally individuals represented in the case have requested that their names and the names of their organization or country be disguised. This has been done when specifically requested. But the issues and problems presented are from real situations. They have been carefully selected, researched, and written. They represent management challenges being faced by agricultural research managers in developing countries.

Management Perspectives for Agricultural Research is not intended for passive study. To benefit fully from the book, the reader needs to be involved actively -- in thought or practice -- in mental dialogue with the issues and problems that agricultural research managers are facing. This means that the book is not designed to be read at one sitting if one is to benefit from the contents. Rather, sufficient time should be allowed between chapters for the reader to reflect on the problems and issues presented in each situation. While each management case study is a self-standing document, the chapters and cases should be read in the order in which they appear to benefit fully from the management theory on decision making that is developed in the text.

All the management case studies we have included have been tested in two key ways. First, and most important, they have been validated by use in management training seminars for leaders of agricultural research in Africa, Latin America, and Asia. (Most of these management case studies have been translated into at least one language other than English, either French or Spanish.) Seminar participants have found these cases to be highly relevant to their professional needs and to be useful vehicles for enhancing their managerial decision-making skills. The second way the cases were tested was less structured. It involved the people represented in a particular case participating in discussions, most of which were informal, with other agricultural research managers about the issues raised in the case. The people represented in the case studies have felt they acquired new perspectives and benefited from the documentation and discussion of the decisions they were confronting as managers.

Management Perspectives in Agricultural Research does not pretend to provide any pat "answers" to the kinds of problems examined. An appropriate and workable response to a specific problem in one environment may be inappropriate to a similar problem in another setting. Futhermore, until a decision has been implemented and the results observed, one can not with any confidence declare which alternative action might prove the more beneficial.

Most management case studies are designed initially for classroom use. The case method traditionally is seen in management schools as including four stages. The first stage occurs when the individual reads and analyzes the case alone. The second stage takes place in small groups of three to seven individuals who gather together for a modest amount of time (usually forty-five to sixty minutes) to compare their understanding of the case and highlight the main issues. The third stage involves a full class discussion of the case where participants present, discuss, and defend various alternatives under the guidance of a professor. When the case ends, a fourth stage remains: each individual decides for him/herself what decisions he would have made, and the implications of the discussion for his/her own managerial tasks. A decision that is appropriate for one person may not be appropriate for another because people are different. For example, people have different risk preferences and, therefore, respond differently to taking risks.

The guiding chapters and introductory case notes are designed to assist the reader who does not have the benefit of class discussions. The guiding chapters present readers with different perspectives and frames of reference from which to analyze cases, deepen their analysis of the cases, and improve their ability to make decisions. The introductory notes highlight selected problems and issues raised in the individual case studies.

AN INTEGRATIVE PERSPECTIVE

FOR

AGRICULTURAL RESEARCH MANAGEMENT

Chapter 1

INTRODUCTION

INTRODUCTION

In every management situation the decision maker has choices. He or she[1] must decide what action to take and how to implement his/her decision. This is the challenge of being a manager.

Management is not a mechanical activity. Formulas do not exist that provide answers to management problems. Instead, management is a process. The process has many dimensions: defining problems, formulating objectives, identifying alternative actions, analyzing the options, making the management choice, implementing the decision, establishing feedback mechanisms, and monitoring the results.

While the decision maker is going through this process, his environment is changing continuously. These changes have to be taken into account as he wrestles with decisions. Once a decision is made, it sets into motion a series of events that creates the demand for additional decisions, and so the decision-making process continues.

Because management is a continuous process, effective management is demanding. The manager is never sure that a particular decision is the best possible one for the situation. He only knows that he sought to make a decision that was responsive to the problem situation. Furthermore, a manager can seldom predict with certainty the outcome of a decision. A good manager anticipates the likely impact of his decisions but he cannot always be certain about the results.

Effective management is an interactive process. In making and implementing any decision, the manager is continuously interacting with the environment, his organization, and individual people. The effective manager is sensitive to, and influenced by, each of these influences, but controlled by none of them. Ultimately, the decision maker has to make the decision.

Decision making is a lonely enterprise. Though the manager takes into account the judgment of others, the decision is his to make. He is responsible for taking action. He is accountable for the results of his actions.

Decision making is a highly personal process. Ultimately, any decision made by a manager is a reflection of his attitudes and commitments. Each manager is different; each is unique. Each brings a different set of experiences and skills to management tasks. These factors in combination with the values of the manager yield the management decision.

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(1) By convention the authors will favor masculine pronouns, but "he" and "his" should be understood to refer to managers of both sexes.

No two decisions can be precisely the same because people make decisions. People are different; cultures are different. The same person will react differently in different places, at different times of the day, and at different stages of life. For that reason, some people say decision making is an art; you are born a manager or you will never be one. We are all born with different gifts and talents, and some may be born with a more instinctive decision-making capability. But the science of decision making can also be learned and mastered.

While each decision that must be made is unique, what is not unique is the process by which a decision is made. Decision making requires an analytical process. It is a process for identifying and considering options which can reasonably be expected to resolve or minimize a problem. What is critical is that the analytical process gives a coherent picture of what needs to be done.

The professional growth of an effective manager is never complete. Like decision making, professional growth is a continuous process. Regardless of the thoroughness of a manager's education and the depth of his experiences, they are in one sense always obsolete. One's background is in the past; a decision-making situation is in the present. Knowledge and events from the past may be guides, but they are never the sole determinants of a decision to be made in the present.

Making effective decisions requires doing two very different and apparently opposite tasks. The first task is to expand one's vision to encompass as comprehensive a view of the situation as possible. The second task is to focus on the one alternative that seems the most appropriate for resolving the problem.

One proven management tool for encompassing a more comprehensive view is to look at a problem or situation from a number of different management perspectives. To examine the challenges faced by agricultural research managers in developing countries, a comprehensive view can be achieved by utilizing a marketing perspective, a partnership perspective, and a systems perspective. A marketing perspective helps to understand the needs, the strengths, and the weaknesses of all of the relevant groups that can be involved or have an impact on the decision to be made. A partnership perspective helps to identify those mechanisms, linkages, and relationships by which the research manager can be more productive. A systems perspective helps to assure that the alternatives being considered are coherent, are workable, and have a reasonable chance of success.

The management perspectives presented here are a system of analysis, a paradigm, which seek to further the objectives of ISNAR of providing improved management concepts and tools, of having more productive national agricultural research systems, and more effective agricultural research managers in developing countries.

In all of its work, ISNAR utilizes a systems perspective, encompassing in its efforts a focus on the policy context of agricultural research, the structure and organization of national agricultural research systems, and the management of agricultural research. A partnership perspective is reflected in ISNAR's concerns for helping to establish appropriate linkages throughout national agricultural research systems. The building of more effective national agricultural research systems requires a marketing perspective to help assure that critical client groups are being adequately serviced.

After achieving a more comprehensive perspective, the manager must focus on choosing the course of action he will follow. The agricultural research manager will find that by having examined the problem or situation from different managerial perspectives, the alternatives that are not suitable have been eliminated as part of the analysis. The decision is reduced to several alternatives that appear to be appropriate. There may still be more than one reasonable answer, more than one promising course of action to follow, but the task of the manager is to identify the course of action that he thinks is the most appropriate response to the management situation.

Good decision making depends heavily on the quality of available information and analysis. Managerial perspectives are tools to improve the analytical process of decision making. A manager has control over the analytical process he employs. A manager has less control over the information available.

The single greatest excuse for avoiding decision making is waiting for additional information, which is often accepted as an excuse because looking for additional information appears to be action, when in reality it is the avoidance of taking action. Using managerial perspectives gives the manager a more comprehensive view of the information that is available and the opportunity to make a better decision in an imperfect world with imperfect information. This is not to belittle the importance of information. Information is vital, but for a manager, information that does not lead to a good and timely decision is irrelevant.

A decision situation does not wait for a manager. A problem situation continues to evolve, develop, and change even if no decision or management intervention is made. In fact, the failure to make a decision is a decision, and the decision maker is accountable for the results of managerial inaction.

Effective decision making is action oriented; it is not a passive enterprise. The decision maker must continuously be involved in, and monitor, the management environment so that he knows when decisions are needed.

The effective manager recognizes that seldom is a management decision either totally good or totally bad. He does not focus on making good decisions but on making optimal decisions, recognizing that every management decision has both positive and negative dimensions. The effective manager strives to take the action that has the most positive impact on the problem situation, given the goals and the environment.

Effective decision making is both an art and a science, and it is a highly personal enterprise. Thus, no single way exists for integrating new perspectives into making and implementing management decisions.

There are many ways -- perhaps as many ways as there are managers. The critical choice for a manager is how much control is he going to achieve over his destiny. Some get carried along by events and attempt to react to changes as they surface. By using managerial perspectives, a manager can achieve a longer term and more in-depth vision. He can prepare strategies to deal with situations before they develop, or even to influence the course of events so that his task can become easier and more productive.

Chapter 2

PATRONATO: THE AGRICULTURAL RESEARCH AND EXPERIMENTATION BOARD OF THE STATE OF SONORA, MEXICO

PATRONATO: THE AGRICULTURAL RESEARCH AND EXPERIMENTATION BOARD OF THE STATE OF SONORA, MEXICO

A Management Commentary

Patronato[1] is a success story. It is an unusual story, not because it is a success, but because it is a story of farmers forcing agricultural researchers to innovate, to try new ways of doing things, and to change.

It is a situation where the marketing, partnership, and systems perspectives were effectively used. From a marketing perspective, Patronato is a story of "pull" proving more powerful than "push." Most professionals involved in agricultural development think of technology generation and transfer as a "push" process; the scientists develop the technology which is then pushed towards its ultimate user, the farmer. A "pull" strategy, on the other hand, begins by identifying the need of the ultimate user, who could be the farmer, and then developing a product to meet that need. Once the ultimate user is made aware of the new product, he demands, or pulls, the product through the system because it satisfies his need.

The Patronato story begins with a young man wandering into the Yaqui Valley of the State of Sonora in Mexico as World War II was ending. He unrolled his sleeping bag on the site of an old abandoned research station, and began to work on wheat rust. The young man organized a field day to show his work to farmers. As soon as the farmers got off the bus, they were so impressed that they waded into the test plots, machetes in hand, to harvest for themselves as much of the seed as they could get. The young man, Norman Borlaug (who many years later would receive a Nobel Peace Prize for his role in the Green Revolution), had witnessed instant extension. From that day on, the farmers of the Yaqui Valley have organized to request, then to demand, then to have delivered to themselves the technology they want.

When the government research system proved too slow to deliver the desired technology, the farmers organized and supported a research network that was more responsive. The farmers wanted researchers that understood their problems, who "laughed at the same jokes," and were willing to call the Yaqui Valley "home." Maintaining a marketing perspective, the farmers set up an evaluation system that would help assure that the researchers focused their scientific knowledge on the problems the farmers faced. After every crop cycle, the researchers were evaluated on three criteria: the adoption of their work by farmers, the urgency of their work (e.g., stemming a new rust outbreak might be more urgent than continuing fertilizer level trials), and the creativity of the researcher's work.

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(1) Patronato was the popular name for the Agricultural Research and Experimentation Board of the State of Sonora, Mexico (Patronato para la Investigación y Experimentación Agrícola del Estado de Sonora, Mexico).

Patronato also demonstrates how a partnership perspective in management can lead to success. Initially, Patronato tried to rely on all existing institutions and linkages that could be used to meet Patronato goals. If these institutions or linkages proved inadequate, Patronato created the institutions and forged the linkages that were required to fulfill the task. While being a private association of farmers, Patronato worked closely with the public sector to the extent that the government covered the bulk of the expenses for agricultural research in the Yaqui Valley. However, Patronato maintained control over the research agenda by having negotiated with the government the right to evaluate each scientist's work, and to pay researchers an additional salary premium for Patronato-oriented research. Patronato established relationships with seed producers to assure that the research was converted into quality seed for the farmers.

By relying on a systems perspective, Patronato was able to identify all the institutions and actors that were important for its success, and to devise mechanisms to involve them in Patronato's work. Patronato drew support from agricultural-input suppliers, government grain-buying agents, agricultural commodity and seed exporters, the milling industry, international donor agencies, and international agricultural research institutions.

Patronato evolved as its needs and the food system of which it was a part evolved. A food, crop, or commodity system is not static, and a systems perspective requires constant surveillance of the environment, scanning for opportunities and the need for adjustments. Patronato successfully interrelated the marketing, partnership, and systems perspectives by integrating an association of farmers "backwards" towards the generation and transfer of the technology they wanted. Patronato's efforts led to increases in wheat yields by farmers in the Yaqui Valley of over 200%. As more farmers became interested, Patronato began to seek the mechanisms and linkages to expand into other crops. Patronato's latest challenge was how to expand to meet the needs of public-sector farmers.

Many will be tempted to see Patronato as a role model and to consider whether this model can be duplicated in their countries. The key lesson of Patronato is not the specific mechanisms, linkages, and procedures the association developed, but rather that Patronato developed the mechanisms, linkages, and procedures that were necessary for its success. As one of the founders of Patronato stated, "People come to study Patronato as this very big successful organization and conclude that it would be very difficult to reproduce Patronato in their countries. I tell them that Patronato started as an idea, and then as a very small organization of two people and no secretary. Patronato grew because it never lost sight of its purpose: to serve the farmers of Sonora. We tried many things and failed many times, but the farmers knew we were working for them. By perseverance and seeking every opportunity we have found ways to be a service to our farmers. You see the proof. The farmers give greater support to Patronato every crop cycle, and now even visitors from far away are interested in Patronato."

PATRONATO: THE AGRICULTURAL RESEARCH AND EXPERIMENTATION BOARD OF THE STATE OF SONORA, MEXICO
A Case Study

by S. Huntington Hobbs IV

During February 1980, a group of leaders of national agricultural systems (NARS) from numerous developing countries visited the Agricultural Research and Experimentation Board of the State of Sonora, known as Patronato. The NARS leaders had been invited to review the Patronato operations in the hope of identifying useful lessons for incorporation into the development efforts of their countries. The visit had been an interesting one.

Patronato, producers and distributors of 50% of all the certified wheat seed[1] in Mexico, was an association founded by the private farmers of Sonora to finance applied agricultural research. Since its inception in 1968, Patronato had primarily funded applied wheat research to improve disease resistance and yield potential. Moreover Patronato produced certified wheat seed by contracting with local farmers in Sonora. Patronato's success was legendary: during Patronato's first decade of operation, average wheat yields in the principal wheat producing region of the Yaqui Valley of Sonora had increased from 3.0 tons per hectare in 1968 to 5.1 tons per hectare in 1979.

The success of Patronato was underscored by the Governor of Sonora's recent proposal that Patronato expand its sphere of activity to include livestock and crop production in areas of low rainfall.

The governor's proposal would have nearly doubled Patronato's budget and made evident the government's hope that Patronato's success in funding and helping orient applied research and seed production in wheat could be extended to other sectors of Sonora's agriculture. To many of the NARS leaders, the governor's proposal reinforced their desire to identify those elements which had been critical to the success of Patronato and which might be transferable to the research, seed multiplication, and distribution efforts of other developing countries.

The Origins of Patronato

In 1944, Norman E. Borlaug began research on wheat in Mexico under the auspices of the Rockefeller Foundation and Mexico's Ministry of Agriculture. Having heard there was an agricultural experiment station in the State of Sonora, Dr. Borlaug made his first trip to Sonora in 1945, where he found that Sonora wheat crops were being destroyed by stem-rust, and that the experiment station, founded in 1934, was a collection of empty dilapidated buildings. Dr. Borlaug single-handedly initiated wheat research on the abandoned research fields, and over the next few years won the grudging support of local farmers and program officials.

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(1) Certified seed is commercial seed which has been inspected for quality and purity.

Dr. Borlaug began to plant two crop cycles a year: a winter crop in Sonora at an altitude of 40 meters and a summer crop in Toluca at an altitude of 2,640 meters (Exhibit 1). This system was implemented to halve the time required to develop a new variety, and to seek resistance to different diseases. Breeding and selecting at contrasting sites for wide adaptability led to development of the day-length insensitivity which was prerequisite for effective world-wide transfer of improved wheats.

Dr. Borlaug's initial research, which centered principally on disease resistance, had a substantial impact on wheat yields in Mexico as average wheat yields increased from 740 kilograms per hectare in 1945 to 1,440 kilograms per hectare in 1957. In 1955, a group of private farmers of Sonora, in support of Borlaug, donated the land to the government for a Center for Agricultural Investigation of the Northwest (Spanish acronym: CIANO) to conduct crop research in Sonora. Yet wheat yields levelled off after 1957 as the new varieties tended to lodge, or collapse, under the weight of the grain when nitrogen fertilizer rates of over 80 kilograms per hectare were applied. Developing a stiff-strawed wheat variety became a central research objective at CIANO.

In 1954, Borlaug began to cross the tall Mexican wheats with the dwarf Norin 10 wheat from Japan. In 1962 and 1964, the first high-yielding semi-dwarf wheats were released: Penjamo 62, Pitic 62, Sonora 64, Lerma Rojo 64 (Exhibit 2). These varieties indicated a yield potential of up to 6,000 kilograms per hectare. Since then, Borlaug's research at CIANO was strengthened through the participation of the International Wheat and Maize Improvement Center (Spanish acronym: CIMMYT), which brought substantial additional donor resources to bear on increasing maize and wheat yields in developing countries.

In 1962, Sonora farmers became the first to plant the newly released semi-dwarf varieties Penjamo 62 and Pitic 62. Average wheat yields in the Yaqui Valley(2) increased from 2.5 tons per hectare in 1961 to near 3.5 tons in 1964. In 1968, India purchased 250 tons of seed from Sonora farmers, and Pakistan purchased 350 tons. The following year, India purchased 18,000 tons, and Pakistan purchased 42,000 tons directly from Sonora farmers.

Yet, from 1964 to 1968, the farmers of the Yaqui Valley were unable to increase wheat yields beyond 3.5 tons per hectare (Exhibit 4). The Borlaug research team at the CIANO-CIMMYT research center had been achieving potential yields of 7 tons per hectare since 1966 (Exhibit 3). The farmers of the Yaqui Valley were convinced that great benefits could be derived from applied agricultural research, and began to search for a way to accelerate the transfer of agricultural technology from the research center to their fields. The farmers of Sonora knew that the Mexican Government had few funds to allocate to Sonora for agricultural

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(2) The Yaqui Valley was Sonora's most important agricultural area, accounting for approximately 33% of Sonora's agricultural production.

research. Already, in 1964, the farmers of Sonora initiated a program of voluntary contributions to help fund agricultural research through the Ministry of Agriculture. Yet the farmers had become disillusioned because their contributions were being absorbed by the Federal Government without any apparent returns for Sonora.

Indeed, in 1968, the public expenditure in agriculture for the State of Sonora had been a mere 9.61[3] pesos per hectare, virtually the lowest rate for any state in the country. Therefore, the farmers of Sonora decided to create and fund an organization to sponsor applied agricultural research for them in Sonora.

The farmers of Sonora were well organized, each belonging to at least one farm association, credit union, or marketing board. In early 1968, the representatives of various Sonora farm organizations met to decide how to best fund the agricultural research they wanted for Sonora. The representatives decided to raise funds among themselves and to use the funds to sponsor complementary research in conjunction with the existing national wheat research program at CIANO. CIANO presented several advantages. CIANO had an existing program which was publicly funded, and therefore the cost of the research could be shared between the farmers and the Mexican Government. CIANO cooperated with CIMMYT, which had assumed the continuation of Dr. Borlaug's work and had a mandate to provide improved wheat seed to developing countries. After some exploratory talks with government officials and CIANO research personnel, in April 1968, the representatives of twenty-four farm and credit organizations of the State of Sonora formally formed PATRONATO, The Agricultural Research and Experimentation Board of the State of Sonora. The charter of Patronato specifically stated that "the objectives of Patronato will be to constitute, increment, and administer funding for the Center for Agricultural Investigation of the Northwest (CIANO). . . and to reproduce for its members the breeder seed produced by CIANO."

Patronato Operations

In exchange for Patronato's financial support to CIANO, the Ministry of Agriculture agreed to provide Patronato with 50% of the breeder seed produced by CIANO. The other 50% of the breeder seed was given to the Productora Nacional de Semillas (PRONASE), the government seed organization. Previously, wheat seed had been multiplied and sold only by government agencies, and on an informal basis by farmers.

In 1968, Patronato provided over six million pesos to CIANO (Exhibit 5), and donated 150 hectares in the Yaqui Valley to CIANO. Additionally, four new research stations were created in other parts of the State of Sonora to broaden the agroclimatic base of CIANO research, and to provide each of the important agricultural areas of Sonora with a research center of its own. Patronato and CIANO initiated a program of visits by farmers to CIANO research centers and a series of lectures on such topics as herbicide use, fertilization in Sonora, soil humidity effects on yields, and optimum planting dates.

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(3) Before September 1976, the Mexican peso had a fixed parity of U.S. $1=12.50 pesos; after September 1976, the Mexican peso was floating versus the dollar.

The results of Patronato and CIANO's efforts were dramatic. In 1969, with the planting of the "Siete-Cerros" variety named after the "seven hills" near CIANO (Exhibits 2 and 3), the 3.5-ton-per-hectare yield barrier was broken with an average yield of over 3.7 tons per hectare in the Yaquí Valley.

By 1975, the average yield was more than 5 tons per hectare, the highest commercial spring wheat average in the world. Though yields decreased to 4.1 tons per hectare in the Yaqui Valley due to a rust outbreak, by 1979 wheat yields were again above 5 tons per hectare through the rapid multiplication and planting of rust-resistant varieties (Exhibit 4).

As other farm organizations involved with other crops in Sonora joined Patronato, Patronato's mandate was extended from wheat to include cotton, soybeans, chickpeas, walnuts, grapes, other fruits, and oilseeds. By 1979, Patronato had donated over 400 hectares to CIANO and had made an additional 350 hectares available for CIANO's use.

Seed Multiplication

Since 1968, Patronato and the government seed company (PRONASE) had each received 50% of the breeder seed produced by CIANO. Patronato multiplied the seed it received by contracting with member farmers who had developed a reputation for quality seed production. Member farmers received a 1,000-peso-per-ton premium over average total costs of production as an incentive to produce quality seed. In 1979, Patronato estimated the average total costs of production had been 3,000 pesos per ton, paid the contracted farmers 4,000 pesos per ton, and sold the seed to member farmers for 6,000 pesos per ton. Eduardo Castello, General Manager of Patronato, stated, "We have found that low-priced seed is misused. A high price insures the seed is treated with respect." Since wheat was only grown in Sonora during the winter, if a new variety was needed with urgency due to a disease or an export opportunity, Patronato contracted with farmers in other areas of Mexico to multiply seed in the summer cycle. Patronato members preferred the seed produced in Sonora as they felt that Sonora farmers took greater precautions to assure varietal purity and elimination of weeds, and it was less expensive. In 1978, Patronato paid 8,134 pesos per ton for seed contracted outside of Sonora, and had absorbed the loss of selling the seed to members at 6,000 pesos per ton. Patronato seed was treated and bagged by seed-processing plants belonging to member associations of Patronato. Patronato sold its seed exclusively to members, and the seed was distributed by the member farm organizations.

In 1980, Patronato had ceased to multiply the varieties planted commercially that year, as a new rust epidemic seemed imminent. Patronato had initiated a crash program to multiply the most recent breeder seed of new rust-resistant varieties released by CIANO. Castello stated, "We have 425 hectares planted. That is all the seed we have. But that should give us 2,500 tons of seed, enough to replace the most susceptible variety in the winter of 1980-81. We are a service, not a business. We provide the seed that members require as fast as possible."

Mexican Wheat Seed Exports

Since the first shipments of high-yielding, semi-dwarf wheat seed from Sonora to the Indian subcontinent in 1964, Mexico had become a significant exporter of wheat seed. Mexican wheats were cultivated throughout the world and, in 1971, Mexico exported a record 77,841 tons of wheat seed (Exhibit 6). Most of the Mexican wheat seed was produced in Sonora. In 1971, Sonora accounted for nearly 68% of the certified wheat seed produced in Mexico (Exhibit 7). Seed was certified by the National Service of Inspection of Certified Seed (SNICS). It was estimated that, in 1979, 95% of the Mexican wheat area was sown with certified seed.

Mexican Seed Policy

Mexican seed policy was formulated by the National Seed Committee (NSC). The NSC was composed of SNICS, the Ministry of Agriculture, the National Plant Registry, the government seed company (PRONASE), and a representative of the private seed producers. In 1976, Patronato became the representative of private seed producers, in recognition of Patronato's role in coordinating seed production in Sonora. The NSC set guidelines for seed imports, exports, and production volumes which SNICS implemented through the use of trade and planting permits. The multiplication of breeder seed to produce large volumes of quality seed for commercial use required careful management and strict supervision. To insure varietal purity and prevent transmission of diseases, SNICS guidelines stipulated that seed could only be multiplied in any given field every third year. Wheat seed was often rotated with cotton in Sonora, as cotton cultivation left the field almost free of weeds.

The National Seed Committee categorized seed into four types: breeder, basic, registered, and certified. Breeder seed was the seed developed by breeders' research. Basic seed was breeder seed which had been multiplied under strict standards to maintain genetic purity. Registered seed was derived from basic or other registered seed, and could be sold commercially. Certified seed was the highest grade of commercial seed and was usually multiplied from top-quality registered seed.

PRONASE

The government seed company (PRONASE), an agency of the Mexican Government, multiplied seed at twenty-three locations throughout Mexico. PRONASE produced seed in wheat, rice, beans, maize, oilseeds, and other crops (Exhibit 8). In wheat, PRONASE itself grew only registered seed. PRONASE contracted with private farmers in thirty locations to grow certified seed. PRONASE offered a 10% premium over the guaranteed price of wheat as an incentive to seed growers. In 1979, the guaranteed price of wheat had been 3,000 pesos per ton. In 1980, the guaranteed price of wheat had been increased to 3,700 pesos per ton. PRONASE sold certified wheat seed at 6,000 pesos per ton. PRONASE planning officials considered that many private farmers were well prepared and experienced in the mass production of certified wheat seed, while PRONASE itself was better suited to maintaining the constant supervision, specialized personnel, and high unit costs of the early stages of seed multiplication. A PRONASE official stated, "It is PRONASE's role to dance with the least desirable girl at the party. We must produce the quality seed in crops the private sector finds unprofitable. We are also better suited to administering the earlier stages of seed multiplication. The beginning and end of our task is simply to maximize production of good crop seed in Mexico."

Private farmers growing certified wheat seed for PRONASE delivered the seed to PRONASE, which cleaned, tested, treated, bagged, and warehoused the seed prior to distribution. PRONASE sold 60% of its wheat seed to the National Rural Bank (BANRURAL), 15% through PRONASE distribution outlets, and 25% through the farmers who grew the seed. PRONASE production levels were determined in consultation with BANRURAL. BANRURAL used the seed to provide loans in kind. In 1974, PRONASE produced a record 77,381 tons of certified wheat seed which accounted for nearly 90% of the national demand (Exhibit 8). However, since 1974, PRONASE had been decreasing its role in wheat seed production, and by 1979, PRONASE's national share of certified wheat seed sales had declined to 50%, or 41,505 tons (Exhibit 8). A PRONASE official explained, "We recognize the efficiency of the private farm organizations of Sonora and their Patronato. We plan to reduce our participation to 25% of national production. With a participation of 25% we can still prevent monopolies and manipulation of the price of seed."

The State and Farmers of Sonora

The State of Sonora (Exhibit 1) was Mexico's bread basket. In 1979, the farmers of Sonora harvested 50% of Mexico's wheat production. The State of Sonora accounted for approximately 9% of Mexico's arable land. A survey indicated that during the winter crop cycle the farmers of Sonora planted 39% of the arable area in wheat, 29% in oilseeds, 22% in cotton, and 9% in other crops. During the summer crop cycle, due to water scarcity, the area planted was halved, yet Sonora farmers still produced 35% of Mexico's soybeans. The Ministry of Agriculture indicated that in 1970, the State of Sonora had 623,000 hectares of irrigated land, and 150,000 hectares of rain-fed agriculture. Sonora's 81% of irrigated farmland was double the percentage of irrigated farmland in any other state in Mexico, and far above the 19% national average. Annual rainfall in Sonora was 20 to 200 millimeters, and the 20-year annual average in the Yaqui Valley was 268 millimeters.

In 1926, the government initiated expansion of irrigation in Sonora, which helped turn 26,000 hectares of desert and sagebrush in the Yaqui Valley into a flat, fertile plain. In 1952, with the construction of a large hydroelectric dam, an additional 200,000 hectares of the Yaqui Valley desert was converted into agricultural land. The Ministry of Agriculture divided the valley into a grid of irrigation zones which allowed for the maximum utilization of available water. The Yaqui Valley became the agricultural center of Sonora. Due to the success of the Yaqui Valley, small dams were built in Sonora wherever a dependable source of water could be found; and where no surface water was available, wells were dug. The Yaqui Valley is ideal for irrigated farming in that it is essentially flat, sloping gradually from the hydroelectric dam 100 kilometers inland to the seacoast; this makes gravity irrigation possible throughout the valley.

In 1972, the State of Sonora had a population of 58,000 involved in agricultural and livestock production, of which 65% were ejidatarios. Ejidatarios were farmers who received use-rights on Agrarian Reform lands, but did not have the right to sell, rent, or bequeath the property. In the Yaqui Valley there were 3,615 private farmers and 4,311 ejidatarios. Ejidatarios held an average of 11.0 hectares, and private famers owned an average of 25 hectares, though some private farms were as large as 900 hectares.

The farmers of Sonora were the most productive farmers in Mexico. In 1970, the average production of a farmer from Sonora had a market value of 54,010 pesos, while the national average production of Mexican farmers in general was valued at 10,520 pesos. Eighty-six percent of all farmers planted wheat during the winter crop cycle (Exhibit 9). The principal crop cycle in Sonora was the winter cycle, from November to May, yet due to Sonora's latitude, altitude, and temperatures, the temperate-climate 'spring wheats' were cultivated. The spring-summer crop cycle in Sonora was limited by water scarcity and high temperature; in the spring roughly half of the lands were planted, mostly with soybeans.

The farmers of Sonora fertilized their lands with an average of 150 kilograms of nutrients per hectare every year, 35% above the national norm. The farmers of Sonora also led the nation in the use of agricultural machinery. By 1970, over 78% of Sonora's farms were fully mechanized, while less than 20% of the farms in the rest of the country were fully mechanized (Exhibit 10). During 1970, the average private farmer in the Yaqui Valley was found to own two tractors and farm equipment worth 228,402 pesos (Exhibit 11). Overall, the investment per hectare during 1970 was 2,050 pesos in Sonora, and the national average was 445 pesos. Furthermore, Sonora farms also had the highest return on investment in Mexico. During 1970, a 1,000-peso investment in agriculture netted a profit of 471 pesos of agricultural produce in Sonora, and only 316 pesos as a national average.

Though irrigation and mechanization had been essential to achieving the high agricultural productivity of the State of Sonora, the farmers of the Yaqui Valley believe that the initiative of the local population was primarily responsible for converting the Sonora desert into Mexico's bread basket. Castelo echoed this conviction: "It is the initiative of the farmers of this valley that led to the foundation of Patronato. The founders of this organization wanted better seed, and they just weren't willing to wait for someone to bring it to them."

The Organizational Structure of Patronato

In 1968, the founders of Patronato perceived that they had two different constituencies of farmers and thus they needed an organization to reflect this. The founders realized that the problems of the farmers of the Yaqui Valley and vicinity--those with gravity irrigation--were quite different from the problems of the well-water farmers in the north of Sonora. Water pumped from wells has a high mineral and saline content which can demand different irrigation schedules and result in different crop responses than those accompanying irrigation by surface water. Patronato was divided administratively into northern and southern jurisdictions. In order to prevent the appearance of favoring either jurisdiction, the Patronato constitution stipulated that no decision was valid unless it was approved by the presidents of both the north and south jurisdictions. Patronato had a board of managers which was composed of the presidents of two jurisdictions, the treasurer, and the secretary. The presidents were elected by the private farm organizations in each of the jurisdictions. The treasurer was also elected by the private farm organizations. The representatives of the Ejidatarios of Sonora had asked to join Patronato, and the private farm organizations of Sonora had voted to welcome the public farm sector into Patronato in 1976. Since then, the treasurer was appointed by the Ministry of Agrarian Reform as a representative of the ejidatarios. The secretary was appointed by the Ministry of Agriculture. The members of the Board of Managers were elected for two-year terms and could not be reelected. The Board of Managers hired the general manager and staff.

By 1980, Patronato membership numbered 33 farm organizations, each of which represented the interests of several hundred farmers. Each member organization elected a representative who attended two General Assembly meetings a year where Patronato policy was decided by majority vote. Member organizations also directed Patronato policy through "liaison consultants." Patronato management hired a full-time liaison consultant for each of the member organizations. The liaison consultant was in everyday contact with Patronato management and member farmers. They kept farmers informed of all Patronato and CIANO activities, and helped extend CIANO agronomic recommendations to the farms. The liaison consultants also kept Patronato and CIANO management fully informed of the needs and interests of member farmers.

CIANO personnel initiated projects to meet farmer concerns by presenting a project outline and budget to Patronato management. Approved projects were reviewed on a monthly basis by the top CIANO and Patronato personnel. Ing. Angel Fierros, President of Patronato, stated, "The costs of new operations are totally absorbed by Patronato while we pursue the necessary procedures to pass these operations to federal budgets. This allows us to seek solutions to regional problems, and prevent the delay that would be entailed in waiting for federal funds to solve our problems."

<u>The Financing of Patronato</u>

Patronato had developed a variety of mechanisms to finance its activities. The most important source of funds had been contributions by member farmers, but over the years Patronato had developed other sources as well.

Before 1980, member farmers had contributed 7.50 pesos for each ton of grain or cotton fiber they produced. But since contributions arrived at harvest time, Patronato had always been faced with the necessity of borrowing short-term funds during the crop cycle to finance its activities. During the March 1980 General Assembly, the representatives voted to give their contributions before the crop cycle on an estimated yield basis (Exhibit 12). Member farmers also contributed 45 pesos for each ton they exported. In 1979, member contributions totalled eleven million pesos.

The member contributions were collected for Patronato by CONASUPO, the government grain-buying agent. CONASUPO, in turn, contributed 1.00 peso to Patronato for every ton of wheat bought in Sonora, and the wheat-flour industry contributed 2.50 for every ton purchased from CONASUPO. The CONASUPO and wheat-flour industry contributions, directed to help improve the milling quality of Sonora wheat, totalled 3.5 million pesos in 1979. Patronato also generated a profit of 2.3 million pesos in 1979 from the sale of seed to members.

The National Service of Inspection of Certified Seed donated two million pesos, and tax-deductible contributions authorized by the Ministry of Finance totalled another two million pesos in 1979. The government of the State of Sonora made an initial contribution of three million pesos, and the M. S. Jenkins Foundation donated 1.5 million pesos in 1979. Several manufacturers donated fertilizers, tractors, and other agricultural inputs.

The Use of Patronato Funds

During 1979, Patronato contributed twenty million pesos towards the 120 million-peso CIANO budget. Patronato management considered that the top priority of Patronato funds was to supplement the incomes of CIANO personnel. Patronato was most interested in developing a cadre of high-quality agricultural researchers who would stay in the State of Sonora. Eduardo Castelo, General Manager of Patronato, explained, "The incentives and compensations are to draw the top professionals available to Sonora. We want these people to take roots here. This will give continuity and drive to our programs. If a person feels at home here and shares our affection for this land, we will progress that much faster. The number one priority of Patronato funds is, and always will be, the agricultural researcher." Patronato and CIANO top management jointly decided on the incentive package of each researcher. Ing. Angel Fierros stated, "Each scientist is systematically evaluated after each crop cycle on the importance of his work, his creativity, and the adoption by member farmers of the technology he generates."

Projects were evaluated and budgeted on a monthly basis, and in 1980 Patronato was preparing a 10-year plan for CIANO infrastructure.

The Patronato Model

Dr. Borlaug, who had been intimately involved with the development of Patronato, was invited to address the visiting NARS leaders, and present some of his views on the Patronato experience. Dr. Borlaug strongly believed the experience could, and should, be repeated elsewhere. "Seed programs are ineffective in so many countries. What is important is that the farmers get involved to protect research from the vagaries of political pressure," he stated. "When someone tried to push a politician into a key slot at CIANO, the farmers' voices were heard." Dr. Borlaug stated that Patronato had been successful because Patronato budgets and expenses were regularly and clearly explained to members, that Patronato leaders left the technical decisions to the scientists, and that members had always elected top people to manage Patronato funds. Dr. Borlaug also considered that the two-year limit for Patronato officials assured that fresh points of view were regularly brought to Patronato. "What is most significant," concluded Dr. Borlaug, "is that not one single farmer in Sonora has ever refused to give a contribution. That tells you something."

The NARS leaders left Sonora with multiple impressions. For some, Patronato seemed to present a model they should seek to replicate in the immediate future. For others, Patronato seemed a unique experience that would be difficult to repeat elsewhere. But all the NARS leaders agreed that Patronato presented some valuable lessons for agricultural development. The key question they were facing was which of these lessons should they seek to apply in their own countries?

Exhibit 1

PATRONATO
THE AGRICULTURAL RESEARCH AND EXPERIMENTATION
BOARD OF THE STATE OF SONORA, MEXICO

Map of Mexico

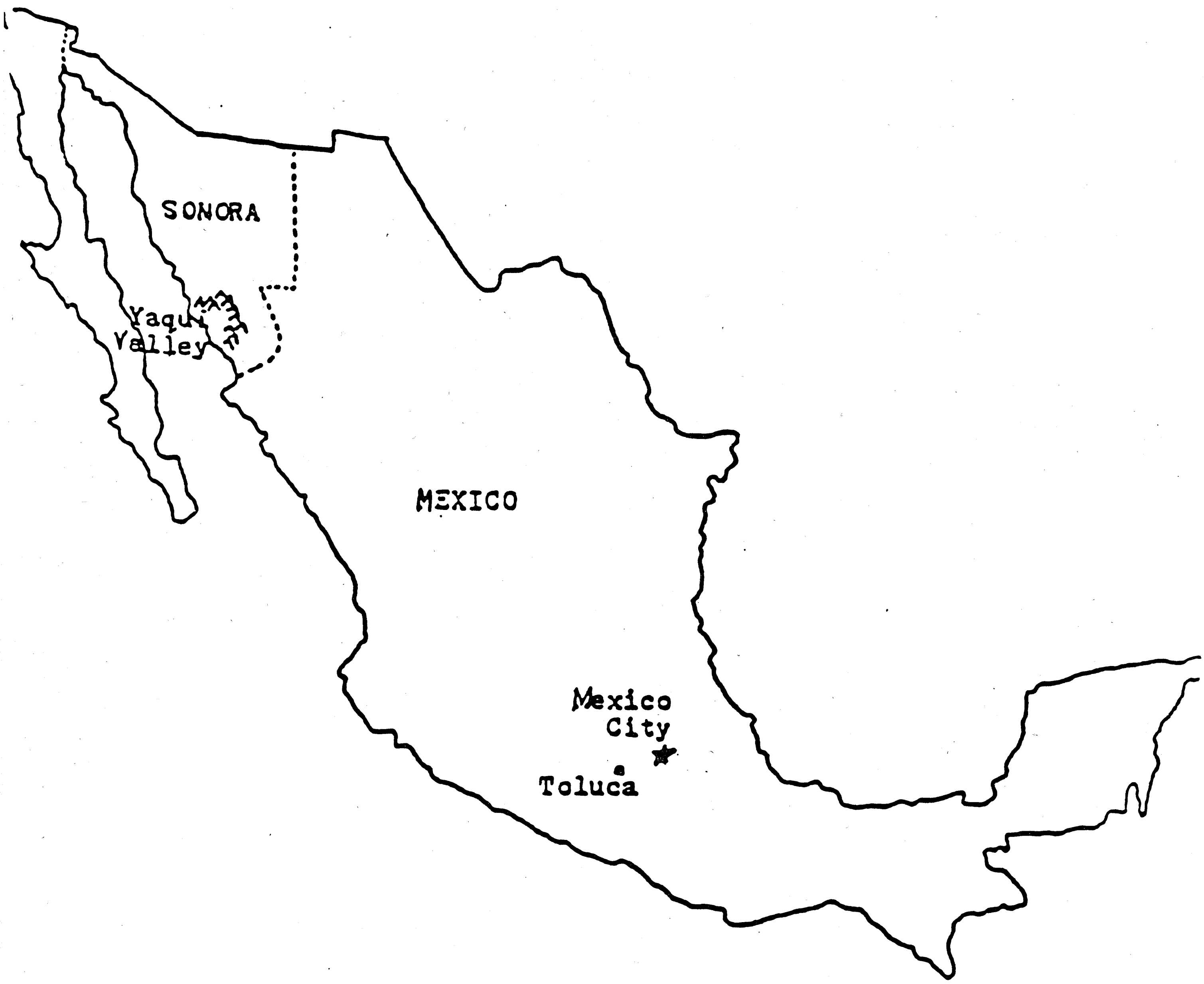

Exhibit 2

PATRONATO
THE AGRICULTURAL RESEARCH AND EXPERIMENTATION
BOARD OF THE STATE OF SONORA, MEXICO

Genealogy of Early "Green Revolution" Semi-Dwarf Wheats

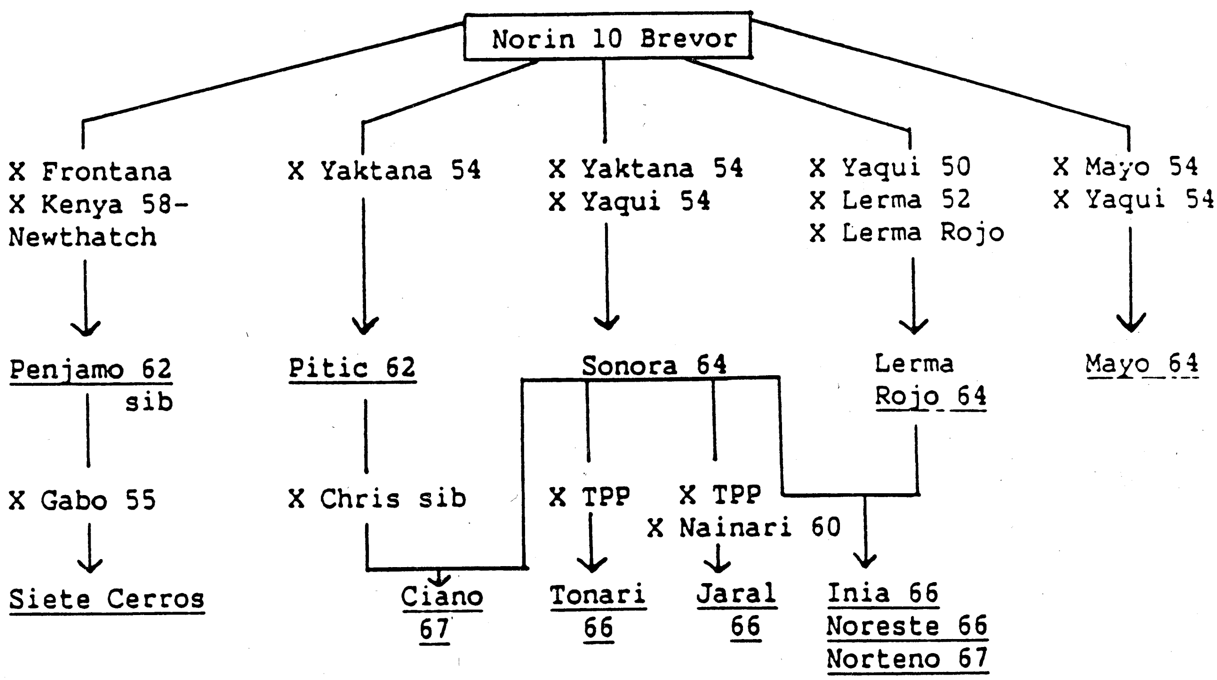

Exhibit 3

PATRONATO
THE AGRICULTURAL RESEARCH AND EXPERIMENTATION
BOARD OF THE STATE OF SONORA, MEXICO

Selected Spring Bread-Wheat Varieties Bred by CIMMYT-CIANO
or Predecessors, Released in Mexico, 1950-78

Year of Mexican Release	Variety Name	Year of Cross	Yield Potential kg/ha*	Plant Height cm
1950	Yaqui 50	1945	3500	115
1960	Mainari 60	1958	4000	110
1962	Pitic 62	1956	5870	105
1962	Penjamo 62	1956	5870	100
1964	Sonora 64	1957	5580	85
1964	Lerma Rojo 64	1953	6000	100
1966	Inia 66	1962	7000	100
1966	Siete Cerros 66	1957	7000	100
1970	Yecora 70	1966	7800	75
1971	Cayeme 71	1966	7000	75
1971	Tanori 71	1968	7000	90
1973	Jupateco 73	1969	7500	95
1973	Torin 73	1967	7000	75
1975	Cocoraque 75	1969	7000	90
1975	Salamanca 75	1967	7000	90
1975	Zaragoza 75	1964	8000	90
1976	Nacocari 76	1969	7800**	90
1976	Pavon 76	1970	7500**	100
1977	Pima 77	1964	7500**	90
1977	Hermosillo 77	1972	7500**	85
1977	Jauhara 77	1969	7500**	90

* Measured at experiment station in Mexico, irrigated under high soil fertility, and essentially disease-free.

** Yield of varieties released in 1976 and 1977 has ranged 7500-9500 kg/ha in different seasons and trials but the conservative minimum of 7500 kg/ha is given here for all five releases.

Source: CIMMYT.

Exhibit 4

Patronato

Average Wheat Yields in the Yaqui Valley

1956 - 1979

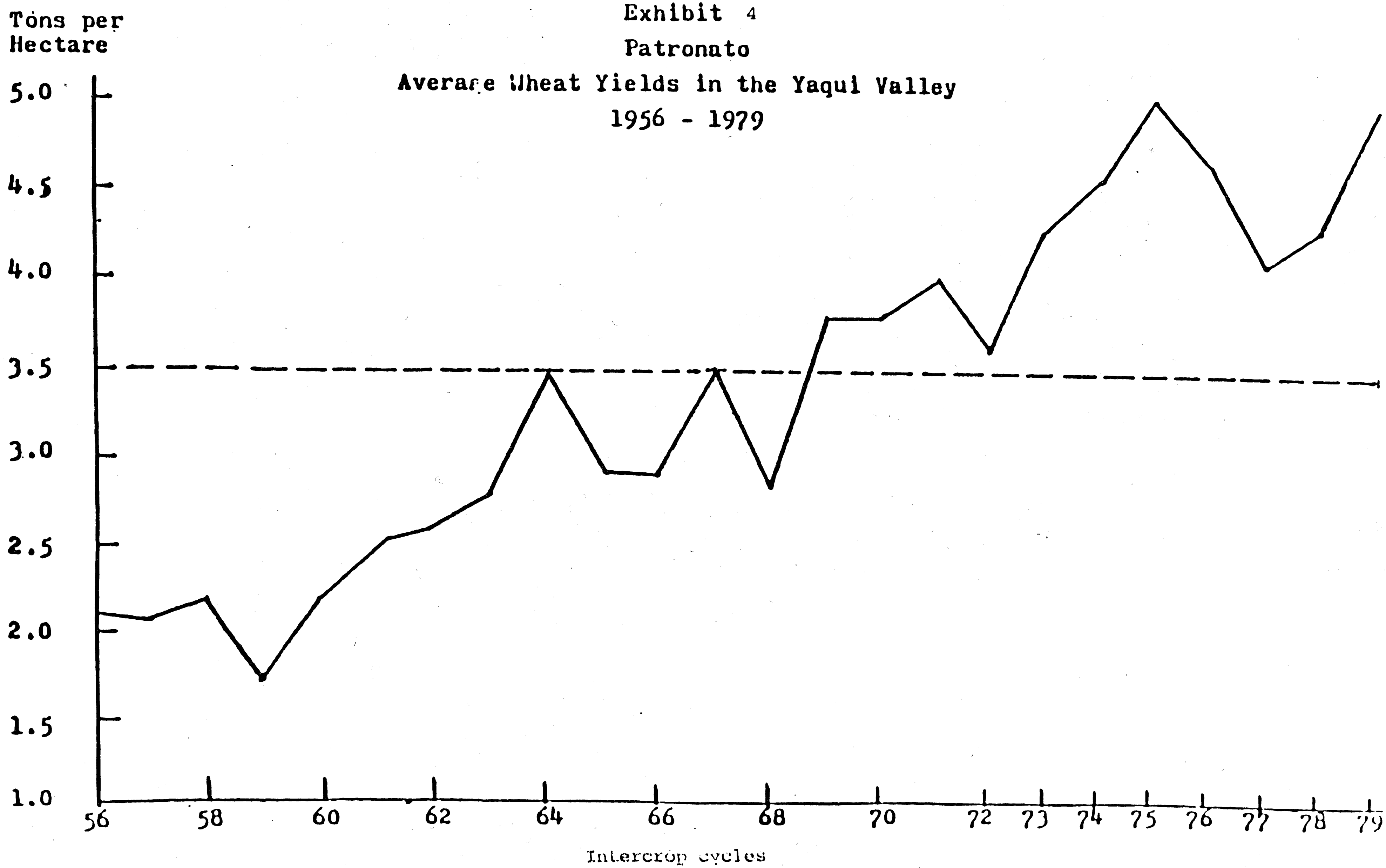

Exhibit 5

PATRONATO
THE AGRICULTURAL RESEARCH AND EXPERIMENTATION
BOARD OF THE STATE OF SONORA, MEXICO

First Patronato Yearly Budget in Pesos
April 1, 1968, to March 31, 1969

	Mexican Pesos
Sources:	
Member Contributions	3,007,529.92
National Service of Plant Sanitation	125,000.00
Ministry of Agriculture	1,356,440.00
CONASUPO	1,000,000.00
Federal Government	714,166.60
Monsanto Mexicana (private company)	8,000.00
	6,211,136.52
Uses:	
Yaqui Valley	3,637,329.19
New Centers:	
Hermosillo	769,226.96
Caborca	275,918.17
Mayo	417,423.51
Guaymas	322,628.02
Working Capital	283,774.27
Patronato Overhead	92,998.24
Patronato Administration	274,644.93
	6,073,943.93
Year-end Surplus	137,193.23
	6,211,136.52

Note: US$1. = 12.50 pesos.

Exhibit 6

PATRONATO
THE AGRICULTURAL RESEARCH AND EXPERIMENTATION
BOARD OF THE STATE OF SONORA, MEXICO

Seed Exports in Metric Tons and Thousands of Pesos
1967 to 1977

Year	Rice		Beans		Maize		Sorghum		Soybeans		Wheat	
	Tons	Pesos (000's)	Tons	Pesos (000's)	Tons	Pesos (000's)	Tons	Pesos (000's)	Tons	Pesos (000's)	Tons	Pesos (000's)
1967	–	–	–	–	51.4	141.0	450.0	1,462.5	–	–	121.0	25.6
1968	–	–	–	–	15.0	52.0	1,007.0	2,720.6	–	–	4,201.6	6,868.7
1969	–	–	–	–	19.0	79.6	2,103.4	6,804.9	–	–	6,070.8	10,043.8
1970	–	–	20.1	20.3	2,300.1	6,260.4	216.0	750.4	–	–	8,894.7	19,524.4
1971	–	–	–	–	2,803.2	8,610,0	457.0	2,412.5	0.6	2.2	77,841.1	149,936.7
1972	–	–	2,550.1	11,948.9	404.1	1,300.0	336.7	1,084.8	–	–	–	–
1973	–	–	1,050.0	2,703.1	28.6	144.1	530.0	2,082.6	5.0	25.0	8,394.4	18,799.0
1974	–	–	1.0	8.7	5,233.1	27,996.4	395.4	1,552.2	–	–	22,792.0	69,904.4
1975	5.0	37.5	–	–	1,049.7	8,312.2	620.0	3,478.0	302.5	1921.5	62,884.5	243,065.0
1976	–	–	20.4	1,003.6	30.1	285.3	286.3	2,185.1	–	–	13.4	23.1
1977	–	–	3.0	28.4	596.1	11;296.3	–	–	2.0	20.0	17,031.1	89,708.3

Source: SARH, S.C.A. Servicio Nacional de Inspección y Certificación de Semillas.

Exhibit 7

PATRONATO
THE AGRICULTURAL RESEARCH AND EXPERIMENTATION
BOARD OF THE STATE OF SONORA, MEXICO

Mexican-Certified Wheat Seed Production by State
1971

State	Area (hectares)	Average Yield	Production (Tons)	Percent of Production
Puebla	25	1.4	34.1	0.1
Aguascalientes	45	1.8	81.8	0.2
Zacatecas	30	3.7	110.2	0.2
Durango	150	0.8	120.4	0.2
Tlaxcala	180	1.9	344.9	0.6
Jalisco	150	3.8	573.1	1.1
Michoacan	310	2.5	789.9	1.5
Sinaloa	270	3.9	1,039.0	1.9
Coahuila	434	3.5	1,516.7	2.8
Guanajuato	1,094	3.1	3,351.8	6.2
Chihuahua	1,224	3.1	3,837.9	7.1
Baja California	1,448	3.9	5,585.1	10.3
Sonora	8,652	4.2	36,598.1	67.8
	14,012	3.9	53,983.1	100.0

Source: National Service of Inspection of Certified Seed.

Exhibit 8

PATRONATO –
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BOARD OF THE STATE OF SONORA, MEXICO

PRONASE Seed Production
1970–1979
metric tons

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	TOTAL
<u>Staples</u>	30,527	34,486	72,891	66,802	94,531	106,743	92,668	54,985	52,881	61,164	667,678
rice	1,520	1,908	1,210	2,799	3,686	11,726	5,495	4,582	3,268	10,660	46,854
beans	830	1,667	4,807	1,447	5,675	13,894	9,925	995	2,224	4,849	46,313
maize	8,011	5,645	4,555	4,662	7,789	14,839	17,069	9,879	9,002	4,150	85,601
wheat	20,166	25,266	62,319	57,894	77,381	66,284	60,179	39,529	38,387	41,505	448,910
<u>Oilseeds</u>	1,159	8,928	12,806	17,176	23,224	15,121	7,094	8,915	16,332	10,031	120,786
sesame	31	46	92	6	48	64	30	36	1	26	380
cotton	--	1,835	6,364	3,346	5,666	958	632	1,250	1,709	996	22,756
peanuts	48	80	95	91	153	360	94	278	453	-	1,652
safflower	917	1,282	1,148	704	2,963	4,290	249	851	3,576	1,223	17,203
sunflower	--	27	191	18	13	--	--	26	--	--	275
soybean	163	5,658	4,916	13,011	14,381	9,449	6,089	6,474	10,593	7,786	78,520
<u>Other</u>	123	430	1,116	3,086	3,639	2,834	3,326	846	3,932	4,978	24,310
oats	82	384	851	2,383	1,386	861	1,329	--	1,687	1,037	10,000
barley	4	--	--	23	10	412	1,323	188	144	346	2,450
garbanzo	--	--	9	322	1,235	90	--	34	739	1,494	3,923
chick-peas	6	--	204	45	209	517	--	368	129	21	1,499
millet	--	--	25	104	3	--	--	24	34	21	211
sorghum f.	--	--	--	--	18	--	--	20	134	--	172
sorghum g.	--	37	--	125	53	397	547	170	991	1,836	4,856
vegetables	31	9	27	84	25	557	127	42	74	223	1,199
T O T A L	31,809	43,844	86,813	87,064	121,394	124,698	103,088	64,746	73,145	76,173	812,774

Source: PRONASE, March 1980.

Exhibit 9

PATRONATO
THE AGRICULTURAL RESEARCH AND EXPERIMENTATION
BOARD OF THE STATE OF SONORA, MEXICO

Crop by Type of Land Ownership
Yaqui Valley
Winter 1970

CROP	EJIDATARIOS AS % OF ALL FARMERS	COLONOS* AS % OF ALL FARMERS	PRIVATE FARMERS AS % OF ALL FARMERS	PERCENTAGE OF FARMERS USING RENTED LAND	PERCENT OF ALL FARMERS
Wheat	41.86 %	4.65 %	33.33 %	6.20 %	86.04 %
Safflower	5.42	0	3.10	0.78	9.30
Barley	0	0	0.78	0	0.78
Chick Peas	0.78	0	1.54	0	2.32
Linseed	0	0	0.78	0	0.78
Canary Seed	0	0	0.78	0	0.78
Percent Total	48.06	4.65	40.31	6.98	100.00

* Ejidatarios holding "use rights" in common.

Source: CIANO.

Exhibit 10

PATRONATO
THE AGRICULTURAL RESEARCH AND EXPERIMENTATION
BOARD OF THE STATE OF SONORA, MEXICO

Type of energy used, as a percent of total agricultural land
Mexico and the State of Sonora

	ANIMAL			MECHANICAL			ANIMAL AND MECHANICAL			NONE		
	1950	1960	1970	1950	1960	1970	1950	1960	1970	1950	1960	1970
MEXICO												
Average	64.5	58.9	52.9	3.8	6.7	18.0	12.4	17.1	12.9	19.2	17.3	16.2
Farms over 5 hectares	54.7	50.8	32.2	7.1	13.1	25.7	12.2	9.1	18.0	25.9	25.0	24.1
Farms under 5 hectares	67.7	62.0	50.1	0.2	0.9	4.3	--	2.1	5.4	32.1	35.0	40.2
Ejidos	75.0	68.1	68.7	0.7	--	13.0	14.5	28.3	9.5	9.8	3.6	8.8
SONORA												
Average	16.1	19.2	8.9	14.1	41.7	74.2	64.3	26.0	0.9	5.5	13.1	16.0
Farms over 5 hectares	8.7	12.8	5.1	16.3	59.9	75.5	69.3	9.0	11.8	5.7	18.3	7.6
Farms under 5 hectares	89.5	75.2	31.7	0.3	3.2	17.2	--	3.9	10.1	10.2	17.7	41.0
Ejidos	42.9	31.0	16.4	5.7	--	73.2	47.7	69.0	3.1	3.7	--	7.3

Source: Ministry of Agriculture.

Exhibit 11

PATRONATO
THE AGRICULTURAL RESEARCH AND EXPERIMENTATION
BOARD OF THE STATE OF SONORA, MEXICO

Average Ownership of Machinery by Private Farmers in
the Yaqui Valley
1970

Description	Average Cost Mexican Pesos	Annual Depreciation Mexican Pesos
Medium Tractor	85,018.00	6,801.44
Small Tractor	65,350.00	5,228.00
Small Harrow	13,478.00	1,684.75
4-disc Plow	14,482.00	1,810.25
Seed Drill	5,397.00	674.62
Small Truck	44,667.00	7,146.00
TOTAL	228,402.00	23,345.06

US$1. = 12.50 Mexican pesos.

Source: CIANO.

Exhibit 12

PATRONATO
THE AGRICULTURAL RESEARCH AND EXPERIMENTATION
BOARD OF THE STATE OF SONORA, MEXICO

Contribution Rates for Members

Crop	Average Yield (ton/ha)	1979 Contribution per ton Mex. pesos	1979 Post-Harvest Contribution per/ha Mex. pesos	1980 Pre-Harvest Contribution per/ha Mex. pesos
Wheat	4.5	7.50	33.75	35.00
Chick-Peas	2.0	7.50	15.00	15.00
Soybeans	2.5	7.50	18.75	20.00
Sesame	1.2	7.50	10.00	10.00
Linseed	2.5	7.50	18.75	20.00
Cotton	3	10.00	30.00	30.00
Sorghum	4.5	7.50	33.75	35.00
Maize	4	7.50	30.00	30.00
Barley	4	7.50	30.00	30.00
Potatoes	20	7.50	150.00	150.00
Garlic	10	7.50	75.00	75.00
Beans	1.2	7.50	10.00	10.00
Grapes	15	20.00	300.00	350.00
Peanuts	2.5	7.50	18.75	20.00
Walnuts				100.00
Peaches				100.00
Olives				100.00
Other Products				10.00

Source: PATRONATO.

SECTION ONE

A MARKETING PERSPECTIVE:

TARGETING THE CLIENTS OF AGRICULTURAL RESEARCH

INTRODUCTION TO A MARKETING PERSPECTIVE:

TARGETING THE CLIENTS OF AGRICULTURAL RESEARCH

Effective agricultural research managers around the world share a common characteristic: they define their clients as all those who are the beneficiaries of the products and services of their research centers. These managers seek to understand the needs of each group of clients. Generally the most visible client group is farmers, but the clients of a research organization also include groups as diverse as government agencies, private-sector agricultural input distributors, and urban food consumers.

A marketing perspective permits an agricultural research manager to be aware of each client group, to identify the group's concerns, and to develop effective ways to meet the group's needs. Each client group can be divided into smaller, more homogenized units that share common characteristics and needs. Farmers, for example, constitute a large number of client groups. They can be segmented in various ways: large, middle, and small-scale farmers; commercial and subsistence farmers; export crop and food crop farmers; and landowners, tenants, farm laborers, and seasonal farm laborers. Each segment is different, and its members share different values and concerns and face different problems.

The government, the source of the salaries of many agricultural research managers, is another important client. The government too can be segmented into many groups: various ministries, different branches in one ministry, the extension service, state rural banks, the agrarian reform farms, government buying agencies, agricultural-input distribution centers, and many others. Each of these groups is distinctive and has different objectives and different needs.

Entire industries also can be the clients of agricultural research. These include among others the grain milling, pharmaceutical, agricultural chemical, farm machinery, commodity export, food processing, and even the educational industries.

In one sense, everyone is a client of agricultural research because everyone eats. And some of the most successful agricultural research managers in developing countries give significant attention to developing appropriate strategies for responding to the needs of consumer groups, such as the urban poor, the rural landless poor, and the growing middle class.

The leader of one of the most successful agricultural research organizations in Latin America considers he has three key groups of consumers: farmers (particularly commercial farmers), politicians, and urban voters. To the farmer he delivers technology that must meet one critical criterion: it must be more profitable than the technology the farmer currently is using. To the politicians he delivers information. He keeps a full-time staff whose central task is to inform politicians on research policy and agricultural issues and to provide politicians with notices of agricultural successes in the regions they represent so they can join and share in the credit. To the urban consumer, this agricultural research manager advertises on television. Several times a week the urban consumer may suddenly have the television begin to emit all kinds of animal noises: pigs squealing, chickens squawking, cows mooing, donkeys braying. The television then shows dozens of people sticking their heads out of apartment windows, balconies, doors, trying to identify what all the noise is about. The television screen reveals a throng of farm animals of all types entering into a city on a principal motorway. A voice then says, "If you are wondering how all your food gets to the city, it starts with your agricultural research institute."

Forces in the environment can discourage managers of agricultural research activities from embracing a marketing perspective. At times an agricultural research manager may be unwilling to subject his work to what he views as the rapidly changing requirements of the political environment or the fickle demands of clients. Furthermore, a manager may have received training that provided him an in-depth understanding of the techniques of research, but comparatively less understanding of the needs of clients.

The agricultural research manager with a marketing perspective realizes he has many potential clients. It is important he reach them all, and that requires him to develop a multiplicity of channels: on-farm research, field days, publications, seminars, meetings, media articles, advisers, consultants, public relations personnel, participation in industry fairs and associations, days at the legislature, commercials, dinners, roadside displays, teaching, and many others.

At the same time, the effective agricultural research manager realizes that clients are not all of equal importance. This challenges him to balance his time and other resources to assure they are employed strategically in relation to the demands of the consumer groups and the needs and interests of the agricultural research organization.

The agricultural research manager broadens the basis of support for his organization with multiple client groups. A broad support base lends stability by preventing the fortunes of the organization from being tied to the resources and negotiating power of a particular client group. It is the manager's responsibility to seek this greater stability that a broader support base can bring.

Development means change, and a marketing perspective permits a manager to scan, monitor, and stay in touch with the changes in his environment. As economies develop, they become more market oriented. The agricultural research process must not lag in an understanding of the market, of changing client tastes and demands, and of the rise of new client groups.

Many agricultural research organizations are quite similar to many farmers in one respect: they maintain a production orientation, which is to sell what is produced. With a marketing orientation, the farmer and the agricultural research organization produce what the client wants. While some farmers may not have much of a choice in what they produce, the agricultural research organization has a responsibility to its clients and to itself to produce what the client is demanding. A marketing perspective will identify the clients, their demands, and ways to reach them.

Chapter 3

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC:

A Management Commentary

The focus of "Rice Self-Sufficiency in the Dominican Republic" is on the targeting of the clients of agricultural research. The case identifies a large number of clients of rice research in the Dominican Republic: large commercial farmers, small-scale private farmers, public-sector farmers, seed companies, rice processors, rice consumers, the public-sector extension service, the public-sector rice-buying agency, and other institutions. The case presents the needs of each of these target groups and poses questions as to which of these clients should be the priority targets of the public rice research system and how the needs of these different client groups can be met. The case raises significant questions: For whom does the public-sector agricultural researcher work: the government, farmers, or other groups? What is the role of the public-sector agricultural research manager when government agricultural policy and the interests of large numbers of farmers seem incompatible? How can the agricultural research manager help provide cheap food in the cities and economic well-being on the farms?

The case also confronts the agricultural research manager with the problems of seeking to overcome the disastrous effects of a hurricane and the no less disastrous effects of pursuing a research strategy which is being rejected by farmers. A marketing perspective indicates that a client's concerns, wishes, and practices cannot be ignored. The case presents a situation where both large-scale commercial farmers and small-scale farmers are rejecting the varieties being promoted by the government. Furthermore, some commercial farmers are claiming to outperform significantly the technological packages being recommended by the government. The case highlights the role that the agricultural research manager should have in monitoring the practices of the various client groups as an essential prerequisite for effective research.

Monitoring the practices of the client is also important for establishing a dialogue with the client. For example, the case raises the issue that if the rice varieties the government is promoting are adopted, the time available to plant two full crop cycles is reduced to a minimum, raising the risk of losing a crop cycle if there are any delays. How should the research manager proceed to discuss this with his clients?

An agricultural research manager needs to develop and nurture appropriate linkages to the relevant client groups in the food system. A marketing perspective helps identify what form those linkages should take. When such linkages are not created, the case demonstrates that key client groups can take an adversary attitude toward the agricultural research organization. Many potential allies are in the food system in both the public and private sectors, and it is the responsibility of the agricultural research manager to secure the support of these potential client groups. A marketing perspective gives the manager the focus to accomplish this task.

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC:

A Case Study

by S. Huntington Hobbs IV

In 1979, in the wake of Hurricane David, Daniel Marte, Director of the Rice Program of the Dominican Republic, met with 18 rice extension technicians in his office at the Juma Rice Research Center. The hurricane had battered the country badly, seriously damaging the rural infrastructure.

Daniel Marte spoke, trying to make himself heard above the drone of the air conditioner and the heavy machinery digging ditches outside his office. "As you well know, the primary goal of our country in 1980 remains self-sufficiency in rice. In addition to the new obstacles to increasing rice production caused by the hurricane, it has also exacerbated a number of existing problems, including distribution of improved seed from the Juma Research Center to the collective farms, the availability of tractors, transportation needs of extension workers, and the reluctance of Dominican farmers to adopt Juma's dwarf varieties."

The concern regarding the adoption of dwarf varieties was particularly troublesome in light of the popularity of "rattoon farming." Rattoon farming was the practice of leaving the rice crop stubble in the field after the harvest and letting the root system develop new tillers. This second crop was known as the rattoon crop. Dominican farmers had traditionally grown tall rice varieties that yielded a rattoon. Some farmers gathered two rattoons, i.e., three harvests from the same root system, each harvest yielding less than the previous one.

Rice researchers had developed dwarf varieties that yielded more than the traditional varieties. Two full cycles of an improved variety could be harvested in place of the traditional variety which yielded one full cycle and one or two rattoons. The dwarf varieties had been released in the Dominican Republic in 1974, during the first year of the Agrarian Reform. The following year the dwarf varieties had been planted late due to drought, and production was poor. This disappointing production performance raised doubts in the minds of many rice farmers about the desirability of the dwarf varieties. Moreover, the high-yielding dwarf varieties did not generally yield a good rattoon.

Daniel Marte concluded his opening remarks to the rice production staff: "The months ahead are going to be extremely challenging. The pressure is greater than ever to increase domestic rice production to the point where imports are no longer necessary. With the skyrocketing costs of oil, we can ill afford to import rice, a product which we can produce here in the Dominican Republic. As you know, government at the highest levels is committed to self-sufficiency. This task falls squarely on our shoulders."

Rice in the Dominican Republic

Rice was the principal food crop in the Dominican Republic. Dominicans derived from 21% to 27% of their daily calory intake from rice (Exhibit 1). The average daily expenditure on rice was 9.8% of the daily budget. The average daily expenditure on rice of those having a per capita income between 600-1,200* Dominican pesos was 16.7% of the daily budget (Exhibit 2). Average per capita income was estimated by the World Bank to be US$480. The World Bank also estimated in June 1979 that the per capita food production of the Dominican Republic during 1976-1978 was 92% of the per capita food production of 1969-1971. The Dominican Republic had a population of approximately 5.3 million in 1979, growing at an annual rate of 2.9%. The apparent per capita consumption of rice was 43.2 kilograms in 1978 (Exhibit 3).

Rice Imports and the Balance Of Payments

After three years without rice imports, the Dominican Republic began to import rice in 1972; imports totalled over 36,000 metric tons from 1972 to 1978 (Exhibit 3). The cost of importing rice into the Dominican Republic reached a peak of US$40.5 million in 1974, which was equivalent to 30.8% of the country's agricultural exports excluding sugar, and 6.2% of all exports that year (Exhibit 4).

Sugar traditionally accounted for nearly 30% of the country's exports. Three large companies accounted for all of the sugar production in the Dominican Republic. Sugar was grown on rain-fed land and was not considered to compete for land with rice. Over half of the agricultural land in the Dominican Republic, 54.6%, was dedicated to export crops in 1978 (Exhibit 5), and export crops accounted for 36.1% of the gross value of agricultural production. Rice accounted for 10.5% of the agricultural land (Exhibit 5) and 9.0% of the gross value of agricultural production. Between 1973 and 1978 rice production increased 28%, while production of export crops in 1978 was near or below 1973 levels (Exhibit 6).

A report to the Central Bank of the Dominican Republic indicated that Hurricane David had so seriously damaged 38% of the rice area, that a minimum of US$12 million in rice imports would be required in 1979 to offset decreased domestic production. The report indicated that the effects of Hurricane David would increase the balance of payments deficit for the Dominican Republic in 1979 from US$375 million to US$415 million.

Juma Rice Research Center

The rice program was established in 1963 at the Juma Rice Research Center as part of an agreement on technical cooperation between the governments of the Dominican Republic and Nationalist China. The Center was based on 75 hectares in the principal rice producing region of the Dominican Republic, and scientists worked in seven sections: plant breeding, agronomy, disease surveillance, soil and fertilizer interaction, irrigation and drainage, seed production, and support to the agricultural

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* During 1980, the official exchange rate was one Dominican Peso equal to one US Dollar: 1 Dominican Peso = US$1.

extension service. Work was initially concentrated in improving native lines of rice, but subsequently a number of varieties were generated by crosses between the local materials and introductions from the International Rice Research Institute (IRRI). Two of the more common improved varieties were named Juma-57 and Juma-58. The breeding program also sought to develop varieties somewhat taller than the semi-dwarfs, in order to improve competition with weeds.

The Juma Center contracted with farmers to multiply seed, paying them a 10% premium above the price of first-quality commercial grain. Juma sold mainly Juma-57 and -58 certified seed. Juma produced rice seed principally for the collective rice farms of the Agrarian Reform.

Institute of Agrarian Reform

In 1972, the Congress of the Dominican Republic passed legislation which subjected to expropriation farms growing rice on land irrigated by government-built canals and exceeding 500 tareas (31.4 hectares). Former owners of appropriated land received the full market value or urban properties in exchange for their land. The Institute of Agrarian Reform (IAR) divided the appropriated land into collective farms and the use of the land was given to the landless poor. Choice irrigated rice lands became the prime target of the Agrarian Reform to ensure the success of the land reform program. Few of the new settlers had experience growing rice, and as productivity on rice lands declined in 1974-1975, the National Rice Program focused its efforts on increasing rice yields on agrarian reform lands. Agrarian reform lands constituted approximately 50% of the total national area planted to rice and accounted for 38.4% of national rice production in 1978. The IAR has used administrative and credit control over collective farms to effect the rapid adoption of high-yielding dwarf varieties Juma-57 and Juma-58. Collective farms are limited to growing rice.

The application of agrarian reform laws created uncertainty among medium- and large-scale farmers. Some farmers ceased investing in improvements to their rice lands, some changed crops, and some let the lands revert to pasture.

In 1977, an international development agency estimated that 32,500 families had received land through agrarian reform programs since 1962, and that 11,500 of these families had received the use of the land in the 1972-1976 period. The report stated that though the pace of land distribution had decreased sharply since 1976, 62% of the land expropriated in the 1972-1976 period was yet to be distributed. It was also estimated that of the 400,000 families in need of land, 100,000 were landless and 300,000 owned less than two hectares.

INESPRE

The Institute for the Stablization of Prices (INESPRE) was created in 1970. All rice mills were required to sell all production at controlled prices to INESPRE. INESPRE also controlled the retail price of rice, was the only authorized seller to the wholesale and retail trade, and was the sole importer of rice (Exhibit 7). INESPRE attempted to stabilize the price of rice by releasing rice into the market throughout the year (Exhibits 8).

From 1972 to 1974, the international price of rice tripled from near US$200 per ton in 1971 to over US$600 per ton in early 1974 (Exhibit 9). In 1974, INESPRE imported a record 70.5 thousand metric tons of rice (Exhibit 4) at a record import price for the Dominican Republic of US$571.72 per ton (CIF). During 1974, as an incentive to domestic production, INESPRE increased the price it paid rice millers by 46% to US$456.50 per ton (Exhibit 10). After 1974, however, the price INESPRE paid to rice millers remained fixed at US$456.50 per ton, while INESPRE increased the retail price of rice from US$0.42 per kilogram in 1974 to US$0.64 per kilogram in 1977.

In 1975, the price of imported rice (CIF) declined to US$389.29 per ton, below the $US456.50 per ton INESPRE paid to the rice mills. Since 1975, INESPRE had relied on the earnings generated by selling the lower-priced imported rice in the Dominican Republic to cover the losses caused by INESPRE's domestic operations. An INESPRE spokesman stated that "The differential in prices obtained by the domestic sale of imported rice has permitted INESPRE, in good part, to subsidize our operations with national rice, permitting a decrease in our budgetary deficits, such as in our program for stablizing rice prices."

There were 790 wholesalers registered with INESPRE, each of whom had a yearly rice quota. It was estimated that 11,000 retail outlets sold rice.

The Rice Producing Industry

In 1976, there were 131 rice mills in the Dominican Republic, a decrease from the 212 rice mills operating in 1969. Even with this reduced number of rice mills, the Ministry of Agriculture estimated the industry had a surplus capacity of 33% based on an eight-hour work day, 250 days of the year. The diminished profit margin left to the rice milling industry by the controlled prices decreed by INESPRE had forced the rice mills with too much excess capacity to close. The Institute of Agrarian Reform was purchasing some of the closed mills to process the rice grown on collective farms.

Processing plants traditionally assured a supply of unhusked rice by providing credit directly to small-scale producers, or indirectly through intermediaries who in turn provided credit and transportation to small-scale producers. The Ministry of Agriculture estimated that 30% of the credit received by producers came from processing plants. Repayment of the loan was usually in kind, and effective interest rates varied from 2% to 10% per month. Large-scale producers sold directly to the processing plants, and generally secured the credit needed from banks. According to the Ministry of Agriculture, up to 60.8% of the credit received from processing plants was used to finance farm labor (Exhibit 11). Producers on Agrarian Reform farms were not allowed to receive credit from processing plants.

Private Seed Industry

30% of the rice seed used in the country was produced by Seed Producers of the Dominican Republic (PROSEDOCA) the only private seed company in the country. PROSEDOCA officials estimated that the Juma Research Station produced 40% of the seed, and 30% of the seed used came from farmer stocks. PROSEDOCA sold certified seed for 0.51 Dominican pesos per kilogram, while Juma sold its seed for 0.48 Dominican pesos per kilogram. PROSEDOCA contracted with farmers to multiply seed, giving them a 12% premium over the farm price for top quality commercial rice of 0.24 Dominican pesos per kilogram. PROSEDOCA sold various rice varieties including Mingolo, ISA-21, Juma-57 and Juma-58. "Mingolo is the backbone of our business," said Juan Henderson, PROSEDOCA's General Manager. "The farmers won't live without it. It's drought resistant and withstands salinity." Though he sold rattoon varieties, Juan Henderson did not buy seed that came from rattoon crops. "There is a saying that whoever plants seed from a rattoon crop is planting trouble," he remarked. To maintain quality control, as a rule of thumb, Juan Henderson used the seed standards of the state of Texas in the USA. Henderson explained, "The government should set the norms and there should be government inspectors, but it doesn't happen. There is a law on the books calling for government inspection but it is useless. There are no inspectors. That law was written in 1972; maybe by 1982 something will happen. We wish they would set and enforce standards. It would give us more prestige, more security."

Henderson wanted PROSEDOCA to export certified seed. PROSEDOCA's first large export shipment, 40 tons of ISA-21 bound for Jamaica, had been caught on the docks by Hurricane David, and the seed had to be sold domestically.

"We can process three to four tons of rice seed in an hour," explained Henderson. "We can easily process twice the amount of seed we currently process. We are self-sufficient in seed. Seed is not a problem."

Rice Production

The Ministry of Agriculture estimated that in 1971 there were 27,800 rice production units, and that farms of 80 tareas (5 hectares) or less accounted for 74.4% of the rice production (Exhibit 12). Since 1974, 50% of the rice lands were collective farms administered by the Institute of Agrarian Reform. Collective farms accounted for 38.4% of the national rice production in 1978. The below-average productivity of collective farms was attributed by many to the inexperience in growing rice of the new collective farmers. While no official statistics were available, Dominican officials estimated that 50% of the total fields in the Dominican Republic were sown with improved varieties. It was estimated that 60% to 80% of the fields of the collective farms were sown with improved varieties. The principal improved varieties in the Dominican Republic were Juma-57, Juma-58, and ISA-21 (Exhibit 13).

The Food and Agriculture Organization (FAO) of the United Nations estimated that average rice yields for the Dominican Republic had increased from 2,238 kilograms per hectare in 1963-65 to 3,970 kilograms per hectare in 1975-77 (Exhibit 14). Rice research was initiated in 1963 in the Dominican Republic and the dwarf high-yielding varieties were released commercially in 1974.

Though rice yields were improving, average yields were still far below the potential demonstrated by rice yields on research stations. The

International Center for Tropical Agriculture (CIAT) in Colombia was reporting yields up to 12,013 kilograms per hectare. The Agriculture Institute of Santiago (ISA) in the Dominican Republic released an imported variety which they named ISA-21 when on-station results showed yields of 10,350 kilograms per hectare (Exhibit 15). Though on-station yields would be difficult to duplicate on-farm, the Ministry of Agriculture considered that the adoption of high-yielding dwarf varieties by farmers would increase farm yields from 40% to 60%.

A survey conducted in 1975 by economists of the Ministry of Agriculture indicated that farmer rice yields in the northeast of the country varied from 2,400 kilograms to 6,800 kilograms per hectare. The survey indicated that collective farmers with previous experience in rice who had sown high-yielding dwarf varieties had a yield of 5,434 kilograms per hectare, while private farmers sowing traditional varieties had a yield of 4,090 kilograms per hectare. The costs of production for collective farmers were found to be 736.64 Dominican pesos per hectare, while the costs of production for private farmers were 643.52 Dominican pesos. Most farmers were found to have used rice nurseries. Collective farmers planting dwarf varieties by direct seeding were found to have costs of production of 724.32 Dominican pesos and an average yield of 4,762 kilograms per hectare (Exhibit 16). The direct water-seeding method was developed primarily to assist in the control of grass and weeds.

A report by visiting rice experts in 1978 noted a problem of high salinity in the northern rice area of the Dominican Republic. The report also stated that "deficiencies in land preparation and levelling were noticed in commercial rice fields. A red rice infestation was another problem observed in commercial fields. These problems were apparently accentuated as a result of a change from tall rice varieties to semi-dwarf types." Nevertheless, the report concluded that "despite these factors, excellent rice crops were observed with high-yielding varieties recommended by the national rice program indicating that problems will be diminished and yields should increase in the near future."

A study indicated that 95% of the rice area in the Dominican Republic was irrigated in 1978 (Exhibit 17). A 1976 survey of water resources in the Dominican Republic found a network of 108 independent river systems, and an irrigated area of 154,000 hectares of which 121,000 hectares were serviced by state-owned irrigation facilities. Nearly 50% of the rice area was irrigated by state-owned canals. The survey found that canals were frequently blocked due to inadequate maintenance. The blockage problem resulted in over-irrigation of upstream areas, and under-irrigation of downstream areas. Thus, in times of inadequate rainfall, downstream areas on blocked canals could face drought conditions. Rice was first cultivated in the Dominican Republic in the early 1900s when the first irrigation canals were constructed.

The first rice crop was generally planted in January-February, with the second crop planted in June-July if a rattoon was not harvested.

Rattoon Rice Production

The full extent of rattoon farming in the Dominican Republic was unknown. Many farmers continued to plant traditional varieties which could yield a rattoon crop that was 50% or more of the first harvest. Some farmers had adopted high-yielding varieties such as ISA-21 that yielded a good rattoon crop. Many government officials considered rattoon farming the single greatest impediment in the Dominican Republic to increasing domestic rice production. A rice researcher at Juma explained the disadvantages of rattoon farming: "A full cycle of Juma-57 or -58 should yield five tons per hectare under farmer conditions. That's 10 tons a year. A traditional variety will yield three to four tons per hectare per cycle. That would be six to eight tons a year. But that's not what they do. They harvest three to four tons per hectare on the first cycle and then leave the stubble in the field and harvest only half as much during the next cycle, maybe two tons per hectare. That is a lot of lost production."

During 1978, CIAT conducted research on first harvest and rattoon yields. The research indicated in part that "yields in the first harvest are not a good indication of the production from rattooning." Indeed, one variety, CICA-8, had the highest yield in the first harvest, 6,046 kilograms per hectare, and the lowest yield in the rattoon harvest, 119 kilograms per hectare. The highest combined yield, 7,109 kilograms per hectare, was achieved by the variety with the highest rattoon yield, 1,566 kilograms per hectare (Exhibit 18). This high regrowth variety, Juma-57, had been imported from the Dominican Republic where the variety was not considered to have a high rattooning capacity. Traditional rattooning varieties from the Dominican Republic were not included in the test. CICA-4, the variety that yielded the highest rattoon as a percent of the first harvest, 33.52%, had been released in the Dominican Republic.

Small-Scale Producer

Belarmino Vasquez knew his land well. For 36 years, he had worked it as a hired laborer. He had cleared the land in 1937, working at 0.10 Dominican pesos per day for a landed family. Then, in 1973, with the uncertainty created for large landowners by the Agrarian Reform, Vasquez was able to purchase 87 tareas (5.5 hectares) on credit from the former owner. During 40 years of farming the same land, Vasquez had developed a farming schedule he adhered to strictly: first planting, February 25; first harvest, June 10-15; second harvest, September 20-24; third harvest, December 10-14. Belarminio Vasquez was a rattoon farmer.

"There are two essential operations to having a good rice crop," said Vasquez, "a good level preparation of the fields to permit uniform irrigation, and a careful transplant. After the first harvest in June, I neglect the rice fields, let the little rattoon grow, and go take care of other business." Vasquez had some small rain-fed plots where he grew "beans, bananas, and other things I like to eat." He always planted the traditional Mingolo rice variety, which produced a good rattoon. By allowing the rattoons to grow, Vasquez avoided the work and expense of planting a new crop cycle. But the principal reason Vasquez allowed the rattoons to grow was that he harvested more from two consecutive rattoons than from one crop cycle. "I get 460 sacks from the two rattoons," said Vasquez. "I never get more than 390 sacks from a single crop cycle". (Exhibit 19).

Vasquez also preferred Mingolo because its height blocked sunlight from potential weeds, and with an application of pre-emergent herbicide in February, weeds were effectively controlled. Vasquez commented that after 40 years of planting the traditional tall varieties, the field was so infested with these varieties that planting a new dwarf variety would yield a mixture of different heights and growing cycles that would be very difficult to work with. "I know this Mingolo very well," said Vasquez, "it has always treated me well. It is tempting fate to change."

Vasquez was pleased with his experience with bank credit. The State Agricultural Bank had given him enough money to plant his crop. "Bank money is delicate money," said Belarminio Vasquez. "You have to work and produce to keep something after you pay back. It would be easy to drink it all. The banks do not take credit away; the user takes his own credit away."

Vasquez stood by the edge of his field, looking at the rattoon crop as he spoke, "We know what has to be done, we know that productivity can increase. I would like to dump 300 pesos of fertilizer on this field right now. We know what is technically correct for rice, but we cannot afford those practices. There are agronomists in the world, they know what to do. They come and go. There are great institutions that study rice. They have the funds; I don't. I have seen the dwarf varieties in this zone. They give good results, but they are too much investment for me."

Large-Scale Producer

José Perrin considered himself the best rice farmer in the Dominican Republic. To prove it, José Perrin challenged Juma Rice Research Center. Perrin gave the center the choice of any 50 tareas (3.2 hectares) of his land, and he took an adjoining 50 tareas. "It was a test of practice versus theory," he remarked. In the first year, Perrin claimed he produced 100 kilograms more per tarea than did the research center. Perrin commented, "Juma claimed I had better land. So they chose another plot, and I still outproduced them by the same amount." José Perrin explained how he did it: "The research center recommended fertilizing before using herbicides. This is nonsense. Since an herbicide retards growth, fertilization should be after the herbicide. The research center recommended 15 cc of herbicide per gallon of water. We used a rum bottle cap to measure the herbicide. The first bottle cap was too big, so we drank the rum and bought a smaller bottle whose cap was just right. As for insecticide, the research center used a half liter mixed in a 50-gallon drum. This is too much. A 50-gallon drum needs only enough insecticide to fill a sardine can. And not only that, Juma weeded and I did not."

José Perrin received visitors on his patio. Leaning back in his chair, his gun stuck in his waistband, he told his favorite story: "A friend of mine was walking through Rosario, Peru, when he saw an excellent rice field. He pulled out one spike, stuck it in his pocket, and one day he gave it to me. I planted the spike and got half a kilogram; I planted that and got 15 kilograms, which I had to water in the drought of '75. I now have 18,000 kilograms. It yields 700 to 800 kilograms per tarea. It yields more than Juma-58. 'What's its name?' I asked my friend. 'Call it whatever you want, give it your name,' he said. So I called it JP. The Ministry of Agriculture has not wanted to recognize JP as a variety. JP is propagating, so they will have to recognize it sooner or later."

José Perrin added, "JP is far superior to Juma-58 for another reason. I can grow a crop of JP in 140 days. That gives me time to harvest and get the machines in there to plant the next crop. Juma-58 takes an extra three weeks per cycle. That cuts the time for land preparation by one and a half months a year. That leaves things very tight. If something goes wrong, you lose a crop cycle."

José Perrin grew two crop cycles a year and did not rattoon. His farm was fully mechanized. He grew only JP on his 2,626 tareas (165 acres) and many farmers came to his farm to buy JP. JP received a premium price from millers. Perrin concluded, "In this country, we have some of the best rice lands in the world. We can produce what we need."

The Rice Program Meeting

Following Daniel Marte's opening remarks and technicians' production reports, discussion touched on a number of issues.

The extension technicians were concerned about the damage done by the hurricane to the infrastructure in their zones: bridges were still unrepaired, irrigation canals blocked, roads washed out. "We must open the roads to maintain the confidence of the farmers of the Agrarian Reform," said one technician. "The communal farmers trust the Rice Program, and they are counting on us."

Another technician voiced concern about the availability and costs of machinery and supplies. He added that due to maintenance problems the tractors on collective farms in many cases were capable of working only a few hours a week. Daniel Marte responded that the Rice Program would rent tractors where necessary, and he told the technicians that the IAR had finally agreed to rent tractors from the private sector; the IAR would provide the fuel as a subsidy to the costs of production of collective farmers, and to prevent overcharging for fuel usage by private equipment dealers.

Several technicians also expressed concern that the Ministry of Agriculture be appraised of the need to secure more cooperation from the Ministry of Water Resources in the repair of canals. One technician commented that the way to secure the cooperation of the Ministry of Water Resources was by building a personal relationship with the water technicians in their area.

The Head of Rice Training discussed another problem. The Department of Extension and Training of the Ministry of Agriculture was about to expand a pilot project of on-farm visits and training. "This will do for beans, bananas, and maize," said the Head of Rice Training, "but not for a highly technical crop like rice. Here, in Juma, we have the physical and human capabilities to teach full-fledged classes, and we have a fully developed program of field days for farmers to visit the center. We must remain an integral center with rice production managed exclusively on a national basis."

Finally, the subject of rattoon farming was raised. When the production reports had been presented earlier, it had become clear that rattoon cropping was on the increase. During 1977 and 1978, after an expensive program of demonstration plots and increased technical support, many farmers were still reluctant to adopt the dwarf varieties Juma-57 and Juma-58. Some farmers were adopting an improved tall variety, ISA-21, that yielded a rattoon. Daniel Marte stated that the Minister of the Institute of Agrarian Reform was in agreement with the Rice Program that the rattoon was to be eliminated on collective farms.

One of the technicians expressed the feelings of the entire group that was assembled in Marte's office: "I found 10,000 tareas of rattoon on a collective farm. We will not permit the rattoon. We will pay for the tractors and we will pay the gasoline and we will plow under the ISA-21. We will block the credit of those planting rattoon varieties, and rattoon varieties will not be accepted for processing. We are meeting farmer resistance. They don't want to put in a second crop. But the land is there, and there are plenty of idle people. If we are to meet the need for increased domestic rice production, we will not permit the rattoon on collective farms."

Exhibit 1

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Percent Daily Caloric Intake Derived from Principal Foodstuffs in the Dominican Republic

ANNUAL FAMILY INCOME Dominican Pesos	RICE	CASSAVA	BEANS	BANANA	MEAT	OTHERS	TOTAL
0 - 600	27	8	4	22	3	36	100
601 - 1200	27	4	4	19	4	42	100
1201 - 3600	25	2	2	17	7	47	100
3600 or more	21	1	2	14	9	53	100

Source: Ministry of Agriculture, Dominican Republic.

Official exchange US$1 = 1 Dominican peso.

Exhibit 2

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Percent of Daily Budget Spent on Rice
in the Dominican Republic, 1977

ANNUAL FAMILY INCOME Dominican Peos	PERCENT OF BUDGET SPENT ON RICE	PERCENT OF BUDGET SPENT ON FOOD
600 - 1200	16.7	50.3
1201 - 2400	13.2	46.5
2401 - 3600	11.2	43.4
3601 - 4800	9.0	39.5
4801 - 7200	5.8	35.3
Weighted average	9.8	N.A.

Source: Central Bank, Dominican Republic.

Official exchange rate US$1 = 1 Dominican peso.

Exhibit 3

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Rice Production, Imports, and Apparent Consumption in the Dominican Republic (in metric units)* -- 1962-1978

YEAR	AREA (THOUSANDS OF HECTARES)	PRODUCTION (THOUSANDS OF METRIC TONS)	IMPORTS (THOUSANDS OF METRIC TONS)	APPARENT CONSUMPTION	POPULATION (THOUSANDS)	APPARENT CONSUMPTION PER CAPITA (KG/YEAR)
1962	79.5	75.2	0.02	75.2	3367.0	22.3
1963	78.5	73.8	32.4	106.6	3475.0	30.5
1964	79.5	92.5	22.0	114.5	3587.0	31.8
1965	74.5	108.4	0.08	108.5	3703.0	29.1
1966	76.5	106.3	-	106.3	3823.0	27.7
1967	74.5	113.8	0.02	113.8	3881.0	29.1
1968	72.5	116.1	17.6	133.7	3941.0	34.1
1969	75.5	125.9	-	126.3	4001.0	31.4
1970	82.5	174.0	-	174.0	4061.0	42.7
1971	75.0	152.7	-	152.7	4181.6	36.4
1972	80.0	162.9	8.9	171.8	4304.9	40.0
1973	87.4	178.0	29.8	207.8	4431.7	46.8
1974	135.9*	194.4	70.5	264.8	4562.3	58.2
1975	131.1	198.9	49.6	248.5	4096.8	51.7
1976	96.4	191.7	32.0	223.7	4835.2	46.4
1977	N.A.	201.6	62.2	249.9	4977.7	50.0
1978	N.A.	228.7	10.5	221.5	5124.4	43.2

Source: INESPRE and Ministry of Agriculture.

* Official rice statistics considered questionable after 1974 by some international agencies.

Exhibit 4

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Rice Imports vs Agricultural Exports and All Exports

YEAR	AGRICULTURAL EXPORTS EXCLUDING SUGAR millions of US dollars	ALL EXPORTS INCLUDING SUGAR millions of US dollars	RICE IMPORTS (CIF) millions of US dollars	RICE IMPORTS AS A PERCENT OF ALL EXPORTS EXCLUDING SUGAR millions of US dollars	RICE IMPORTS AS A PERCENT OF ALL EXPORTS
1970	65.6	211.2	--	--	--
1971	62.1	240.7	--	--	--
1972	78.0	248.0	2.2	2.8	0.1
1973	99.2	450.9	14.6	14.7	3.2
1974	131.5	650.8	40.3	30.6	6.2
1975	105.8	930.5	19.3	18.2	2.1
1976	189.2	714.7			
1977	N.A.	780.0			

Source: Ministry of Agriculture.

Exhibit 5

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Area by Crop in the Dominican Republic

Domestic consumption Crops	Area (thousands of hectares)	Percent
Rice	102.23	10.3
Maize	47.54	4.9
Bean	43.20	4.5
Banana	49.68	5.1
Cassava	24.46	2.5
Potato	1.69	0.2
Yam	3.14	0.3
Sweet Potato	7.86	0.8
Yautia	6.16	0.6
Peanut	49.05	5.1
Coconut	13.83	1.4
Sorghum	4.40	0.4
Vegetable	5.72	0.6
Fruit	25.28	2.6
Guandul	9.18	0.9
Frying Banana	25.00	2.8
Industrial Tomato	5.06	0.5
Red Pepper	0.80	0.1
Onion	0.70	0.1
Bija	0.50	0.1
Ginger	2.30	0.2
Cotton	1.10	0.1
Other	11.22	1.1
Subtotal	440.00	45.4
Export Crops		
Tobacco	35.35	3.6
Cocoa	94.34	9.7
Coffee	155.31	16.0
Sugar	245.00	35.3
Subtotal	530.00	54.6
TOTAL	970.00	100.0

Source: Ministry of Agriculture.

Exhibit 6

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Production of Principal Foodstuffs
Dominican Republic 1973-1978
(Thousands of metric tons)

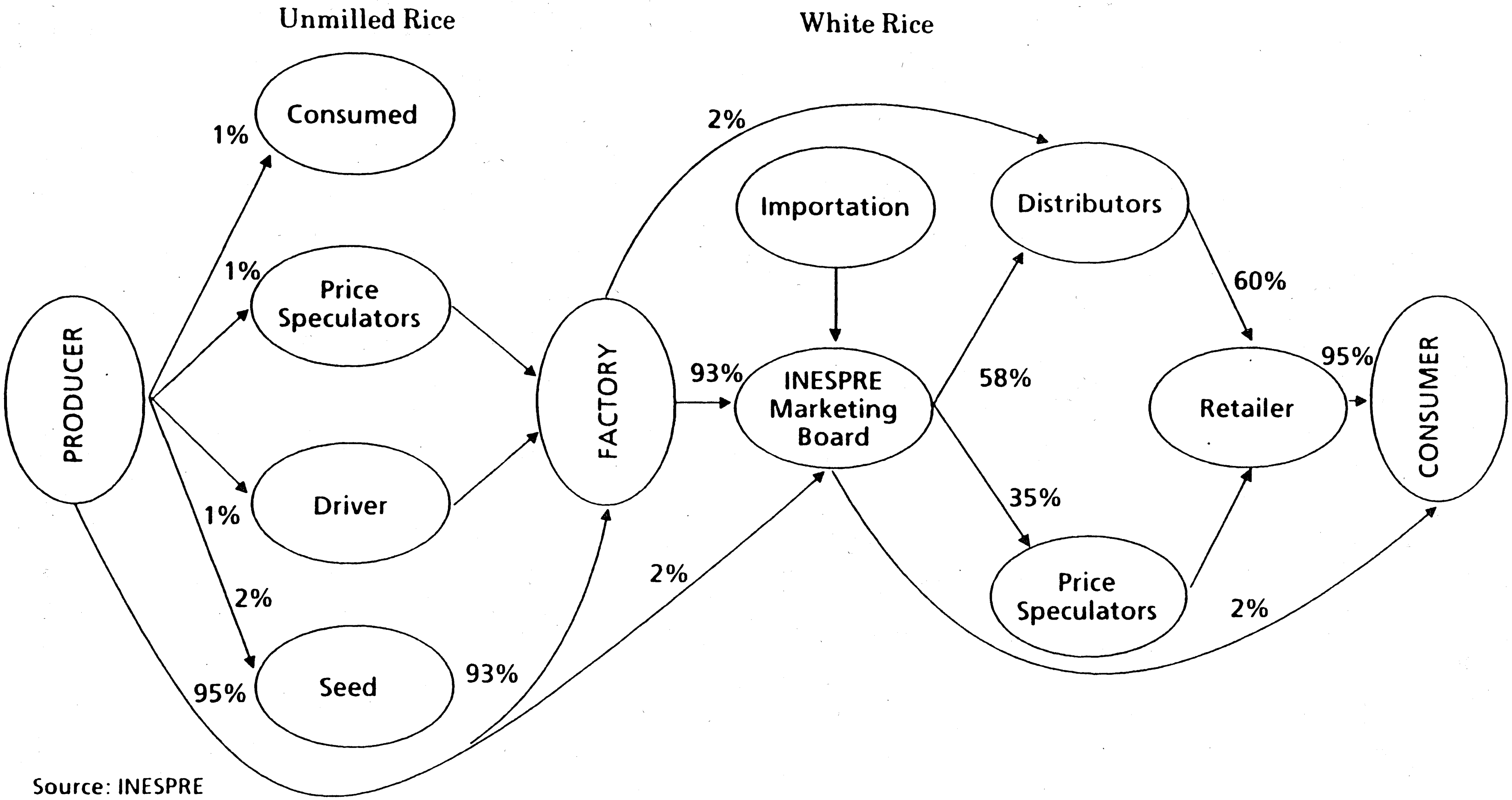
							INDICES					
	1973	1974	1975	1976	1977	1978	1973	1974	1975	1976	1977	1978
DOMESTIC CONSUMPTION												
Rice	178.0	194.4	198.9	191.7	201.6	208.7	100	111	114	119	113	128
Beans	29.1	40.1	22.6	20.2	32.4	26.5	100	138	78	70	116	91
Maize	51.9	59.0	43.7	86.0	63.4	60.8	100	114	84	166	122	95
Sweet Potatoes	83.4	75.3	68.8	75.1	59.6	60.9	100	90	83	90	72	73
Cassava	174.9	115.0	152.3	124.2	231.4	148.7	100	66	87	71	132	85
Potatoes	21.5	21.5	17.5	22.1	12.3	11.7	100	100	82	103	57	54
Banana (million)	39.0	38.8	31.1	37.7	28.0	39.5	100	99	79	95	75	101
Yams	27.3	28.0	28.7	29.2	29.5	23.6	100	103	105	107	108	87
Yautia	37.7	41.3	32.9	36.4	40.9	37.0	100	103	82	91	102	93
Guandul	13.1	13.4	14.1	14.5	14.1	16.6	100	102	108	111	108	127
Auyama	9.3	9.0	9.5	9.8	7.4	8.8	100	97	103	105	79	95
Onions	6.9	11.1	7.8	9.1	6.0	13.6	100	161	113	132	87	197
Tomatoes	17.7	18.2	16.9	16.6	13.3	16.2	100	103	95	99	75	91
Peanuts	20.0	18.0	14.0	10.6	10.2	11.0	100	90	70	53	51	55
Milk (million liters)	11.5	12.5	11.2	11.8	12.2	12.7	100	104	93	98	102	106
Meat:												
Beef	44.7	45.3	40.9	44.0	40.5	46.9	100	101	91	98	90	105
Pork	11.1	11.4	11.7	12.0	12.6	15.9	100	103	105	109	114	143
Chicken	29.5	29.1	36.7	38.7	33.7	40.9	100	112	142	149	130	156
EXPORT PRODUCTS												
Sugar	1,142.7	1,233.4	1,132.3	1,250.0	1,777.6	1,165.0	100	108	99	109	103	102
Coffee	46.4	42.0	55.1	21.8	39.9	37.1	100	91	119	47	86	80
Cocoa	30.9	40.7	33.1	33.0	33.7	27.1	100	132	107	107	109	88
Tobacco	39.6	30.6	18.0	34.5	35.5	42.3	100	77	45	87	89	107

Source: Ministry of Agriculture.

Exhibit 7

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Flow of Rice in the Dominican Republic

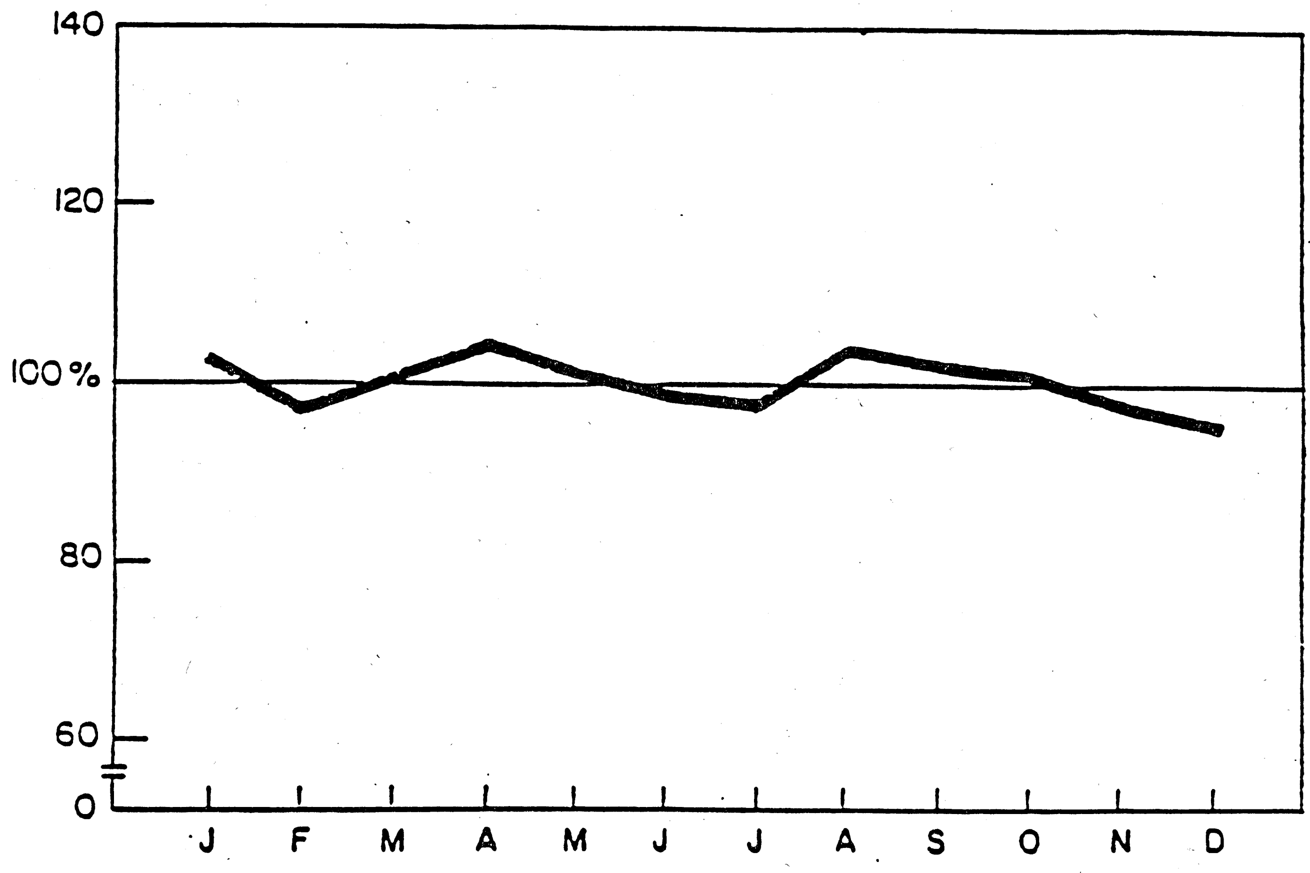


Source: INESPRE

Exhibit 8

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Seasonal Variation of Consumer Rice Prices
(Average 1968-76)



Source : INESPRE

Exhibit 9

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

International Price of Rice

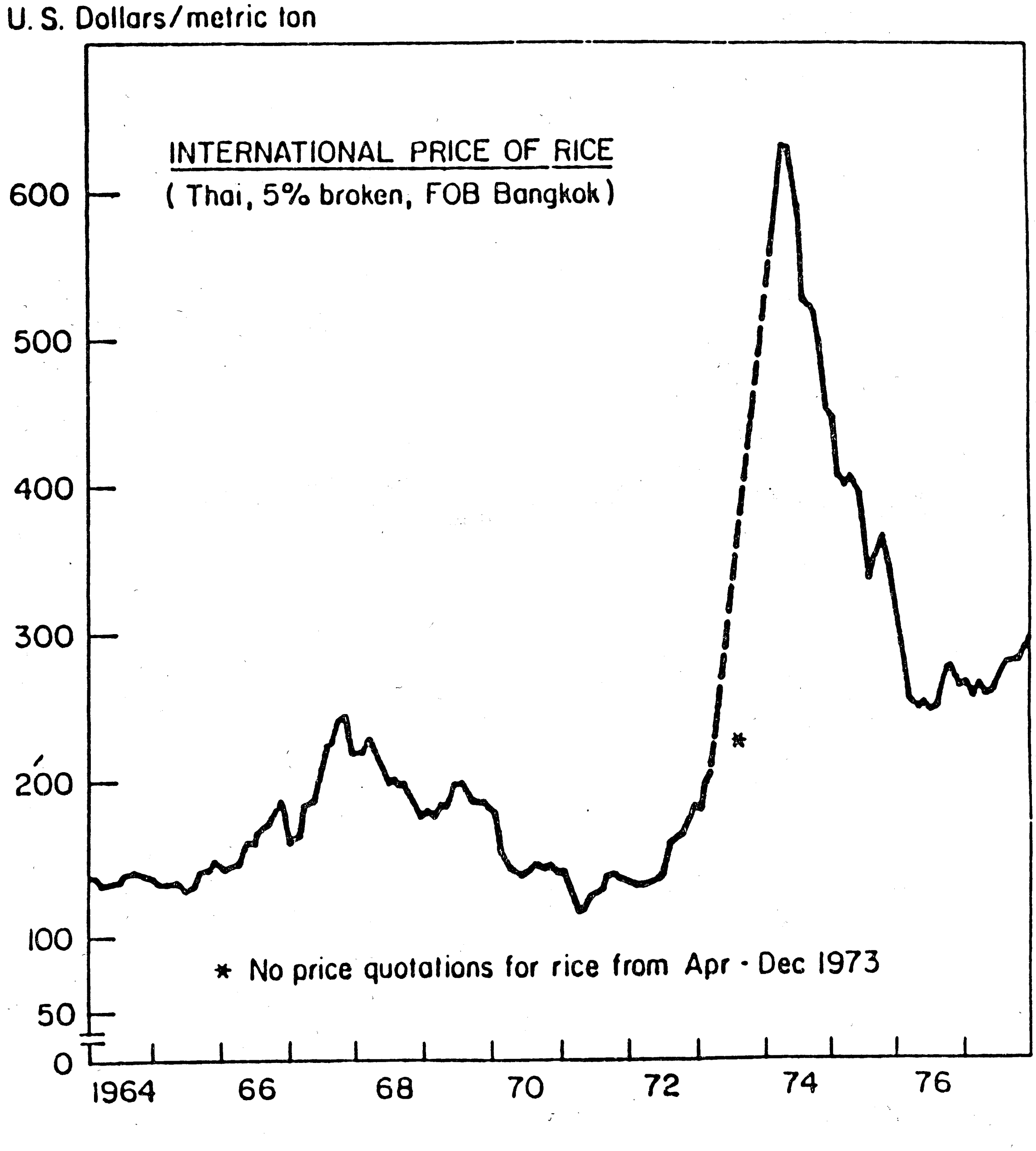


Exhibit 10

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Price of Imported and Domestic Rice for INESPRE
and Average Annual Consumer Price
1972-1977

YEAR	INESPRE IMPORT PRICE CIF US$/ton	INESPRE PURCHASE PRICE FROM RICE MILL* US$/ton	DOMESTIC RETAIL PRICE OF RICE (annual average) US$/ton	RATIO OF IMPORTED RICE PRICE vs DOMESTIC RICE PRICE TO INESPRE
1972	243.60	N.A.	330	N.A.
1973	488.21	312.67	420	1.56
1974	571.72	456.50	510	1.25
1975	389.29	456.50	590	0.85
1976		456.50	570	
1977		456.50	620	

* Estimated by the Ministry of Agriculture since INESPRE prices were not registered in government statistics.

Exhibit 11

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Relative Use of Credit from Dominican Rice Processing Plants by Farm Size, 1977

Use of credit	Size of Farm Unit (in hectares) Less than 3	3 to 6	6 to 31	31 to 125
Rental or purchase of machinery	39.2%	11.7%	9.7%	20.8%
Fertilizer	18.2	13.0	31.3	10.4
Labor	21.3	60.8	42.0	41.7
Seed	4.8	4.7	7.3	2.1
Family expenditures	3.1	8.3	9.7	4.2
Other	13.4	1.5	-	20.8
TOTAL	100.0%	100.0%	100.0%	100.0%

Source: Ministry of Agriculture.

Exhibit 12

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Rice Production (in percent) by Farm Size
in the Dominican Republic, 1977

Farm size in tareas	Percent of national production	Percent consumed by producer	Percent sold commercially
Less than 5	0.7	53.8	46.2
5.1 - 30	10.2	18.7	81.3
30.1 - 80	63.5	4.0	96.0
80.1 - 200	19.4	4.5	95.5
More than 200	6.2	3.3	96.7

1 tarea = 1/16 hectare

Source: Ministry of Agriculture, Dominican Republic.

Exhibit 13

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Principal Rice Varieties in the Dominican Republic

VARIETY	ORIGIN	HEIGHT (CENTIMETERS)	LENGTH OF GROWING CYCLE (DAYS)	RATTOON(1)	PHOTO-SENSITIVITY	SALINE TOLERANCE
Mingolo	Traditional	150-170	140-150	Good	No	Yes
Juma-57	Juma Rice Research Center	80- 90	155-165	-	No	No
Juma-58	Juma Rice Research Center	85- 95	155-165	-	No	No
ISA-21	Instituto Superior de Agricultura(2)	100-110	140-145	Good	No	No
Cica-4(3)	International Center for Tropical Agriculture (CIAT)	85	120-130	Good	Yes	Yes

(1) Any variety left in the field can yield a rattoon, but some varieties yield a better rattoon. Varieties marked as having a "good rattoon" can yield a rattoon equivalent to 50% of the first harvest.

(2) The Instituto Superior de Agricultura (ISA) adapted ISA-21 from material from the International Center for Tropical Agriculture (CIAT) in Colombia.

(3) Also known in the Dominican Republic as Avance-72.

Exhibit 14

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Average of Rice Yields for Selected Countries in Latin America
Averages for 1963/65, 1973/75, and 1975/77
in kg/ha

Country	1963/65	1973/75	1975/77
Colombia	1964	4229	4169
Peru	3965	4152	4425
Dominican Republic	2238	3444	3970
Venezuela	1841	2774	3246
Ecuador	1501	2698	2787
Costa Rica	1374	1182	2065
Nicaragua	1314	2976	2954

Source: Estimated from FAO.

Exhibit 15

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Rice Yields on Research Stations
International Center for Tropical Agriculture (CIAT)
Cali, Colombia

VARIETY	YIELD (kg/ha)
Bg 90-2	12,015
2135	10,093
2123	10,041
CICA-8	9,252

Source: CIAT Annual Report 1978.

Agricultural Institute of Santiago (ISA)
Santiago de los Caballeros, Dominican Republic

VARIETY	YIELD (kg/ha)
ISA-21*	10,350
ISA-22*	9,040
IR-6**	9,060
Mingolo***	7,810

Source: ISA.

* Supplied by the International Center for Tropical Agriculture, Colombia.
** Supplied by the International Rice Research Center, Philippines.
*** Traditional Dominican variety.

Exhibit 16

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Costs of Rice Production in the Northeast of the Dominican Republic
by Type of Land Tenure and Variety Planted
August-December 1975

ACTIVITY	PRIVATE FARMERS TRADITIONAL VARIETIES		COLLECTIVE FARMERS DWARF VARIETIES		COLLECTIVE FARMERS DWARF VARIETIES WITH DIRECT SEEDING	
	Dominican Pesos per hectare	Percent	Dominican Pesos per hectare	Percent	Dominican Pesos per hectare	Percent
TOTAL	643.52	100.0	736.64	100.0	724.32	100.0
PREPARATION OF NURSERY	50.72	7.9	44.16	6.0	--	
Seed	42.24		42.24		54.8	7.5
Cutting	3.20		--		--	
Bund Repair	2.24		--		--	
Planting	0.32		0.16		--	
Fertilizer	1.92		1.76		--	
Insecticide	0.48		--		--	
Application	0.32		--		--	
LAND PREPARATION	168.00	26.1	168.00	22.8	168.00	23.2
Cutting	112.00		11.20		112.00	
Bund Repair and Field Levelling	56.00		56.00		56.00	
TRANSPLANT	48.00	7.5	64.00	8.7	--	
AGRICULTURAL INPUTS	195.84	30.4	248.64	33.7	269.12	37.2
Herbicide	55.36		41.76		62.56	
Fertilizer (15-15-15)	89.60		154.40		154.40	
Ammonium Sulphate	26.40		25.12		25.28	
Insecticide	20.16		23.84		23.84	
Pesticide (for rats)	4.32		3.52		3.04	
LABOR	95.36	14.8	96.96	13.2	132.16	18.2
Irrigation	4.96		4.96		4.96	
Canal Maintenance	16.00		32.00			96.0
Weeding	48.00		32.00	--		
Application of						
Herbicide	8.00		3.20		6.40	
Fertilizer	14.40		19.20		19.20	
Insecticide	4.00		5.60		5.60	
HARVEST	72.00	11.2	96.00	13.0	84.00	11.6
CROP TRANSPORT	9.60	1.5	16.00	2.2	14.08	1.9
WATER TAX	4.00	0.6	2.88	0.4	2.88	0.4
YIELD (kg per hectare)	4,090.00		5,434.00		4,762.00	

Source: Ministry of Agriculture, Department of Economics.

Exhibit 17

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Area Sown in the Two-rice Sectors for the Years
1969, 1975, and 1978 by Country in Latin America

Country	Area in thousands of hectares					
	1969		1975		1978	
	Irrigated	Upland	Irrigated	Upland	Irrigated	Upland
Argentina	89.0	0.0	93.0	0.0	91.0	0.0
Belize	2.0	0.0	4.0	0.0	4.0	0.0
Bolivia	0.0	54.0	0.0	74.0	0.0	83.0
Brazil	1101.2	3686.8	791.8	4487.2	756.0	4644.0
Colombia	91.0	169.0	279.0	93.0	261.2	79.8
Costa Rica	2.2	41.8	2.9	84.1	3.3	59.7
Cuba	164.0	0.0	200.0	0.0	200.0	0.0
Chile	23.0	0.0	23.0	0.0	35.0	0.0
Ecuador	27.3	50.7	46.2	85.8	56.1	58.9
El Salvador	1.2	10.8	5.9	11.1	4.5	8.5
Guatemala	0.0	13.8	0.0	31.4	0.0	11.5
Guyana	-	-	120.0	14.0	95.8	39.5
Haiti	25.0	13.0	32.0	16.0	36.0	12.0
Honduras	0.9	8.1	2.2	15.8	4.8	19.2
Mexico	114.0	38.0	128.5	128.5	99.3	73.7
Nicaragua	5.2	20.8	15.0	15.0	11.6	3.4
Panama	0.8	104.2	1.1	113.9	3.4	111.6
Paraguay	-	-	-	-	19.5	10.5
Peru	110.0	30.4	100.3	22.2	93.5	28.5
Dominican Rep	72.0	8.0	62.7	3.3	61.7	3.3
Surinam	-	-	-	-	49.0	1.0
Uruguay	34.3	0.0	46.9	0.0	58.3	0.0
Venezuela	24.0	96.0	43.5	70.5	111.3	36.7
Totals	1887.1	4345.4	1998.0	5265.8	2055.3	5284.5

Source: Gross data from FAO for area sown with estimates of the proportion in the two sectors obtained from participants at Third IRTP Conference at CIAT, May-June, 1979.

Exhibit 18

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Rice Yields in First Harvest and Rattoon
CIAT, Colombia, 1978

VARIETY	YIELD (KG/HA)			
	FIRST HARVEST	RATTOON	RATTOON AS PERCENT OF FIRST HARVEST	TOTAL
CICA-8	6046	119	1.96	6165
CICA-9	5793	478	8.25	6271
Juma-57	5543	1566	26.25	7109
Tikal-2	5236	421	8.04	5657
Inti	4926	415	8.42	5341
CICA-4	4343	1456	33.52	5799
CICA-6	4256	700	16.44	4956
CICA-7	4233	991	23.41	5224
IR-8	2463	590	23.95	3053

Source: CIAT Annual Report 1978.

Exhibit 19

RICE SELF-SUFFICIENCY IN THE DOMINICAN REPUBLIC

Rice Planting and Harvesting on the Vasquez Farm, Dominican Republic 1978

ACTIVITY	DATE	AMOUNT HARVESTED (BAGS)	AMOUNT HARVESTED (KILOGRAMS)	YIELD (BAGS/TAREA)*	YIELD (KILOGRAMS/HECTARE)**	ESTIMATED DRY RICE YIELD (KILOGRAMS/HECTARE)***
PLANTING	Feb. 25					
1st HARVEST	June 15	387	34.830	4.5	6.403	5.874
2nd HARVEST	Sep. 15	265	23.850	3.0	4.385	4.023
3rd HARVEST	Dec. 10	185	16.650	2.1	3.600	3.303
TOTAL		835	75.330	9.6	14.388	13.200

* 1 Tarea = 1/16 hectare

** Yield reported by Vasquez was on wet paddy-rice basis.

*** Estimated dry rice yield assumes a 12% humidity content for dry paddy rice, and a 21% humidity content for Vasquez wet paddy rice.

Chapter 4

FARMING SYSTEMS RESEARCH IN ECUADOR

FARMING SYSTEMS RESEARCH IN ECUADOR:

A Management Commentary

The management case study "Farming Systems Research in Ecuador" brings to the fore the issue that identifying and targeting the clients of agricultural research is an essential step, but it is also only a first step. The more difficult task is organizing to produce what the target client requires. Impact can only be achieved when the appropriate product or service is produced and delivered to the target client. "Farming systems research" is one way of understanding the needs of a particular group of clients and of market testing whether the products being developed for that group of clients are acceptable to them. While this kind of research is a relatively new innovation in agricultural research, the private sector long ago developed many methodologies for identifying client desires and testing the client appeal of the prototypes that were being developed.

Because this kind of market testing is a relatively new development in agricultural research in developing countries, the first attempts to conduct these activities are usually done as pilot projects. Successful pilot projects frequently document the need for change, identify potentially new ways of doing things, and show that change is possible. The challenge is then to expand from the pilot experience. This presents some major problems.

The first problem is the assumption that what works on a pilot scale will work in a larger environment. This assumption is not always valid, because in a pilot project many variables are more controlled than they are in the general environment.

A second, more intractable, problem has to do with the culture within the organization. Pilot projects are usually run by believers, who with conviction and dedication will do everything possible to prove the pilot project a success. The majority in the organization may not share those convictions.

A third problem is that high-caliber staff are often selected for pilot projects. From the beginning the pilot project is manned by some of the most capable people in the organization. When the time comes to expand, the same quality of staff is not available on a wider basis.

Finally, the "Hawthorne effect" exists. This is the name given to a well-tested management theory that people perform better in a pilot project or a special situation simply because they know they are being observed and evaluated.

Any organizational change, be it in procedures, staff, or philosophy, will generate resistance within the organization. The research manager must, therefore, have a marketing perspective not only to target the clients of agricultural research, but also to monitor the needs and concerns of the people within the organization.

FARMING SYSTEMS RESEARCH IN ECUADOR:

A Case Study

by Robert Tripp

Mario Lalama, the Director General of Ecuador's National Agricultural and Livestock Research Institute (INIAP),(1) turned to Fernando Torres, the deputy director of the institution. "I've just had another phone call from the people over at the Rural Development Secretariat. They wanted to let us know how much they appreciate our cooperation in the integrated rural development projects. They were especially pleased with our Production Research Program (PIP)(2) and wanted us to know that they are expecting us to provide PIP personnel to work in their new projects as well. I told them we would be delighted, but that we simply don't have the funding at the present time to expand any of our programs."

"Our pockets are empty, that's for sure," responded Torres, "but I think we have a more fundamental problem here as well. You've read the recent Ministry of Agriculture report that supported our PIP work, I'm sure. It seems to me that we are in a position where there is an increasing amount of attention focused on PIP, and rising expectations regarding its contribution to rural development objectives. But we still have not decided how to integrate this program within INIAP. The PIP is really our first formal attempt at on-farm research, and because this entails doing agricultural experimentation on farmers' fields and posting technicians to various districts away from the research stations, it has caused a number of problems.

"For instance, there is certainly a lack of communication between the PIP and other members of INIAP, both with respect to general goals and specific results."

"You're right," replied Lalama. "I think it is time for us to decide exactly what role the PIP is going to play within INIAP."

The National Agricultural and Livestock Research Institute (INIAP)

INIAP had been established in 1962 with a mandate to "improve the production of food crops, food products, export crops, and agro-industry; to contribute to the diversification of production and the diffusion of the results of investigation; and to prepare personnel for agricultural research." INIAP carried out its work from eight research stations (Exhibits 1 and 2). Three of these were on the coast, three in the highlands, one in the eastern lowland, and one in the semi-arid area of the interior. Work at the research stations was divided among crop and animal breeding programs (e.g., maize, oilseeds, cattle) and supporting departments (e.g., plant protection, soils, seed multiplication). There were also two administrative offices in Ecuador's principal cities, Quito and Guayaquil.

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(1) INIAP -- Instituto Nacional de Investigaciones Agropecuarias.

(2) PIP -- Programa de Investigación on Producción.

The office in Quito was home for the director and his staff, the administrative services for the highland and semi-arid research stations, and the head of the Agricultural Economics Program. The deputy director for coastal research had his office in Guayaquil, along with administrative services for the coastal experiment stations.

INIAP's budget was provided by the Ministry of Agriculture (MAG) and augmented by INIAP's own activities (sale of crops, milk, etc.) and by loans and grants from various donor agencies. In recent years INIAP had received approximately 10% of the total MAG budget each year. The vast majority of INIAP's budget was provided either directly through MAG or from grants or loans from various donor agencies.

INIAP was governed by a Board of Directors whose president was the Minister of Agriculture. The other members were the Minister of Finance, the President of the National Planning Commission, the President of the National Development Bank, the President of the National Finance Corporation, the Director General of INIAP, and a representative of Ecuadorian farmers. The Board of Directors was responsible for appointing the Director General.

INIAP took great care in developing its own personnel. In the recruitment of scientists, for example, the most common method was for a university student in one of the agricultural sciences to finish his or her course work, and then do the thesis required for the degree of Ingeniero Agronomo[3] with INIAP. Under this system, the student spent one year or more doing research with one of the programs or departments of INIAP. About half of the time was devoted to work with the sponsoring INIAP division and the other half to work on the thesis. When the thesis was completed, about half of the graduates were offered positions with INIAP. At least 90% of INIAP's technical staff hired in recent years with Master's degrees had followed this procedure.

INIAP also took pride in the level of training of its scientists. The institution offered opportunities to its personnel for participation in short courses as well as long-term training. Although INIAP faced the problem of keeping its people with advanced training from leaving for higher-paying positions in the private sector, about one-quarter of INIAP scientists had advanced degrees (Exhibit 3).

Ecuador's Agriculture

Approximately 43% of the Ecuador work force was employed in agriculture, which provided 21% of the gross domestic product and 40% of export income. Yields of most food crops however were quite low, showing little or no improvement over the decade 1970-80 (Exhibit 4). This meant that some basic staples had to be imported. In 1979, for instance, wheat imports amounted to 84% of total consumption, and rice imports to roughly 10%. Hard maize was imported during some years as well. In 1979 there were no maize imports, but in 1978 they amounted to 12% of consumption and in 1977 to 6%.

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(3) Agronomic Engineer, B.S.

Land distribution was very uneven. Almost a third of the farms were less than one hectare and 74% of them were less than five hectares (Exhibit 5).

These accounted for only about 10% of the farmed area of the country, but they supported about 60% of the economically active population in rural areas. The majority of Ecuador's farmers were quite poor, with small landholdings and few other resources, and were generally isolated from the benefits of the rapidly expanding national economy. This isolation included access to improved agricultural technology, for there was little evidence that these small farmers had taken up the recommended varieties or practices that INIAP had produced.

Extension services were the responsibility of the Ministry of Agriculture. Extension operations were divided among 10 regional zone offices. The field operations of each zone were channeled through 108 service units, which were responsible for such varied activities as mechanization services, cooperatives development, and rural infrastructure projects.

Another approach to extension was through rural development projects. The Rural Development Secretariat, which was part of the President's office, had initiated a number of these projects in target areas throughout the country. Most of them were supported by loans from USAID, IDB (Inter-American Development Bank), and the World Bank, and attempted to coordinate the actions of various national institutions (Ministries of Agriculture, Health, Education/National Development Bank/National Land Reform Institute, etc.) to bring rapid development to selected rural areas.

PIP History

The Production Research Program could trace its origins to an IDB loan made to Ecuador for INIAP in mid-1977. It was to cover a four-year period (later extended to five) and provided US$11 million from IDB and US$5.9 million from the Ecuador government. The purpose of the funding was to:

> "Permit INIAP to strengthen and increase its operating and technical capacity, increasing current investigation programs in cereals, cattle and oil seeds and allowing the initiation of new programs in fruits, vegetables, legumes, and poultry, for which it will be necessary to employ scientists, improve infrastructure, and acquire necessary materials. At the same time, supporting activities and professional capabilities will be improved, and a system of technology transfer will be introduced through specialists in production."

The details for the technology transfer system were not spelt out in the original loan documents, but a rough outline for a strategy was provided:

> "As part of the project, and in order that the results of investigation are able to reach farmers in the most efficient manner, INIAP will establish a mechanism for the transfer of technology with 40 specialists in production who will carry out experiments and

demonstrations at the farm level in cooperation with other government services. In this way new technologies generated in the institute will be communicated to small farmers...

"These specialists in production will be trained by INIAP with the purpose of achieving improved efficiency in its cooperation with agricultural extension in areas under the control of MAG. These specialists will carry out regional trials with the participation of technicians from the Ministry and some 6,000 farmers of the region."

INIAP had little experience in working under small farm conditions. All extension was carried out by the MAG. INIAP's contact with farmers was limited to field days and demonstrations that it conducted, usually on the research stations, in which farmers were invited to see a new variety or the results of a new technology. This is not to say that INIAP did not work outside of its stations; a large amount of research was regularly carried out in what were known as testing sites. These were planted in order to test the adaptability of varieties and practices under ecological conditions representative of the various parts of the country. But because these trials generally required optimum management conditions, they were usually planted on larger properties such as corporation or government experiment sites, rather than on small farms.

By the mid-'70s the idea of "on-farm" or "farming systems" research was being discussed with increasing frequency in international agricultural development circles, and INIAP's Director General, Enrique Ampuero, became interested in experimenting with these methods as a way of implementing the technology transfer section of the IDB loan program. In 1977, Ampuero began discussions with the head of the CIMMYT[4] Economics Program about the possibilities of an on-farm research pilot project for INIAP.

In mid-1977 the province of Imbabura was chosen as the initial testing ground for the pilot project. It was an area of small farmers whose principal crop was maize and was located about two hours' drive north of Quito.

The CIMMYT Economics Program assigned a regional economist to Quito, and he began to work with the incipient on-farm research activities of INIAP. INIAP's Agricultural Economics Department, in cooperation with its Maize Program, designed and executed a survey of 230 farmers of the region in order to learn more about their practices and problems. The Maize Program at the Santa Catalina Research Station used this information to design trials which were planted on farmers' fields in Imbabura in October 1977.

By 1979, the on-farm work had expanded to other areas of the country, and Ampuero began to consider the future of this type of research within the institution. As it was, the Agricultural Economics Department played the leading role in collecting and managing data for the planning of work,

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(4) Centro Internacional de Mejoramiento de Maiz y Trigo (International Maize and Wheat Improvement Center), based in Mexico.

while the crop-breeding programs contributed most heavily to the design of the trials. But as trials generally looked at a number of production factors, it meant that the breeding programs were being called upon to coordinate their work with that of several support departments and disciplines. Although there was some collaboration between programs and departments in specific research projects at the station, they usually went their separate ways in producing recommendations, and the breeding programs did essentially no agronomy of their own. In addition, on-farm research in any given area often involved more than one breeding program (maize and legumes, for instance). There was, it seemed, the need for some sort of coordination of the various programs and departments that would necessarily have to work together in on-farm research. Furthermore, the emphasis on relating farmers' circumstances to the development of technologies was a new focus for INIAP and would require research methods different from those found on the station. After discussions with various other members of the administration, the Director decided to coordinate on-farm research under a new program, the Production Research Program (PIP).

An early document produced by the PIP defined its objectives and methodologies in the following way:

> DEFINITION
>
> It is a technology transfer program which investigates production constraints as well as production opportunities on farmers' fields and focuses on farming systems.
>
> OBJECTIVES
>
> (1) Screen and test on the farmers' own fields those technological components that are being generated in the support departments and crop programs of the adjustment to the agro-economic circumstances and principal farming systems of a region.
>
> (2) Provide farm-level feedback information which will orient and guide the research carried out in the research stations. This will give rise to the development of new technological components which respond to problems and to the detection of limiting factors among the farmers of a region.
>
> (3) Formulate alternative technologies, subject to economic validation, which can be made available for later technology transfer by the extension and agricultural credit agencies.
>
> METHODOLOGY BY STAGES
>
> (1) Identification of working areas in terms of "recommendation domains." This is defined as a roughly homogeneous group of farmers with similar agro-economic circumstances for whom more or less the same recommendation can be made. Information for the above is derived from secondary sources and by a preliminary survey carried out in the project area.

(2) A random sample of farmers is surveyed within each recommendation domain to ascertain their felt needs, production constraints, and agro-economic circumstances and to determine means to improve productivity.

(3) Use of information derived from the above sample to identify priority technological components which have potential to increase productivity, and which are consistent with the circumstances of farmers in the recommendation domains.

(4) A joint program of experiments and farmer trial plots to obtain yield and other relevant information on selected technological components. Basically, these experiments are of three types: multifactorial trials to measure relevant interactions under farmer circumstances and to identify the most important factors; level trials, which measure responses to various levels of an input; and verification trials, which compare recommended practices to farmers' practices.

(5) Simultaneously, along with the farmer trials, studies are performed of input supply conditions, labor, capital and marketing costs to determine what effect they might have on the adoption of alternative technologies.

(6) Economic evaluation of alternative technologies is made, analyzing the combined data from experiments, surveys and marketing studies.

The focus on farming systems is realized by giving explicit consideration to critical system interactions between and among crops, livestock, and non farm enterprises of the farming system which influence the choice of an alternative technology for a major crop or mixture. The strategy is to begin making the major crop or mixture enterprise more productive and profitable and then to build upon this base and add other farming activities as the farmers' confidence and available technology improve.

PIP Organization

When the PIP was established, it was organized at the national level, while crop programs and support departments were organized at the station level (Exhibit 6). PIP did without a leader for the first year, although the work was coordinated by CIMMYT's regional economist. When Mario Lalama took office as Director General in 1980, he asked the head of the Agricultural Economics Department to be the coordinator of PIP. Patricio Espinoza, the head of Agricultural Economics, found that he devoted about two-thirds of his time to duties with PIP, which included supervision of the field work done by PIP, coordination of the planning process for each year's trial work, representation of the requests of PIP field staff to the proper authorities at INIAP, and handling relations of PIP with MAG, the Rural Development Secretariat, and donor agencies.

The entire PIP program consisted of the national coordinator, based in the Quito central office, and 18 officers stationed at various research stations throughout the country. Because time and budget constraints prevented Espinoza from visiting the field sites more than once or twice a year in most cases, the PIP field staff had a considerable degree of independence in managing their own schedules. This led to complaints from many of the research stations' personnel about lack of supervision in the PIP.

The PIP did not have a separate budget. Eleven of its officers were permanent members of INIAP, while seven were on yearly contracts with money provided by the counterpart funds of the IDB loan agreement (Exhibit 7). Besides providing salaries for some of the PIP officers, counterpart funds also provided for all fuel used by the program, rent for all PIP officers working in the field, as well as various supplies. Other funds were provided between 1978 and 1980 by a Swiss Government grant of US$100,000 through CIMMYT for technology transfer in maize. An agreement signed in 1981 with USAID as part of a technology transfer program provided funds for vehicles, materials, and training for four of the PIP programs.

INIAP provided most of the vehicles used in the program and some basic agricultural supplies as well. For operational necessities (such as spare parts or materials for experiments) PIP officers had to go to their respective research stations, where their requests were handled by the station director. They received their pay at the research stations as well and had to seek reimbursement for gasoline expenditures there too.

Of the 18 field staff working in PIP, three were agrónomos, who have a secondary school degree in agriculture, and the rest were university graduates with the title of ingeniero agrónomo. Nine of the 15 ingenieros with PIP prepared their theses under INIAP, including two who had done their theses on PIP activities. Nine of them had been members of other INIAP programs before joining PIP (Exhibit 7). All of them had taken part in special training courses run by PIP on on-farm research.

As most PIP personnel were young, they tended to be at the bottom of the promotional ladder (Exhibit 8). Station scientists often complained about this lack of experience, combined with little supervision, when discussing the PIP.

Another sore point was the salary paid to PIP field staff. They received the same basic pay as others at their level, but because they lived in the field their rents were paid. Also, until the Director General had found it necessary to curtail it, they had received a living allowance equivalent to 50% of their salary. In place of this, they had been promised a smaller allowance, equivalent to about 15% of the average salary.

PIP had argued that there were a number of justifications for the previous living allowance. Work in the field involved more risk than station work, as PIP officers spent long hours on rural roads and footpaths that were in poor condition, and a good deal of their work was done in isolated areas. The officers at the stations worked regular hours, as opposed to the generally longer and more irregular schedules of PIP, and they could avail themselves of station facilities such as laboratories, libraries, and clinic, as well as receive subsidized meals and buy milk, cheese, and meat produced at the station and sold at low prices. Furthermore, every time a station officer travelled to a regional trial or to other official business, he was paid S/1,0000[5] for every night away from his post. The PIP people received no such payment. Finally, the station scientists were allowed to take one day a week to teach at a university and thus supplement their incomes, while the nature of PIP precluded this possibility for its members.

The PIP in Imbabura Province

As the oldest of the 10 PIP field programs, the operation in Imbabura Province offered a good example of the procedures, accomplishments, and problems generally encountered in PIP's work. The work began in Imbabura Province in 1977 with a farmers' survey followed by 17 on-farm trials planted by Victor Hugo Cardoso, an agronomist who was assigned to live in Ibarra, the provincial capital. The following year, Cardoso planted another series of trials, which were used not only for research purposes, but also as the basis for a course on the methods of on-farm research. The course met three times during the growing cycle and included about 30 participants, including extensionists from MAG, members of the National Development Bank and other institutions working in rural development, as well as INIAP personnel who were being trained for future assignments with PIP. Members of INIAP programs and departments participated as instructors. The farmers of Imbabura Province planted maize associated with climbing beans as their principal crop, but grew potatoes, wheat, barley, sunflowers, peas, and other crops as well. Average farm size was about 2.5 hectares. Farmers complemented their agricultural work with animal raising, crafts, and various off-farm jobs, either in nearby haciendas or in urban centers. One of the principal things learned from the survey had been the great interest that farmers expressed in the possibility of growing a maize that matured more rapidly than their local varieties. INIAP's Santa Catalina Maize Program had been working with early-maturing maize for the past five years, but had not yet considered the possible applications for small farmers in Imbabura. Thus, one of Cardosa's main objectives in the first year's trials was to test some of these early-maturing maizes. He also examined other promising maize varieties and factors such as weeds, insect control, and fertilizer level.

Cardoso was responsible for formulating plans for each year's trials. His ideas were refined by contacts with the Maize and Legumes Programs and the support departments at Santa Catalina, as well as meetings with the PIP coordinator and various consultants. However, at times the crop programs and support departments complained that they were not given sufficient opportunity to contribute to the planning. In the first years there had been no formal approval process for PIP trials, although a meeting was always convened at the research station for relevant personnel to comment on the past year's results and the proposed plan for the coming cycle. But, beginning in 1980, at Santa Catalina, and in 1981, at the coastal research stations, PIP trials had to go through the process of being approved by a technical committee.

The technical committee was a part of each research station. At its core were five station scientists, named each year by the station director.

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(5) About US$40.00

The committee met once a week to consider specific proposals prepared by programs or departments, and invited other station scientists whose work was associated with the proposed research to attend. Although the general breeding work of the crop programs did not pass through this process (this was considered at an initial meeting, and if the breeding objectives continued for a number of years they were not reconsidered each year), any special projects they might do, including those of affiliated students, had to be approved by the technical committee. Much of the experimental work done by the support departments was in the form of projects which the committee considered as well. Research projects at times involved more than one program or department, but communications between these separate entities at the research stations were generally not very well developed, and there were few examples of coordinated efforts to solve particular research problems. There was no formal process for evaluating projects once they were completed.

Besides planning the trials, Cardosa also had to select representative small farmers with whom to work. His duties included planting all the trials and visiting them during the growing cycle to take data. He was also responsible for collecting other relevant information for his area (e.g., rainfall data, market prices) and for collaborating with local extensionists from MAG and other institutions in planning field days and demonstrations based on the on-farm trials. By 1980 there were two other PIP officers working with him in Imbabura.

Everyone at INIAP agreed that communications between PIP and the rest of the institution were a problem, and several attempts were made to improve the situation. The station director at Santa Catalina had asked that each PIP officer submit a monthly summary of his activities and a plan for the following month. This was requested because the PIP personnel were away from the station. It was not done by station-based officers. Each station program and department had to submit a quarterly progress report to the station director, and it had been requested that each of the 10 PIP projects also produce these quarterly reports. The coordinator of PIP also asked that a mid-term report be turned in to him. A final report was prepared for each PIP area, giving details of all trials harvested and economic analysis of results. A copy of this went to the PIP coordinator, the director of the research station, the INIAP libraries, and the IDB. Crop programs and support departments at each research station prepared similar yearly reports.

Contact between Cardoso and station personnel was carried out on an informal basis during the year; no reports or memos were required to be exchanged. When conferring with station personnel, Cardoso generally consulted with crop breeding programs and support departments on an individual basis rather than by bringing together members of two or more disciplines to discuss a problem. Station personnel were encouraged to visit the PIP trials in Imbabura, and although some did manage to spend a day visiting the work, the principal contact the station scientists had with the trials was a yearly visit that was arranged for the heads of programs and departments. Opinions were always exchanged during these visits, but no written report was produced.

In Cardoso's discussions with station scientists, he emphasized several of his own interests. One was the great enthusiasm of farmers for early-maturing maize. But problems were encountered with the stalk strength of the early materials as well as with performance on very sandy soils, and he wanted to make sure that the Maize Program was aware of these. For their part, the Maize Program assured him that these problems were included in their breeding program. He also spent time with the Legume and Oilseed Program, emphasizing the need for an early-maturing bean that could be planted with the new maize, and sunflower varieties that could be planted in rotation with the early-maturing bean varieties. Over the course of four years, the Legume and Oilseed Program had made significant progress on both fronts. Another concern was maize storage, which his experience in Imbabura had shown him was a serious problem. He consulted with the Plant Protection and Agricultural Engineering Departments to design and test simple storage facilities and disinfestation procedures. Other problems in soil fertility, pathology, and weed control were also discussed with the station scientists.

PIP considered that it was to play the leading role in producing recommendations, but this view was not shared by many people at the station. Under INIAP procedures, new varieties produced by crop breeding programs had to be approved by a special station technical committee, which considered all the evidence available, before they could be released. Agronomic recommendations, such as fertilizer or insecticide applications, which were based on the research of station support departments, were published in bulletins or pamphlets which also had to pass the approval of a technical committee. PIP complained that recommendations to farmers, be they varieties or practices, were considered by the technical committees on a piecemeal basis, each program or department doing its work and presenting the results individually. The PIP approach offered an opportunity to synthesize these separate efforts and formulate recommendations based on experiments under farmers' conditions.

Now that the PIP in Imbabura had several years of data from its on-farm trials, it had the possibility of making recommendations, and there were two quite contrary experiences. In one, INIAP had decided to release the early-maturing maize variety "101" that had shown the greatest promise in Imbabura. PIP supported this, and as the seed would initially be sold by the national seed distribution company, ENSEMILLA, in 50-kg sacks, and would only be available in principal cities, PIP decided to buy some of the seed and repackage it in 5-kg bags that could be sold by MAG extensionists. PIP wanted to see in what rotations and associations farmers planted the "101" and thus planned to follow as many of the farmers who purchased the seed as possible. The Santa Catalina Maize Program was very supportive of this idea and credited PIP with bringing the new variety to the farmers of Imbabura.

The experience with another variety was quite different. The Maize Program had a variety "126", of normal maturity, that they had been working on for several years. The variety had been approved by INIAP's technical committee for release throughout the highlands, but the PIP objected strongly, saying that their data showed that "126" had no advantages over local maize in Imbabura, and that the variety should not be promoted. This was a source of some ill feeling between the Maize Program and PIP.

In the INIAP Director's Office

"This business about recommendations really sums up our dilemma with PIP," said Fernando Torres, after his review of the situation. "The PIP sees itself as the final step in the research process which leads to the development of recommendations. Most people at the research station, on the other hand, view the PIP data as a valuable contribution to the technical committee's consideration of recommendations, but certainly not as the last word."

We have two competing views of the PIP -- as an innovator or as a partner," replied Mario Lalama. "If the PIP is really an innovator, then the program should be strengthened through extra training and supervision for its personnel. Its status as an independent program would have to be assured, and the entire institution's focus would have to be redirected towards work that emphasizes farmers' circumstances, both biological and economic.

"On the other hand, we can see PIP as more of a partner. The PIP can be a good way to expand our off-station work, to provide feedback to breeders about farmers' needs and to do experimentation under a wide range of conditions. It will also be useful in getting our point of view across to extension. But its independence would be reemphasized. Individual departments and programs could participate in the PIP by rotating their own personnel through the PIP for periods of several years.

It is true that the PIP will play an important role in INIAP's future. The question is: What is the specific future role of PIP in INIAP? What have we learnt from PIP to date? What do we need to do to combine the strengths of PIP and INIAP?"

Exhibit 1

FARMING-SYSTEMS RESEARCH IN ECUADOR

INIAP Experiment Stations

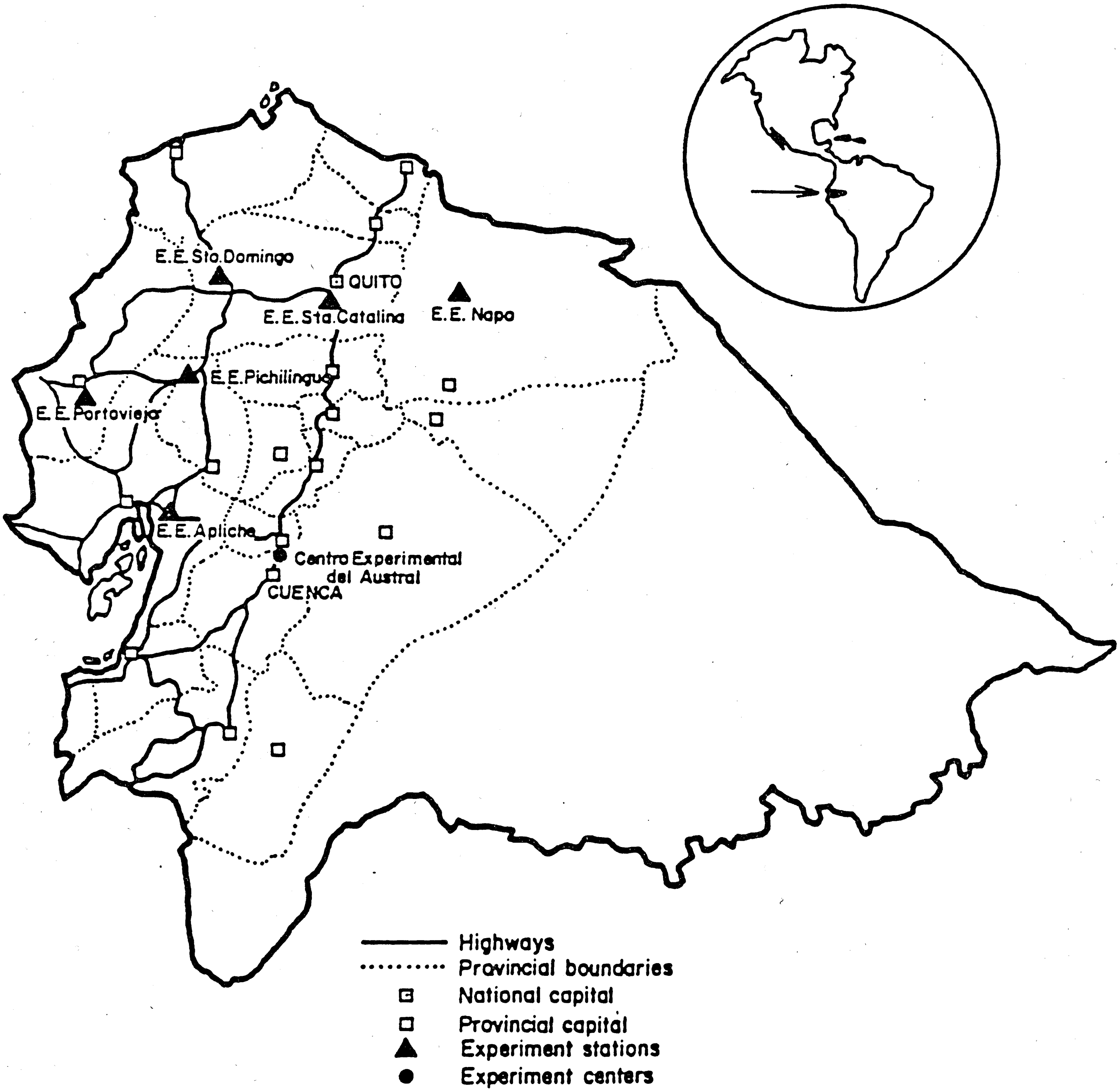

Exhibit 2

FARMING SYSTEMS RESEARCH IN ECUADOR

INIAP Research Stations and Centers -- 1981

STATION	LOCATION	ZONE	SIZE ha	NO. OF TECH. PERSONNEL	YEAR ESTABLISHED	BREEDING PROGRAMS	SUPPORT DEPARTMENTS
Santa Catalina	18 km S of Quito	Temperate	950	110	1962	Maize Cereals Potatoes Vegetables Legumes Fruits Pastures/ cattle Swine Poultry	Soils Weed Control Pathology Entomology Seed Mutipl. Nutrition Engineering Nematology
Pichilingue	14 km SE of Quevedo	Humid Tropical	1,200	64	1963	Cocoa Coffee Maize Oilseeds Pastures/cattle	Soils Weed Control Pathology Entomology Seed Multipl. Engineering
Boliche	26 km E of Guayaquil	Tropical	200	58	1969	Cotton Rice Oilseeds Legumes Banana Fruits Vegetables Swine	Soils Weed Control Pathology Entomology Seed Multiplication
Santo Domingo	38 km W of Santo Domingo	Subtropical	327	28	1963	Oil Palm Pastures/cattle Swine	Soils Weed Control Pathology Entomology Oil Quality Laboratory
Portoviejo	12 km N of Portoviejo	Arid Tropical	240	36	1962	Cotton Maize Oilseeds Legumes Pastures/ cattle Fruits Vegetables	Soils Weed Control Pathology Entomology Seed Multiplication
Napo	Between Agrio and Coca	Tropical	980	7	1978	Pastures/cattle Coconut Crop Production	Soils
Experimental Center "AUSTRO"	18 km N of Cuenca	Temperate	15	5	1975	Cereals Maize Legumes Pastures/cattle	Soils

Source: INIAP.

Exhibit 3

FARMING SYSTEMS RESEARCH IN ECUADOR

INIAP Personnel, by Type of Training, 1980

SITE	"AGRONOMOS" (Secondary School Graduates)	"INGENIEROS" (University Graduates)	VETERINARIANS	M.Sc.	Ph.D.	TOTAL
Central Administration	0	2	0	5	0	7
Regional Administration	0	2	0	1	0	3
Santa Catalina	36	51	4	15	3	109
Pichilingue	16	28	1	12	1	58
Boliche	11	36	2	10	1	60
Portoviejo	7	23	0	5	0	35
Santo Domingo	11	11	3	5	0	30
Napo	5	2	1	0	0	8
"El Austro"	2	2	0	0	0	4
TOTAL	38	157	11	53	5	314

Source: INIAP.

Exhibit 4

FARMING SYSTEMS RESEARCH IN ECUADOR

Production and Yields of Some Basic Crops, Ecuador, 1970-1980

YEAR	RICE*		BEANS		FLOURY MAIZE		HARD MAIZE		WHEAT	
	PRODUCTION Tons	YIELD kg/ha	PRODUCTION Tons	YIELD kg/ha	PRODUCTION Tons	YIELD kg/ha	PRODUCTION Tons	YIELD kg/ha	PRODUCTION Tons	YIELD kg/ha
1970	117,165	1,353	41,331	506	167,990	794	101,516	1,265	81,000	1,062
1971	82,344	1,455	30,148+/-	449	140,385	581	120,528	1,088	68,493	906
1972	104,639	1,145	26,038	419	170,642	682	100,748	989	50,640	903
1973	133,683	1,577	31,961	482	100,342	811	153,346	1,089	45,189	972
1974	151,808	1,478	28,001	423	76,252	696	185,628	1,148	54,989	977
1975	207,295	1,694	26,103	417	90,247	830	203,392	1,225	64,647	921
1976	202,649	1,503	33,053	486	105,653	898	171,210	1,221	52,349	886
1977	327,622	3,060	26,000	441	54,350	647	164,100	1,007	39,800	973
1978	225,273	2,771	18,760	481	39,247	754	136,513	1,030	28,904	1,075
1979	318,471	2,872	23,196	523	35,539	734	182,329	1,070	31,248	1,029
1980	380,614	3,006	26,275	545	45,266	764	196,414	1,179	31,113	969

* Rice 1970-1976 = shelled
1977-1980 = paddy

Source: MAG, Dirección General de Planificación,
Departamento de Estadísticas Agropecuarias (various reports).

Exhibit 5

FARMING SYSTEMS RESEARCH IN ECUADOR

Farm Size, Ecuador

Farm Size	Number of Exploitation Units	% of Total Units	Total Area * (hectares)	% of Total Area
Less than 1 ha	206,273	32.6	93,018	1.3
1 - 5 ha.	264,074	41.7	615,556	8.9
5 - 50 ha	137,501	21.7	1,970,202	28.4
More than 50 ha.	25,370	4.0	4,258,744	61.4
TOTAL	633,218	100.0	6,937,520	100.0

* Crops and pasture.

Source: INEC
Encuesta Agropecuaria 1968, Quito.

Exhibit 6

FARMING SYSTEMS RESEARCH IN ECUADOR

Proposed Organizational Chart, INIAP

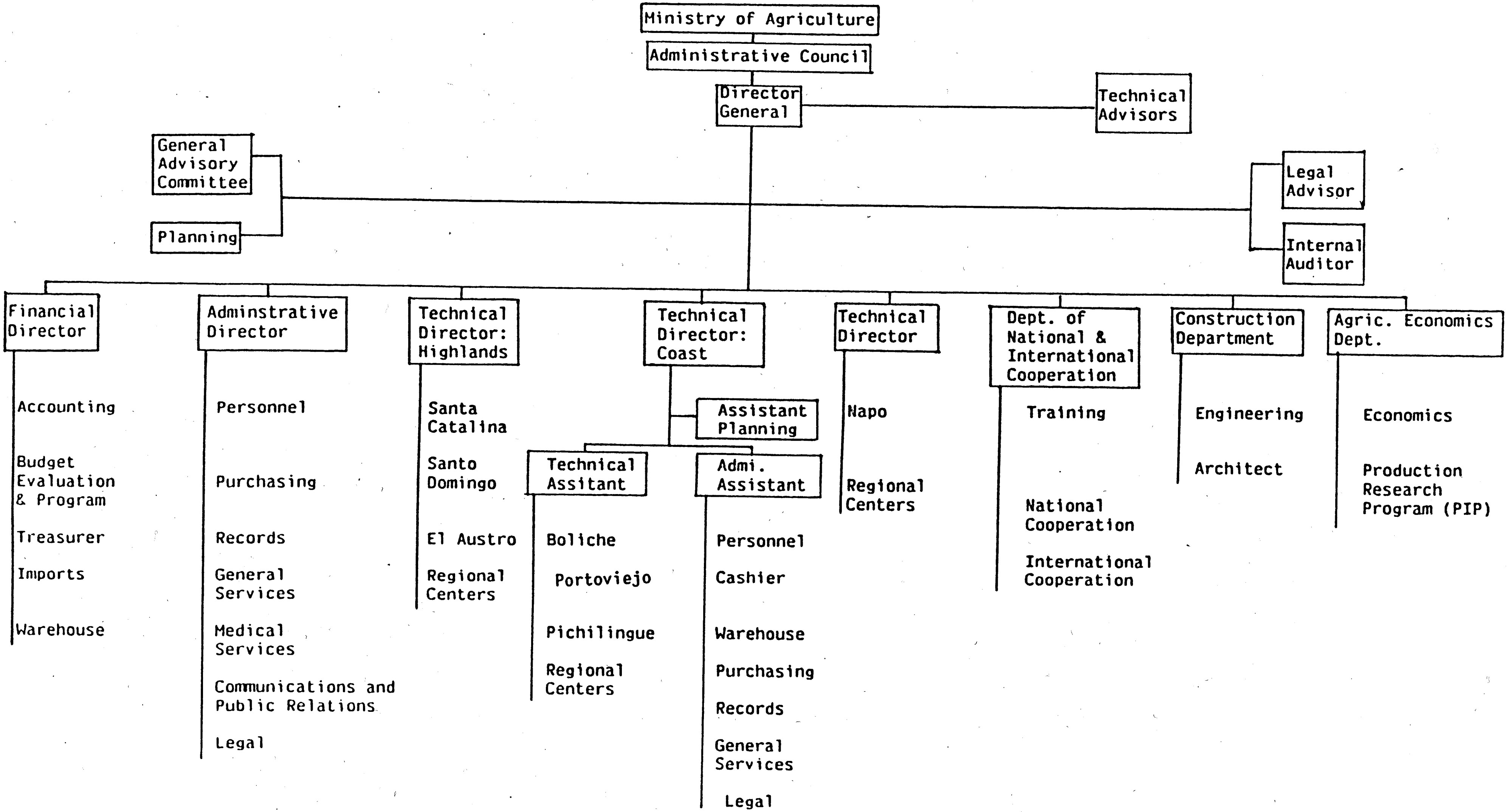

Exhibit 7

FARMING SYSTEMS RESEARCH IN ECUADOR

Production Systems Program - Personnel

LOCATION	POSITION	Number of Staff	Employment Status*	TRAINING INIAP = Thesis with INIAP X = Thesis done elsewhere	Time with INIAP before joining PIP
Carchi	Investigator	1	C	INIAP	0
	Assistant	2	M	-	0
Imbabura	Investigator	2	M	X	0
	Investigator	2	M	INIAP	2 years
	Assistant	1	M	-	0
Cayambe	Investigator	1	M	INIAP	1 year
	Assistant	1	M	-	0
Quimiag-Penipe	Investigator	2	M	INIAP	1 year
Loja	Investigator	2	M	INIAP	1 1/2 years
	Investigator	1	C	X	0
Balzar	Investigator	1	C	X	0
Manabi	Investigator	4	M	X	3 years
	Investigator	3	M	INIAP	1 1/2 years
Puerto Ila	Investigator	2	M	INIAP	1 1/2 years
	Investigator	1	C	X	0
Quininde	Investigator	1	C	INIAP	1 year
	Investigator	1	C	INIAP	1 year
Samborondon	Investigator	4	C	X	0
COORDINATOR	Chief Investigator	2	M	INIAP	8 years

* C = Yearly Contract.
M = Member of INIAP.

Exhibit 8

FARMING SYSTEMS RESEARCH IN ECUADOR

INIAP Technical Staff by Rank

POSITION		NUMBER IN INIAP	NUMBER IN PIP
Chief Investigator*	3	4	0
Chief Investigator	2	14	1
Chief Investigator	1	19	0
Investigator*	5	5	0
Investigator	4	26	2
Investigator	3	37	1
Investigator	2	45	5
Investigator	1	20	7
Assistant**	5	3	0
Assistant	4	12	0
Assistant	3	19	0
Assistant	2	28	1
Assistant	1	20	2

* Investigators have university degrees.

** Assistants have secondary school degrees.

Chapter 5

GUARANTEED PRICES OF MAIZE IN MEXICO

GUARANTEED PRICES OF MAIZE IN MEXICO:

A Management Commentary

"Guaranteed Prices of Maize in Mexico" highlights the contrasting needs of three client groups of agricultural research: subsistence farmers, the urban poor, and the government. The requirements of the various client groups are not necessarily compatible and may often be in conflict. The case presents contrasting stories of the very distinct requirements that each of the three groups have in relation to maize, the staple food of Mexico.

The situation facing the subsistence farmers shows the dependence of this group on the maize crop. Without maize this group would not survive. While subsistence farmers consume a high percentage of their maize production, the government-determined guaranteed support price for maize will dictate at what price these subsistence farmers will be able to sell the small surpluses they achieve and will determine their economic well-being until the next harvest. In this case, Dr. Gustavo Gomez from the Ministry of Agriculture determines that these desperately poor farmers, who represent the majority of the country's agricultural producers, deserve the highest guaranteed prices the nation can provide them.

Mr. Alejandro Lopez works for the government agency responsible for the nutrition of the urban poor. He concludes with great conviction that the guaranteed prices of maize must be as low as possible. The urban masses are depending on maize-derived foods (basically tortillas) for the bulk of their nutrition. Higher maize prices, in his view, can only lead to higher staple food prices, endangering already marginal nutritional levels and provoking urban unrest.

The burden of this dilemma falls on the shoulders of Mr. Mario Ayala. His job is to determine the guaranteed price of maize in Mexico. Reporting to the President of the Republic, he has been told his job is to "stimulate agricultural production and, on the other hand, defend the interests of the popular classes." Mr. Ayala is also under great pressure from the Ministries of Finance, Budgeting, and Planning to eliminate subsidies and reduce government spending.

This case serves to highlight how a marketing perspective broadens a manager's understanding of his environment and his definition of his client base. It enables him to recognize more accurately who his clients are and to understand more fully their needs and concerns.

Having multiple clients inevitably leads to competing demands on the agricultural research manager and his organization. The marketing perspective gives the manager a deeper understanding of his clients and better prepares him to arbitrate among competing clients and their demands.

The requirements of clients and the capabilities of research organizations evolve and change over time. This means that today's prime client may not be the most important client tomorrow. A marketing perspective permits research managers to monitor and anticipate changes. This enables them to plan ahead, to anticipate rather than be overwhelmed by change, and to prepare to respond to the changing needs of client groups.

GUARANTEED PRICES OF MAIZE IN MEXICO:

A Case Study

by S. Huntington Hobbs IV

The Committee for Variable and Guaranteed Prices

Mario Ayala, Technical Director of the Committee for Variable and Guaranteed Prices (CVGP), was frowning at his phone.

"There just is no way to please everybody," he said. Within the hour he had received phone calls from both the Ministry of Agriculture and the Ministry of Commerce. Dr. Gómez, Technical Consultant in Economics for the Ministry of Agriculture, had called to request the upcoming meeting of the CVGP be pushed forward 10 days to ensure that the 1979 guaranteed prices for maize could be posted before the April 1 deadline. Dr. Gómez hoped that an earlier date for the CVGP meeting might preempt mounting political pressure by the National Board of Millers and Tortillerías in opposition to an increase in guaranteed prices for maize. Dr. Gómez had requested the cooperation of Ing.[1] Ayala to ensure that "Mexican farmers receive a fair price for their maize in 1979."

Ing. Ayala had also received a call from Lic.[2] López, Subdirector of the National Commission of Maize for Human Consumption (CONAIM). Lic. López, representing the Ministry of Commerce at the upcoming meeting of the CVGP, requested that the meeting be postponed by a month. Lic. López explained that the National Board of Millers and Tortillerías was threatening to sell tortillas at a price above the official prices. "The time is not propitious to discuss raising the price of maize," López had stated. "We must wait and let the situation calm down." He had added that he was sure Ing. Ayala understood that higher maize prices at this time would only give added impetus to the tortillerías' petition for an increase in the price of tortillas.

As Ing. Ayala reflected upon the upcoming CVGP meeting, his secretary handed him the newspaper. Mexico's President Portillo was on the front page guaranteeing the availability of cheap food for low-income Mexicans. President Portillo had proclaimed, "Our official policy of prices is sufficiently flexible to, on the one hand, stimulate production and, on the other hand, defend the interests of the popular classes." It was Ing. Ayala's job to make sure that this was so.

Organization of CVGP

The Committee for Guaranteed Prices (CGP) was formed in 1976 with the advent of the Portillo administration. The purpose of the CGP was to coordinate the actions of those government agencies that had jurisdiction in the setting of agricultural guaranteed prices. In 1978, the concept

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(1) Ing. is an abbreviation from Ingeniero, a form of address commonly used by those having attained a technical degree.

(2) Lic. is an abbreviation from Licenciado, a form of address commonly used by those having received a professional degree.

of Variable Prices for Commercialization was first used, and the name of the CGP was changed to the Committe for Variable and Guaranteed Prices (CVGP).

The CVGP was composed of the Ministry of Agriculture, the Ministry of Commerce, the National Company for the Provision of Basic Foodstuffs (CONASUPO), and the State Rural Bank (BANRURAL). Included as observers were the Ministry of Finance, and the Ministry of Budgeting and Planning.

The Ministry of Agriculture was responsible for all agricultural production in Mexico, and was responsible for disseminating guaranteed price information to the farmers. As agricultural production was lagging behind population growth, the Ministry of Agriculture was seeking new programs that would dramatically increase production.

The Ministry of Commerce had the responsibility of enforcing regulated prices of consumer goods. Prices for regulated consumer goods were set within the National Commission of Prices (NCP), a semiautonomous agency of the Ministry of Commerce. NCP price guidelines had to be approved by the Ministry of Commerce. The NCP set the prices for tortillas using guidelines put forth by the National Commission of Maize for Human Consumption (CONAIM). NCP forwarded the prices to the Ministry of Commerce, and after approval by the Ministry of Commerce, the prices were forwarded to the President for his approval. CONAIM, the NCP, and the Ministry of Commerce worked closely to regulate the price of the tortilla, and thus it was not unusual for CONAIM to be called on to help represent the interests of the Ministry of Commerce in the discussions of the guaranteed price of maize in the CVGP.

The National Company for the Provision of Basic Foodstuffs (CONASUPO) was a semiautonomous agency reporting to the Ministries of Agriculture and Commerce. CONASUPO was created in 1961 to decrease the costs of distribution of basic goods to lower-income groups. CONASUPO saw its role as replacing "inefficient middlemen, speculators and hoarders that increase their profits at the expense of the producer and the consumer,"[3] with an organization capable of reducing the costs of distribution and marketing of basic products. Thereby, CONASUPO hoped to decrease prices to the consumer and increase prices to the producer. CONASUPO was the government's agent for buying crops at guaranteed prices. CONASUPO's purchases of domestic agricultural production had been as high as 44% of national wheat production in 1972-73, 73.5% of national safflower production in 1975-76, and 19.1% of national maize production in 1970-71. CONASUPO was the agency responsible for purchasing grain in the international markets when there was a deficit in national production, and it also controlled public grain storage throughout Mexico.

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(3) CONASUPO, Annual Report, 1978.

The State Rural Bank (BANRURAL), an agency of the National Bank of Mexico, had as its purpose the provision of credit and inputs to the agricultural sector. During 1978, BANRURAL lent 40 billion pesos(4) to 1,300,000 small producers. BANRURAL experienced a 40% default rate on loans made in 1978 but some of this could be recovered later. One BANRURAL official defended its high annual default rate stating, "Incomes in the rural sector are low due to low guaranteed prices. It is BANRURAL's duty to prevent the decapitalization and subsequent collapse of the rural sector."

Operation of the CVGP

At the beginning of each calendar year, the Ministry of Agriculture prepared a document detailing their recommendations for guaranteed prices. This document was circulated to the other agencies in the CVGP, and served as a basis for discussion. Due to the central role of maize in the national diet, the possible effect of the guaranteed price of maize on the retail price of tortillas was included in the deliberations. The representatives of the different agencies in the CVGP met in mid-February and after some debate recommended a narrow band of possible guaranteed prices to the Ministers of Agriculture and Commerce. These two ministers in turn made a common recommendation to the President of Mexico, who made the final dicision.

Guaranteed prices become law when printed in the Official Daily. The president had ordered that guaranteed prices be made public in early April before the main spring planting to inform the farmer of these prices, and the Ministry of Agriculture disseminated the information of guaranteed prices through newspaper ads and radio spots. In October, when harvesting of spring plantings began, CONASUPO received crops at guaranteed prices. CONASUPO had strict guidelines on moisture content, pest infestation, and degree of impurities. Produce that did not meet these standards was discounted accordingly.

CONASUPO bought, shelled, transported, and sold the maize to maize millers at subsidized prices. During 1978, while the guaranteed price of maize was 2,900 pesos per ton, CONASUPO sold the product, after processing and transport, at 2,375 pesos per ton. This maize was sold exclusively to processors who supplied maize flour to the tortillerías. CONASUPO processed 20% of the maize it received in 1978 into maize flour. CONASUPO measured its subsidy outlays for each crop as the selling price minus the purchase price. Administrative or operational expenses were not taken into account. CONASUPO's subsidy for maize in 1978 was 4.2 billion pesos. CONASUPO also subsidized wheat bread, cooking oils, rice, school supplies, and other products considered as basic to the needs of lower-income groups. In 1978, CONASUPO's total subsidy outlay was 19.5 billion pesos.

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(4) All monetary units are in Mexican pesos. Before September 1976, the peso had a fixed parity to the US dollar of US$1 = 12.50 pesos; after September 1976, the Mexican peso was floating versus the dollar. In 1978, the exchange rate was approximately US$1 = 22.50 pesos.

During the time between early April, when guaranteed prices were made public, and October, when guaranteed prices were first paid, CONASUPO had to decide at what price it would supply maize to millers and tortillerías. If guaranteed prices for maize were to be raised, CONASUPO could absorb the price increase by increasing its subsidy to maize millers. If CONASUPO decided to pass on all or part of the price increase, CONAIM was notified so that it could draw up new recommendations for the price of tortillas. CONAIM would pass its new recommendations to the National Committee of Prices (NCP), the NCP to the Ministry of Commerce, and the Ministry of Commerce to the president for approval.

Variable Prices For Commercialization

Ing. Ayala, who was responsible for overseeing the use of the "Variable Prices for Commercialization" (VPC) mechanism, was pleased with the first year's experience with the VPC. In 1978, when the farm price of beans had risen to 8,000 pesos per ton, CONASUPO had been unable to buy any beans at its guaranteed price of 6,250 pesos per ton. In order to procure its minimum requirements of beans, CONASUPO had requested, and received permission, to temporarily raise the guaranteed price of beans. This new policy of temporarily raising the guaranteed price to obtain its minimum requirements became known as "Variable Prices for Commercialization." Variable prices also allowed CONASUPO to increase the efficiency of its operations by better utilizing its storage capacity. Ing. Ayala wondered if flexible prices could be used to relieve transportation bottlenecks at harvest time, and at Mexican ports when the wheat and maize import shipments arrived.

At that time, CONASUPO experienced severe bottlenecks in the transportation of imported maize, wheat, and other foodstuffs, since it followed a procurement program whose major objective was to buy when the price of maize and wheat were low in the Chicago Commodities Market. While this reduced the cash purchase price and saved foreign exchange, the purchases tended to be concentrated during September, October, and November when the United States harvested its maize and spring wheat crops. Thus, much of the saving in foreign exchange was later lost due to bottlenecks in transportation, storage costs, and storage losses. Ing. Ayala considered that by raising or lowering the guaranteed price, domestic maize and wheat purchases could be streamlined to make CONASUPO's transport and storage more efficient.

Ing. Ayala expressed his satisfaction with the subsidy scheme for tortillas worked out by CONASUPO, CONAIM, and the CVGP. "It is quite simple," he explained. "We give most of the subsidy to the maize miller. The maize miller sells to the tortillería, and if the maize miller overcharges, the tortillerías howl. The tortillerías sell to the consumer; if the tortillerías overcharge, the consumers howl. Why subsidize the tortilla through the maize millers and not through the farmers or the consumers?" asked Ing. Ayala rhetorically. "There are relatively few maize millers, but 22,000 tortillerías, 3 million producers, and 65 million consumers!"

The Upcoming CVGP Meeting

Ing. Ayala considered it would not be advisable to raise the price of the tortilla this year. If the price of the tortilla were raised, the minimum wage in the cities would have to be raised as well. The price of the tortilla and urban minimum wage went hand in hand. Though there existed an official minimum wage for rural employees, Ing. Ayala also considered guaranteed prices for maize a proxy for the minimum income of Mexico's small landholders.

Ing. Ayala was not looking forward to the upcoming meeting of the CVGP. "It is all so predictable," he fretted. "The Ministry of Agriculture wants high prices to boost production, BANRURAL wants high prices to ensure that its loans are paid back, the Ministry of Commerce wants low prices to control irritating prices, and the Ministry of Finance wants to hold the line on inflation and protect the value of the Peso."

Production Considerations

Dr. Gustavo Gómez, Technical Consultant in Economics for the Ministry of Agriculture, stared at the piles of documents, graphs, and computer printouts on his desk. Dr. Gómez had been asked by the Ministry of Agriculture to draft the 1979 report on guaranteed price for maize. This report was to be used as a basis for discussion by the Committee for Variable and Guaranteed Prices (CVGP). The Ministry of Agriculture had emphasized to Dr. Gómez that the ministry would use this document to advocate better prices for Mexican farmers. Dr. Gómez was wondering how the 1979 report should be written. Dr. Gómez had drafted the Ministry of Agriculture's 1978 recommendations for an increase in the guaranteed price of maize, and these had been rejected by the CVGP.

The 1978 Report on Guaranteed Price for Maize

In 1978, Dr. Gómez had recommended establishing a guaranteed price for maize between 3,350 and 3,400 pesos per ton, an increase of 15.5% to 17.2% over the guaranteed price of 2,900 pesos per ton in effect during the spring/summer and fall/winter crop cycles of 1977. Dr. Gómez had justified the recommended increase by stating that (1) the guaranteed price for maize would have to increase 18.8% in order to maintain parity with the increase in average production costs during 1977 (Exhibit 1); (2) the guaranteed price for maize would have to increase 15.5% in order to maintain the purchasing power that a ton of maize had in the period 1956-66 (776 in 1960 pesos), a time when Mexico had a surplus of maize to export; and (3) the guaranteed price for maize would have to increase 18% to keep pace with the cost-of-living index supplied by the Banco de México.

The 1978 guaranteed price recommendations for maize prepared by Dr. Gómez had been rejected by the CVGP. To help the producer the CVGP did, however, continue its policy of restricting fertilizer price increases relative to price increases of other agricultural inputs (Exhibit 2). Dr. Gómez had added that the prices of agricultural inputs were increasing more rapidly than the prices farmers received for their products. Fertilizers represented on the average only 9.9% of the costs of production.

Dr. Gómez had developed a model to explain maize production and this was included in the 1978 report (Exhibit 3). Dr. Gómez had concluded that guaranteed prices have their greatest effect on production three years after they were announced. Though the model had not actually been used to predict future maize production, Dr. Gómez was very discouraged that his model had not been used to help set a guaranteed price, lamenting that "the more precise economists are, the less politicians listen."

Dr. Gómez had analyzed the historical relationship between guaranteed maize prices and maize production in Mexico. He divided the years 1957 to 1977 into three principal periods.

Period 1: 1957-1966

In 1957, 820,000 tons of maize were imported, almost 600% more maize than was imported the previous year. In order to increase domestic production, the government raised the guaranteed price in 1957 to 680 pesos per ton, an increase of 21% over the previous year. In 1958, the price was raised 18% to 800 pesos per ton, and a further increase of 18% was decreed in 1963, with a price of 940 pesos per ton, adding up to a cumulative increase in nominal prices of 67% from 1956 to 1963 (Exhibits 4 and 5).

During this period, the surface area planted in maize increased 52%, from 5,460,000 hectares in 1956 to 8,287,000 hectares in 1966. At the same time, production doubled from 4,382,000 tons in 1956 to 9,271,000 tons in 1966, an annual growth of 11%, while population grew at 3.3%. Thus, Mexico was able to export 1,347,000 tons of maize by 1965, and 4,350,000 tons from 1965 to 1968. The real price of a ton of maize (in 1960 pesos) reached 856.10 in 1963.

Period 2: 1966-73

During the years 1966 to 1973, the guaranteed price of maize was maintained at 940 current pesos per ton, which, due to inflation, reduced the real price of a ton of maize in 1960 pesos from the record 856.10 in 1963 to 537.14 in 1973, a cumlative decline of 37% during the period 1963 to 1973.

As the real price per ton decreased, maize production decreased from 9,271,000 tons in 1966 to 8,609,000 tons in 1973, and the surface area planted to maize decreased at an annual rate of 1.2% from 8,280,000 hectares in 1966 to 7,600,000 hectares in 1973. During the same period, the production of crops competing with maize increased: sorghum increased from 1,411,000 tons in 1966-67 to 2,960,000 tons in 1973, and soybeans increased from 95,000 tons in 1966 to 586,000 tons in 1973. This declining production of maize, coupled with continued population growth, led Mexico to import 1,145,000 tons in 1973.

Period 3: 1974-77

The guaranteed price per ton of maize was increased form 940 pesos in 1973 to 1,500 in 1974, 1,750 in 1975, 1,900 in 1976, and finally, 2,900 pesos in 1977. Thus, the nominal price per ton of maize increased 209% in four years, a 33% annual rate. Nevertheless, due to inflation the real price of a ton of maize in 1960 pesos increased at an annual rate of 9.5%, from 537 in 1973 to 773 in 1977. In terms of 1960 pesos, the real price of a ton of maize in 1977 was still below the 1963 price of 856. Maize production responded to the 1974-77 price increases: 10,024,000 tons were harvested in 1977, an increase of 28% over the 7,848,000 tons produced in 1974. The area cultivated in maize also increased from 6,717,000 hectares in 1974 to 7,374,000 hectares in 1977, an increase of 10%.

Since 1974, all guaranteed prices for agricultural commodities were pegged to maize, since maize was considered to be the most important crop in Mexico. Thus, if the government wanted to promote wheat production, the relative price of a ton of wheat would be raised vis-à-vis maize. If the government wanted more maize and less sorghum, the price of sorghum relative to maize would be lowered.

The Producer

The World Bank reported in 1978 that 45% of Mexico's total labor force worked in agriculture and produced 10% of Mexico's Gross Domestic Production. The National Bank of Mexico estimated that the labor force active in agriculture in 1978 numbered 10 million, of which 3,300,000 did not have land of their own, and another 1 million had land holdings so small that they worked only 100 days during the year on their own farms. The National Bank of Mexico estimated there were 2,816,000 farm units in Mexico, and classified these units as:

Modern: Progressive, commercial farms applying improved technological practices, representing 7% of total units;

Traditional: Semi-commercial farms adopting some improved technological practices, representing 41% of total units;

Subsistence: Farms consuming most of their production, mostly maize and beans, representing 52% of total units.

Land ownership in Mexico was divided into private and ejido. An ejido was land distributed by the Agrarian Reform of the Mexican Government to landless farmers. The ejidatario had the right to farm the land but could not rent or sell it. Ejidos represented 43% of the national agricultural land in 1970 (Exhibit 6).

The average land holding was estimated at 10.7 hectares per unit, of which about 6 hectares were arable. In 1970, 91% of the ejidatarios had less than 10 hectares (Exhibit 7). Of the farms belonging to the private sector, 81% were below 10 hectares, and 34% of the private farms were smaller than one hectare (Exhibit 7).

The use of farm machinery was increasing. In 1970, 18% of the agricultural land was farmed with mechanical equipment exclusively, as opposed to only 3.8% in 1950. Nevertheless, animal labor was still used on over half of the total agricultural area in 1970, and 69% of the ejidatarios used animal power (Exhibit 8). Ejidatarios used less agricultural inputs than private farmers on the average, but roughly similar quantities for similar farm sizes. In 1970, private farmers used 1,120 pesos of inputs per hectare, while ejidatarios used only 373 pesos per hectare.

Only a third of the farm units had access to irrigation in 1978. About 80% of the farm families had an income below the national average. Farm families derived a fifth of their income off the farm. Though the average literacy rate of Mexico was 76% in 1976, the literacy rate was as low as 30% in some rural areas. It was estimated that nearly 70% of the rural homes did not have running water, and 40% did not have electricity.

Since 1949, agricultural production had averaged an annual growth rate of 1.5%, with maize output lagging behind all other crops, with a 0.4% annual growth rate (Exhibit 9).

The 1979 Guaranteed Price Recommendations

In January 1979, Dr. Gómez was considering various alternative recommendations for guaranteed price increases for maize. He told his colleagues, "It's a lot harder to sell a 30% increase to cover two years' inflation than it is to sell a 15% increase each year." Dr. Gómez was carefully examining the following alternatives:

Alternative 1: Increase the guaranteed price of maize at a rate equal to the average increase in costs of production. During the last two years, costs of production had risen 34% (Exhibit 10).

Alternative 2: Increase the guaranteed price of maize at a rate equal to the increase in the cost-of-living index. During the last two years the cost-of-living index had risen 31% (Exhibit 11).

Alternative 3: Increase the guaranteed price of maize at a rate equal to the increase of the official rural minimum wage. During the last two years, the rural minimum wage had risen 35% (Exhibit 12).

Consumption Considerations

Alejandro López, Subdirector for the National Commission of Maize for Human Consumption (CONAIM), knew that performing his job well meant maintaining low tortilla prices to consumers. It was already mid-January 1979, and in just three weeks he was to receive the new guaranteed price recommendations for maize from the Ministry of Agriculture. The Ministry of Agriculture would surely propose an increase, and raising the price of maize could only place additional upward pressure on the price of tortillas.

In 1978, Lic. López had argued before the CVGP that the tortillerías, the 22,000 retail tortilla outlets in Mexico, would be threatened with bankruptcy if the price of maize was increased while the price of the tortillas was not. He had explained that while the tortillerías had maintained the official national average ceiling price of 3.60 pesos for a kilo of tortillas since 1976, the input costs of rent, labor, and machinery had increased 20% a year due to inflation. López had added that the average low-income Mexican consumed 0.430 kg of tortillas per day, and that the low-income families already spent 60% of their daily budget on food. He had argued that if the CVGP recommended an increase in the guaranteed price of maize, either the tortilla industry would collapse, or the subsidies to the industry would have to be increased, or the price of the tortilla would have to rise, a price increase for which the CVGP would have to accept responsibility. In 1978, the CVGP had finally recommended that there be no increases in agricultural guaranteed prices. The president had accepted the recommendation.

López knew it would be much harder this year to avoid increases in the guaranteed price of maize. Mexico was importing record amounts of grain, and the Ministry of Agriculture was bound to sharpen its arguments for higher guaranteed prices. The Ministry of Agriculture had asked CONAIM for a breakdown of the costs of a typical tortillería.

An independent study conducted in 1978 indicated that one northern Veracruz tortillería that produced 540 kg of tortillas a day had fixed costs of 17,000 pesos per month and variable costs of 2.485 pesos per kg of tortilla. The official retail tortilla price for the northern Veracruz zone was 4.80 pesos per kg. Large-volume commercial buyers, such as restaurants, were occasionally offered discounts.

The National Board of Millers and Tortillerías, a private association representing 70% of the tortilla industry, claimed that the production of tortillas was unprofitable and had formally petitioned that the price of tortillas be permitted to rise by 35% in the rural sector and 20% in the cities in order to offset increases in the costs of production. The National Board of Millers and Tortillerías was threatening to instruct its members to raise prices without the government's permission, and to go on strike if a single establishment was closed by government inspectors.

CONAIM

The National Commission of Maize for Human Consumption was an autonomous public organization established in 1973 to regulate the maize milling and tortilla industries. Prior to 1973, the authorization to open a tortillería was granted by the mayor in each locality; this led to a proliferation of tortillerías in some towns, and to monopoly situations in others. Since 1973, CONAIM had allowed a maximum growth rate of 2.4% per year in the number of tortillerías, which was below the 3.5% national population growth rate.

Since 1976, CONAIM had been trying to reduce the number of tortillerías. The plan, originated by Alejandro López, was to increase the average volume of sales per tortillería from 300kg of tortillas per day to 500 kg. By increasing the sales volume per tortillería, the tortillería owners would be compensated for the declining margin per tortilla. "Let the inefficient tortillería disappear," said López.

Besides regulating the tortillerías, CONAIM advised government agencies on tortilla prices and worked with CONASUPO to regulate the national distribution of maize. Consumers preferred the domestic white maize tortillas to tortillas manufactured from imported yellow maize. However, CONAIM had found that consumers were willing to accept tortillas that had a content of up to 30% of yellow maize. CONAIM therefore routed a 30% yellow, 70% white maize mixture from CONASUPO to the mills. When

CONASUPO stocks of white maize ran low, CONAIM would arrange for private traders and processors to trade their stocks of white maize for CONASUPO's imported yellow, with CONASUPO absorbing the transportation and handling costs. Some private traders traded their maize in order to remain on good terms with CONASUPO, and some processors preferred the yellow maize due to its higher starch content.

CONAIM had divided the country into 102 economic zones and recommended a tortilla price for each of these zones. CONAIM had devised a formula to derive a tortilla-price recommendation for each zone. This formula took into account average raw material procurement costs and operating expenses for each zone.

The formula allowed a reasonable operating surplus at a standard sales volume per tortillería. The local raw material procurement costs depended upon the local price of maize and the amount of raw material supplied by CONASUPO. While Mexico City tortillerías received 90% of their maize requirements from CONASUPO, tortillerías in northern Baja California received no CONASUPO maize. CONASUPO supplied an average of 40% of the tortillerías' needs nationwide. In early 1979, official tortilla prices based on CONAIM recommendations ranged from 2.60 pesos to 5.20 pesos per kg, with a Mexico City price of 3.60 pesos per kg. In general, tortilla prices were set lower in cities than in rural areas.

The Consumer

In 1978, Mexico numbered its population at 65 million. The World Bank estimated Mexico's annual population growth rate at 3.5%. Mexico's population was projected to reach 126 million in the year 2000. Mexico's rural population was migrating to the urban areas. During the period 1960-75, the urban population increased at an annual rate of 4.6%, as rural migration to the cities changed the 50% rural - 50% urban population ratio of 1960 to a 37% rural - 63% urban ratio in 1975. It was estimated that 1,500 people migrated each day to Mexico City, already the third largest city in the world with a population of over 13 million in 1978.

The average income in Mexico in 1976 was 24,800 pesos (US$ 1,090). The poorest 20% of the population received only 4.2% of the national income in 1970, while the richest 10% of the population received 50% of the national income.

The National Institute of Nutrition had defined three typical diets that were consumed by Mexicans according to their economic status.

Diet A, consumed by 50% of Mexico's population, was composed of maize (usually consumed as tortillas) and beans, supplemented occasionally by fruit, sugar, and meat on special occasions. Diet A, which prevailed among rural and urban low-income groups, provided 2,115 calories and 56 grams of protein daily. The National Institute of Nutrition estimated that the minimum nutritive intake of a male 18 to 34 years old should be 2,750 calories and 83 grams of protein daily (Exhibit 13). Tortillas and fried beans accounted for 67% of the calories and 77% of the protein of low-income consumers (Exhibit 14) -- 51% of the calories and 52% of the protein that a minimum nutritional diet requires.

Diet B, also based on maize and beans, was supplemented by wheat bread, rice or pasta, coffee, and meat. Diet B was common in small towns and among the upper-lower and middle classes. Tortillas and beans accounted for between 20% and 50% of the nutritional value of Diet B. Diet B was consumed by approximately 30% of Mexico's population.

Diet C, consumed by middle and upper urban income groups, was similar to the dietary patterns of developed countries. Breakfast generally included juice, milk, and eggs. Other meals included meat, salad, rice, and dessert. Approximately 20% of Mexico's population consumed Diet C.

Maize For Human Consumption

During 1974, CONAIM had conducted a campaign to prohibit the use of maize in the production of commercial animal feed. The purpose of this campaign was to increase the availability of maize for human consumption. The campaign was successful and by 1976 the use of maize in the production of commercial animal feed had been phased out (Exhibit 15). In addition, CONAIM initiated, in 1977, a campaign to prohibit the feeding of nonprocessed maize to animals. By prohibiting the use of nonprocessed maize as animal feed, CONAIM hoped to promote Mexican self-sufficiency in maize. In 1978, Mexico imported 1,035,000 tons of maize and used 2,609,000 tons of maize as nonprocessed animal feed.

CONAIM was also pursuing a project to enhance the nutritional content of the tortilla by adding soybeans to the maize flour. "An 8% content of soybeans," stated López, "will triple the protein content of the tortilla." In 1979, this project was hampered by the movement of domestic soybean production to export markets, as well as by the lack of an enforcement mechanism to insure that premium-priced, soybean-reinforced maize flour actually contained the required soybean content.

CONAIM was also seeking to reduce the use of maize by the private agribusiness sector in order to increase the amount of maize available for tortillas. CONAIM was calling on the private agribusiness sector to substitute the use of sorghum for maize in a variety of consumer products.

"Our Most Politicized Food"

Ing. Alejandro López had been with CONAIM since its formation in 1973. "These years have not been easy," explained López. "The tortilla is the staple of the Mexican diet. It is our most politicized food. I have survived four directors of CONAIM. Every time the price of the tortilla increases, lightning strikes the Director of CONAIM. We must keep the price of the tortilla low. It is the cheapest source of protein and carbohydrates available to the Mexican."

López was concerned that the variable price mechanism would be used to bid up the price of maize, though up to now it had only been used with beans. "The mechanism was so successful," said López, "that the Committee for Guaranteed Prices changed its name to the Committee for Variable and Guaranteed Prices." Though CONASUPO had the authority to use variable prices for commercialization, during the 1978 bean scarcity, the government placed a ceiling price on beans of 8,000 pesos per ton, and closed the borders of the principal producing states to allow CONASUPO to purchase the crop.

López was also concerned about the actions of another government agency, the Ministry of Health. The Ministry of Health had recently released an ordinance that prohibited any person handling food from also handling money. This meant that many tortillerías would have to hire an additional person. López feared that the measure would increase the costs of the average tortillería by as much as 20%. López exclaimed, "Such a measure can only arouse the anger of the National Board of Millers and Tortillerías. How can we keep the price of the tortilla low if nobody cooperates?"

"Maize was domesticated by our prehispanic ancestors," López concluded, "and since then maize has been the cornerstone of the Mexican diet. Every Mexican has a right to sufficient maize. We must find the way of ensuring this is so."

Exhibit 1

GUARANTEED PRICES OF MAIZE IN MEXICO

Maize: Cost Comparison of Different Technological Levels
During the Spring-Summer Cycle of 1977 and 1978

Technology	Area 1977 (1,000 ha)	Yield 1978 (ton/ha)	Cost/ha 1977 (pesos/ha)	Cost/ha 1978 (pesos/ha)	Percent Change in cost/ha 1977 to 1978	Cost/ton 1978 (pesos/ton)
IVF	154	3.48	6,980	8,070	15.5	2,320
RVF	1,018	1.50	4,270	5,450	27.8	3,640
RLF	535	1.29	4,720	5,700	20.9	4,420
RVW	372	1.21	2,520	3,230	29.0	2,670
RLW	4,293	1.07	2,860	3,290	15.0	3,070
Total	6,372	1.22	3,320	3,950	18.8	3,240

I = irrigation
V = improved varieties
F = fertilizer
R = rainfed
L = local varieties
W = without fertilizer

Source: Secretaría de Agricultura y Recursos Hidráulicos, BANRURAL.

Exhibit 2

GUARANTEED PRICES OF MAIZE IN MEXICO

Indexes of Farmgate Prices for Crops and Agricultural Inputs, 1968-78

Year	Crops						Inputs			
	Rice	Beans	Maize	Wheat	Soybeans	Sorghum	Improved Seed	Nitrogen	Insecticide	Minimum Rural Wage
1968	100	100	100	100	100	100	100	100	100	100
1969	107	102	96	99	100	103	99	99	110	100
1970	104	105	97	98	105	104	100	94	127	117
1971	107	113	96	100	106	109	99	88	156	117
1972	98	115	96	99	115	118	97	84	188	150
1973	140	170	119	104	194	137	104	85	211	179
1974	235	318	156	156	212	204	182	95	253	208
1975	246	299	199	201	215	254	283	115	312	285
1976	264	267	232	203	266	267	283	144	456	313
1977	271	327	309	258	366	329	344	173	–	380
1978	273	363	373	344	385	385	–	199	–	440

Source: The Second State-of-the-Nation Address, 1978.

Exhibit 3

GUARANTEED PRICES OF MAIZE IN MEXICO

Econometric Model for Estimating
Maize Production in Mexico

$$\text{Log } Y = 3.64 + 0.70 \text{ Log } X_1 - 0.77 \text{ Log } X_2 - 0.3 \text{ Log } X_3 + 0.23 \text{ Log } X_4 + 1.41 \text{ Log } X_5$$

Where Y = maize production in Mexico during year t

X_1 = real price of maize (in constant 1960 pesos) in year t-3

X_2 = real price of sorghum during year t

X_3 = real price of fertilizer in year t

X_4 = rainfall in millimeters during year t

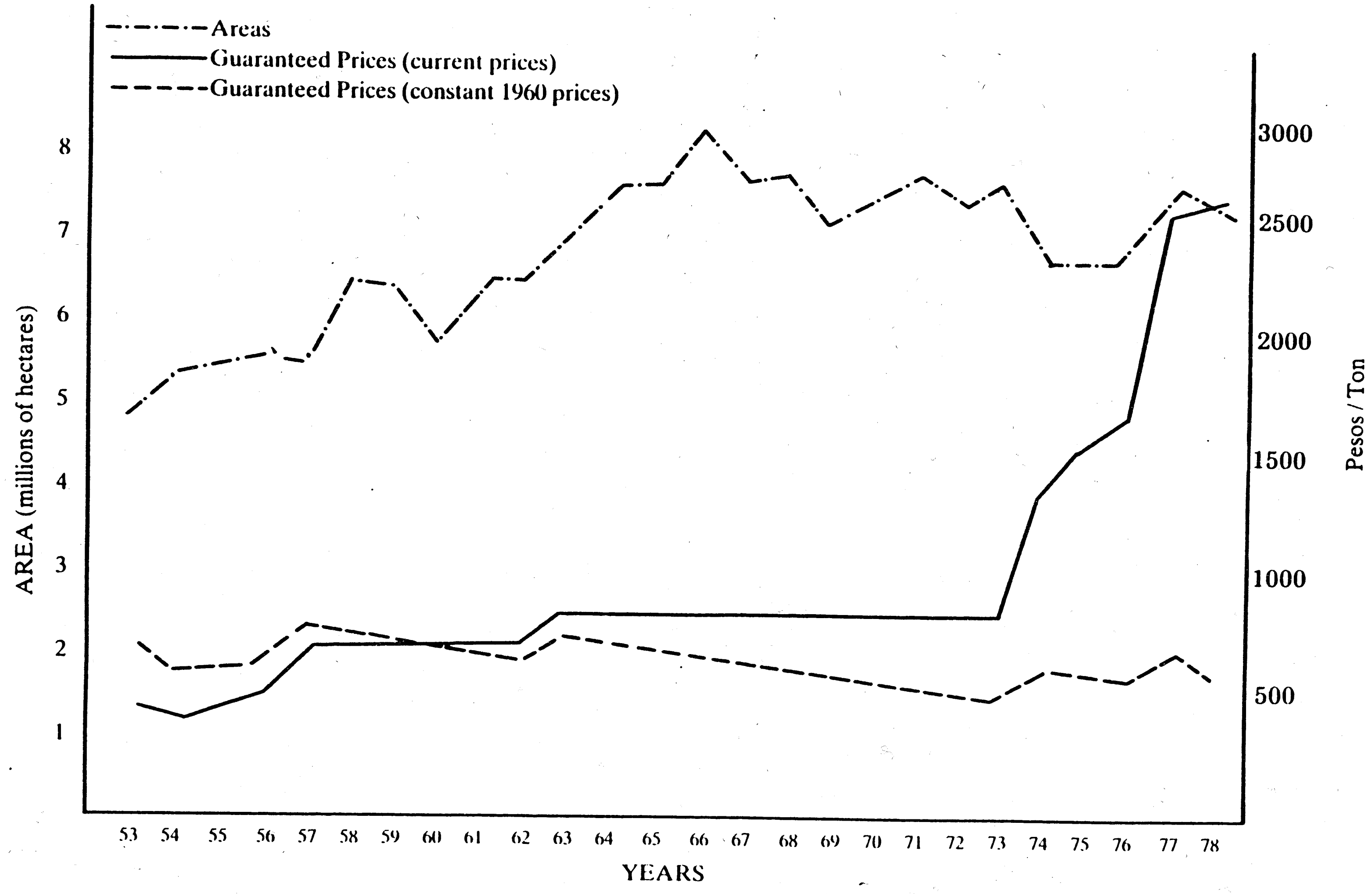
X_5 = yield in kg of maize per hectare in year t-1

Source: Dirección General de Economía Agrícola, Mexico City.

Exhibit 4

GUARANTEED PRICES OF MAIZE IN MEXICO

Trends in Maize Area and Guaranteed Prices



Source: Dirección General de Economía Agricola, Mexico City

Exhibit 5

GUARANTEED PRICES OF MAIZE IN MEXICO

Maize: Area, Yield, Production, Production Value, International Trade, and Prices, 1956-76

Year	Total Area Cultivated (million ha)	Area in Maize (million ha)	Percent Area in Maize	Yield (ton/ha)	Maize Production (million ton)	Maize Imports (million ton)	Maize Exports (million ton)	Apparent Consumption (million ton)	Per Capita Consumption (kg)	Guaranteed Prices: Current Prices pesos/ton	Guaranteed Prices: Constant 1960 Prices pesos/ton
1956	10.8	5.46	51	0.80	4.38	0.12	-	4.50	145	563	662
1957	10.8	5.39	50	0.84	4.50	0.82	-	5.31	167	650	687
1958	12.1	6.37	53	0.81	5.28	0.81	-	6.09	185	800	825
1959	12.1	6.32	52	0.88	5.56	-	-	5.61	165	800	817
1960	11.4	5.58	49	0.98	5.42	-	0.46	4.99	143	800	800
1961	12.4	6.29	51	0.99	6.25	-	-	6.28	174	800	774
1962	12.4	6.37	51	0.99	6.34	-	-	6.35	171	800	751
1963	13.3	6.96	52	0.98	6.87	0.4	-	7.35	191	940	856
1964	14.4	7.40	52	1.13	8.45	-	0.28	8.22	207	940	810
1965	14.4	7.72	54	1.16	8.94	-	1.35	7.60	185	940	792
1966	15.7	8.28	53	1.12	9.27	-	0.85	8.42	199	940	762
1967	14.9	7.61	51	1.13	8.60	-	1.25	7.35	163	940	740
1968	15.0	7.68	51	1.18	9.06	-	0.90	8.71	181	940	723
1969	14.2	7.10	50	1.18	8.41	-	0.79	7.63	163	940	696
1970	14.9	7.44	50	1.19	8.88	0.76	-	9.64	200	940	667
1971	15.8	7.69	50	1.27	9.79	-	0.28	9.53	191	940	737
1972	15.2	7.29	48	1.26	9.22	0.20	0.43	8.99	174	940	603
1973	15.9	7.81	48	1.13	8.61	1.15	-	9.72	182	940	537
1974	14.9	6.72	45	1.17	7.85	1.28	-	9.12	164	1500	691
1975	15.5	6.69	43	1.26	8.45	2.63	-	11.08	193	1750	702
1976	14.7	6.78	44	1.18	8.02	0.81	-	9.17	154	1900	698
1977	16.1	7.37	46	1.36	10.02	1.76	-	11.72	181	2900	773

Source: Dirección General de Economía Agrícola, SARH, DGE, SIC, and CONASUPO.

Exhibit 6

GUARANTEED PRICES OF MAIZE IN MEXICO

Ownership of Land in Mexico

Year	Area				Percent Distribution			
	Total (million ha)	Ejidos (million ha)	Communities (million ha)	Private (million ha)	Total	Ejidos	Communities	Private
1930	132	8.4	6.0	117.3	100	6	5	89
1940	129	28.9	6.1	94.8	100	23	5	73
1950	146	38.9	7.6	99.1	100	26	5	68
1960	169	44.5	8.7	115.8	100	26	5	68
1970	140	60.5	9.2	70.1	100	43	7	50

Source: Ministry of Agriculture, Fifth Agricultural Census, 1970.

Exhibit 7

GUARANTEED PRICES OF MAIZE IN MEXICO

Distribution of Ejido Farms and Private Farms by Farm Size, 1970

Ejido farms:					
Farm size (hectares)	0-1	1-4	4-10	10-20	20 or more
Percent of total	16.3	39.1	35.2	8.4	1.0
Cumulative percent	16.3	55.4	90.6	99.0	100.0
Private farms:					
Farm size (hectares)	0-1	1-4	4-10	10-20	20 or more
Percent of total	34.1	34.7	12.1	9.7	9.4
Cumulative percent	34.1	68.8	80.9	90.6	100.0

Source: Ministry of Agriculture, Fifth Agricultural Census, 1970.

Exhibit 8

GUARANTEED PRICES OF MAIZE IN MEXICO

Type of Energy Used, as a Percent of Total Agricultural Land, Mexico

	Animal			Mechanical			Animal and Mechanical			Human Labor Only		
	1950	1960	1970	1950	1960	1970	1950	1960	1970	1950	1960	1970
Average	65	59	53	4	7	18	12	17	13	19	17	16
Farms over five hectares	55	51	32	7	13	26	12	9	18	26	25	24
Farms under five hectares	68	62	50	–	1	4	–	2	5	32	35	40
Ejidos	75	68	69	1	–	13	15	28	10	10	4	9

Source: Yates, Paul Lamartine. El Campo Mexicano. Ediciones El Caballito, Mexico City, Mexico, 1978. p. 395.

Exhibit 9

GUARANTEED PRICES OF MAIZE IN MEXICO

Area Sown to Principal Crops
(three-year averages)

Crop	1949-51	1959-61 (millions hectares)	1969-71	1973-75 (percent)	Annual Growth Rate
Maize	6.3	6.5	7.4	6.9	0.4
Beans	1.3	1.4	1.8	1.7	1.1
Wheat	0.6	0.9	0.8	0.7	0.7
Sorghum	-	0.1	0.9	1.31	-
Alfalfa	0.1	0.1	0.2	0.2	6.0
Soybeans	-	0.1	0.3	0.6	-
Other oilseeds	0.3	0.4	0.4	0.4	1.2
Total oilseeds	0.3	0.5	0.7	1.0	4.7
Sugar	0.2	0.3	0.5	0.5	3.7
Cotton	0.7	0.8	0.5	0.4	-
Cacao, coffee, sisal	0.3	0.5	0.6	0.7	3.1
Fruits(1)	0.1	0.2	0.3	0.4	5.2
Total	10.3	11.7	14.0	14.1	1.4
Other crops	0.4	0.7	0.8	1.2	4.6
Total	10.7	12.4	14.8	15.3	1.5

(1) Avocado, peach, lime, mango, apple, orange, banana, and grape.

Source: Yates, Paul Lamartine, El Campo Méxicano, Ediciones El Caballito, Mexico City, Mexico, 1978. p. 395.

Exhibit 10

GUARANTEED PRICES OF MAIZE IN MEXICO

Cost of Production for Different Technological Levels,
1977, 1978, 1979

Technological Level	Area as Total Percent of Area Harvested	Costs 1977	Costs 1978 (pesos/ha)	Costs 1979	Relative Increases 1977 to 1978 (percent)	Relative Increases 1978 to 1979 (percent)
IVF	2.2	6,980	8,090	9,180	18	32
RVF	20.2	4,970	5,900	6,850	19	38
RVW	9.8	2,600	3,000	3,400	16	31
RLF	9.4	4,770	5,560	6,360	17	33
RLW	56.3	2,860	3,290	3,780	15	32
Average		3,650	4,250	4,880	16	34

I = irrigation
V = improved seed
F = fertilizer
R = rainfed
L = local variety
W = without fertilizer

Source: SARH-BANRURAL.

Exhibit 11

GUARANTEED PRICES OF MAIZE IN MEXICO

National Index of Consumer Prices

Year	General	Food, Beverages, and Tobacco
October 1977	100.0	100.0
October 1978	115.1	114.6
October 1979	132.5	131.2

Source: Dirección General de Economía Agrícola, SARH.

Exhibit 12

GUARANTEED PRICES OF MAIZE IN MEXICO

National Index of Rural Minimum Wage

Year	Rural Minimum Wage Index
October 1977	100.0
October 1978	115.7
October 1979	135.4

Source: Dirección General de Economía Agrícola, SARH.

Exhibit 13

GUARANTEED PRICES OF MAIZE IN MEXICO

Recommendations for Human Nutrition Intake
(for normal individuals under Mexico conditions)

Age	Weight* (kg)	Energy (kcal)	Proteins (g)	Calcium (mg)	Iron (mg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg Eq)	Ascorbic Acid (mg Eq)	Retinol (mg Eq)
Children (both sexes):										
0- 3 months		120/kg	2.3/kg	600	10	0.06/kg	0.07/kg	1.1/kg	40	500
4-11 months		110/kg	2.5/kg	600	15	0.05/kg	0.06/kg	1.0/kg	40	500
2-23 months	10.6	1,000	27	600	15	0.6	0.8	11.0	40	500
2- 3 years	13.9	1,250	32	500	15	0.6	0.8	11.0	40	500
4- 6 years	18.2	1,500	40	500	10	0.8	0.9	13.5	40	500
7-10 years	26.2	2,00	52	500	10	1.1	1.3	16.9	40	500
Male adolescents:										
11-13 years	39.3	2,500	60	700	18	1.3	1.6	23.0	50	1,000
14-18 years	57.8	3,000	75	700	18	1.5	1.8	27.0	50	1,000
Female adolescents:										
11-18 years	53.3	2,300	67	700	18	1.2	1.4	20.7	50	1,000
Men:										
18-34 years	65.0	2,750	83	500	10	1.4	1.7	24.8	50	1,000
35-54 years	65.0	2,500	83	500	10	1.3	1.5	22.5	50	1,000
55 or more years	65.0	2,250	83	500	10	1.1	1.4	20.3	50	1,000
Women:										
18-34 years	55.0	2,000	71	500	18	1.0	1.2	18.0	50	1,000
35-54 years	55.0	1,850	71	500	18	1.0	1.2	16.6	50	1,000
55 or more years	55.0	1,700	71	500	10	1.0	1.2	16.0	50	1,000
Pregnant	-	+200	+10	1,000	25	+0.2	+0.3	+3.0	80	1,500
Nursing	-	+1,000	+30	1,000	25	+0.5	+0.7	+7.0	80	1,500

* Assumes average weight for the age.

Source: Dept. de Coordinación de Alimentación y Nutrición, Mexico.

Exhibit 14

GUARANTEED PRICES OF MAIZE IN MEXICO

Nutrition Derived from Tortillas and Beans
for Low-Income Consumers in Mexico*

	Calories	Protein (gm)
A) Nutritional value of tortilla (100 grams)	226	5.9
B) Nutritional value of fried black beans (100 grams)	162	6.6
C) Nutritional value of average daily consumption of tortillas (430 grams)	972	25.4
D) Nutritional value of average daily consumption of fried black beans (270 grams)	437	17.8
E) Total nutritional value of average tortilla and fried black bean diet (C & D)	1,409	43.2
F) Average daily nutritional value of diet among low-income consumers ('Diet A')	2,115	56.0
G) Percent of daily nutrition supplied by tortillas and fried black beans among low-income consumers (E - F)	67	77
H) Minimum daily nutritional requirement **	2,750	83.0
I) Percent of minimum daily nutritional requirement supplied by average tortilla and fried black bean diet** (E - I)	51	52

* Nutritional and daily consumption data derived from "The Nutritional Value of Food." National Institute of Nutrition, Mexico, 1971.

** For males 18 to 34 years old -- as demonstrated in Exhibit 13.

Source: Dept. de Coordinación de Alimentación y Nutrición, Mexico.

Exhibit 15

GUARANTEED PRICES OF MAIZE IN MEXICO

Estimated Distribution of Maize Entering the Mexican Market
(in thousands of metric tons)

Year	Direct Retail	Tortilla Manufacture (1000s of tons)	Manufacture of Maize By-Products (1000s of tons)	Production of Commercial Animal Feed (1000s of tons)	Total (1000s of tons)	Animal Feed as Percent Total
1965	1,140	2,760	180	1,680	5,760	29
1966	1,170	2,860	190	1,440	5,650	25
1967	1,200	2,960	200	1,200	5,560	22
1968	1,240	3,060	210	1,200	5,710	21
1969	1,270	3,180	220	1,290	5,960	22
1970	1,140	3,460	220	720	5,540	13
1971	1,170	3,590	230	1,040	6,030	17
1972	1,210	3,730	260	1,320	6,520	20
1973	1,240	3,870	320	1,040	6,470	16
1974	1,270	4,020	340	1,040	6,670	16
1975	1,310	4,180	340	600	6,430	9
1976	1,350	4,340	370	20	6,090	4

Source: Comisión Nacional de la Industria del Maíz.

SECTION TWO

A PARTNERSHIP PERSPECTIVE:
MAXIMIZING PUBLIC- AND PRIVATE-SECTOR LINKAGES

INTRODUCTION TO A PARTNERSHIP PERSPECTIVE: MAXIMIZING PUBLIC- AND PRIVATE-SECTOR LINKAGES

The resources in every developing country are limited, and the challenge exists to maximize the impact of available resources. Often, who does a task is not as important as getting the task done, especially when resources are scarce. In many developing countries significant opportunities exist for partnerships between the public and private sectors that enhance the accomplishment of agricultural research and other development tasks.

The cases presented in this section illustrate that the roles of the public and private sectors need not be predetermined. The roles can be defined by national needs, environment factors, past performances, resource availability, commitment, and other elements. Once the roles have been identified, the need is to find or develop mechanisms and linkages that can build on the strengths and enhance collaboration among the participants in the environment.

The "Kenya Seed Company" case shows a private-sector organization performing a vital task for the government and perhaps performing it better than any entity in the public sector could do it. "Sabritas, S.A." focuses on a private-sector organization moving into an area the public sector has neglected. The case shows how the public and private sectors can cooperate to provide the services each is better suited to provide and, thus, be a multiplier for each other's efforts. The third case, "Biotechnology: The Challenge to Bombalaya," highlights a partnership perspective that adjusts continually to a changing environment, underscoring the idea that linkages established today may not suffice for the challenges of tomorrow.

The relationship between the private and public sectors is one where checks and balances are important, but these must not be so rigid that they interfere with an efficient accomplishment of the task. Recall the earlier case, "PATRONATO: The Agricultural Research and Experimentation Board of the State of Sonora, Mexico." Some commentators consider that the success of Patronato is rooted not so much in what that organization did, but in what the government did not do; the government did not prevent Patronato from exploring and establishing innovative linkages with public-sector entities.

The private sector often feels more vulnerable in these partnerships because it has no economic recourse to failure. If the private-sector company loses money, it may disappear. However, in these partnerships the public sector often feels it is at a disadvantage because it sees the private sector as having greater flexibility, more resources, and the capability to attract the personnel it desires. A marketing perspective can help the agricultural research manager define these fears and concerns, and a partnership perspective can help identify the mechanisms and linkages for overcoming these problems.

A manager with a partnership perspective is a sector spanner, a leader who is capable of building a bridge between the public and private sectors. Sector spanners do not have preconceived ideas about what the mechanisms and linkages between the sectors should be. The potential relationship between the sectors will vary significantly from country to country and from government to government, depending on many variables: economic, social, political, historical, and even climatic.

A sector spanner understands limitations but seeks opportunities. Time and time again, limitations on cooperation prove to be more in the mind of the manager than in the reality of the environment. Several of the cases in this volume show sector spanners in action: "Sabritas, S.A.," "Kenya Seed Company," and "Seed Corporation of the Philippines." The lessons these sector spanners demonstrate are not the specific solutions they found, for these solutions may not be functional in other environments and countries. Rather, the lesson is that the task of the agricultural research manager is to seek innovative linkages with partners that can help to multiply the organization's resources.

For the agricultural research manager in developing countries, a partnership perspective will become increasingly crucial as biotechnological advances result in more practical applications. Biotechnology is promising not only a revolution in agricultural technology, but also a revolution in the roles the private and public sectors have played in the generation and transfer of agricultural technology. While many of the products that biotechnology seems to offer are still on the horizon, it is becoming apparent that biotechnology offers the private sector an opportunity to establish significantly greater control over agricultural technology than it ever could in the past. New linkages for cooperation between the private and public sectors will have to be devised.

Most present agricultural research managers have had some training in botany and have participated in the "Green Revolution" during which the public sector played the central role. The agricultural research manager of tomorrow, on the other hand, will have to operate with a technology based on an understanding of biology in a setting of change where the private sector is likely to assume leadership. A partnership perspective may be the best tool today's agricultural research manager has to avoid becoming obsolete.

Chapter 6

KENYA SEED COMPANY

KENYA SEED COMPANY:

A Management Commentary

"Kenya Seed Company" is about a sector spanner, an organization that builds a bridge between the private and public sectors to draw from the strengths of each. The company was a private-sector organization with a deeply ingrained private-sector culture; yet the majority of the shares of the company were owned by the government.

The management of the Kenya Seed Company had a marketing perspective. It had examined its product and had developed appropriate linkages between its own research initiatives and the public agricultural research establishment. The company had developed an incentive program for its contracted seed growers. Its distribution system was exemplary and was highly innovative in the region, being the first to provide seed in 5- and 10-kg bags, which were sizes appropriate for small-scale growers who were the bulk of the company's customers. Because of these and similar activities, the Kenya Seed Company was considered a cornerstone of Kenya's impressive increases in maize production through the use of hybrid maize varieties.

While being a sector spanner presents opportunities, it also presents new problems and challenges. At the time of the case, the government's agricultural policy and pricing policies were changing faster than the company's capacity to adjust. This highlights the importance that sector spanners must give to information channels while establishing linkages. While the company had established linkages to various agencies within the government, the company was not receiving adequate information on government plans for seed pricing, maize support prices, maize storage levels, and maize export plans, all of which were factors that had a direct and dramatic impact on the demand for the company's hybrid maize seed. The result was that the company was caught with excessive seed inventories and worrisome bank overdrafts which threatened its existence.

A sector spanner, such as the Kenya Seed Company, can be caught between divergent and sometimes incompatible goals. The company can be trying to increase seed sales at a time the government is interested in lower maize prices; the company can be interested in recruiting additional commercial farmers to produce seed at the time the government is extending agrarian reform to commercial farms. The goals of the participants in a partnership may well differ, but a partnership seeks to find common ground. A partnership recognizes that a compromise cannot be worked out on every issue but does seek to achieve a balance in the benefits the various participants gain from the relationship.

The case shows that the private and public sectors do have much to gain from establishing a partnership. For example, through the Kenya Seed Company, the government gains an organization that has proven extremely capable in providing quality seed, and in seeing that the seed is effectively delivered to the majority of the country's farmers. On the other hand, the company gains in the government an organization that is an effective promoter of its products and the provider of technical assistance to farmers. Nearly a third of the farmers indicate being introduced to the company's hybrid maize seed through government extension agents. Indeed, the support of the government extension service is vital to the company. The company is not only selling a hybrid seed, but also new cultural practices. For the seed to be effective, the farmer must plant earlier than the traditional planting date and must weed. The government provides the necessary technical support to assure that the company's product is a success.

As organizations and the environment evolve, partnerships evolve as well. The Kenya Seed Company was founded to produce pasture seed for commercial farmers, later shifted to producing hybrid maize seed for larger and small-scale farmers, and now is in the seed export business. Each of these activities requires that the company establish different partnerships to be able to meet its objectives. Thus, a partnership perspective is not a static process; it is a process that continually seeks better and more appropriate linkages.

THE KENYA SEED COMPANY:

A Case Study

by James A. Lynch
Edward B. Tasch

In March of 1980, eight months after assuming the managing directorship of the Kenya Seed Company (KSC), Mr. Ben Gakonyo met with Mr. Ted Hazelden, the Kenya Seed Company's Commercial Director, in their Nairobi office.

"Ben, I have just received the latest sales figures for hybrid maize seed. From the look of things, our only problem this year appears to be that we can't seem to move the hybrid seed out to our distributors fast enough. Our sales are already more than a month ahead of last year, and with a bit of luck we might even top the 1 million bags we sold in 1977-78."

"That's very encouraging news, Ted", responded Ben. "The government increase in the farm price of maize from KSh 65(1) last year to KSh 90 this year has certainly stimulated maize plantings. The country should now be able to rebuild its depleted strategic maize reserves and in a year or two may even begin to export again."

"Any news from the Minister of Agriculture on our petition for a price increase for maize seed?"

"Nothing yet, Ted, although the general mood at Finance and Planning is quite strongly opposed to inflation. The most expeditious way they see to control inflation is simply to control prices."

Ted Hazelden flushed. "But our retail price for hybrid maize seed has been at KSh 40 for almost two years! If we don't get more for our maize seed we won't be able to pay our growers more. If they don't get more there will be a shortage of hybrid maize seed that will reduce maize yields in Kenya. Lower yields mean lower production and another national maize shortage that will do more to boost the rate of inflation in Kenya than any increase of hybrid maize seed ever could!"

"Well, Ted, you may have put your finger on it, but we must nevertheless be sympathetic to the government's concern. We are the national seed company and our monopoly privileges don't come without strings attached. Maize is by far the major food staple of Kenya, and hybrid maize seed is the key to high maize yields. The government's concern is a legitimate one: to ensure that every farmer can afford to buy good-quality seed of high-potential yield. Our task is to make sure government officials know the pros and cons of seed pricing. It is they who must ultimately make the choice.

"That reminds me, Ted", continued Ben, "we must arrange to meet with Mr. Kamau at Agriculture next week to begin discussing the issue of future

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(1) KSh = Kenyan Shilling. One KSh equals approximately US$0.13.

land availability and the future fragmentation of farms in Kitale. I feel it's time now to begin discussions since it's unlikely that any action will be taken for several years. Once the large farms in Kitale are broken up, the task of seed production will become very difficult indeed."

KSC Organization

The Kenya Seed Company was an enterprise engaged in the production and marketing of seeds of maize, wheat, barley, sunflower, pasture, grasses, and horticultural crops. The KSC entered into contracts for the production of foundation and certified seed. Thereafter it dried, cleaned, graded, tested, treated, and prepared seed for certification. The KSC distributed certified seed to farmers through the Kenyan Farmers Association, a nationwide, farmer-owned cooperative that supplied inputs and marketed the surplus of its members and customers.

To assist seed growers with the production of seed, the KSC also provided a management and machinery service to its contract growers. The Management Service Scheme was begun in 1977, and in 1979 was employed on over 930 hectares of maize seed and 280 hectares of wheat seed.

KSC currently had approximately 60 senior staff members and an average of 1,000 employees, and worked with 300 growers throughout Kenya. The KSC had 13 of their own extension people: five in maize, a total of five in wheat and barley, two in pasture grass, and one in sunflower seeds.

Although the KSC was originally owned by private individuals, by 1980, 51% of the KSC stock was held by the Agricultural Development Corporation (ADC) and 27% by the Kenya Farmers Association, Ltd (KFA). The ADC was a parastatal corporation that had the goal of promoting development of the agricultural sector in Kenya, while the KFA was a farmer input and marketing cooperative that served as the sole agent for the marketing of KSC seeds to Kenyan farmers.

Maize seed production was the largest single crop produced on ADC farms. In 1977-78, ADC farms produced 68,183 90-kg bags of maize seed on 1,317 hectares. All ADC maize seed was produced on a contract basis for the Kenya Seed Company and represented 45% of KSC's maize-seed production.

Origins and Early History of The KCS

Prior to 1956, little certified seed was available to farmers in Kenya. Better farmers selected seed from their crop and processed it on their farms, although some merely retained a portion of their crop for the following year's seed requirements. Sales of desirable material were on a farm-to-farm basis and there was very little control of seed production by either commercial or government agencies.

In 1956, the Kenya Seed Company was formed by a group of farmers in the Trans Nzoia District to multiply the seed of improved varieties which had been selected from indigenous Kenyan grasses on the Grasslands Research Station, Kitale (now the National Agricultural Research Station) and, as a result of field days and extension work, a demand for the seed had been created among farmers. KSC operations began with a limited acreage of grass and legume seed grown under contract in the Trans Nzoia from basic seed supplied by the Grasslands Research Station. The seed was processed with secondhand seed-cleaning equipment that the company acquired.

In 1963, when Kenya achieved its independence from Britain, many of the European pasture farmers stopped investing in improved pastures. This resulted in a sharp decline in the demand for pasture seed, causing severe financial problems for the KSC. It was shortly thereafter, in late 1963, that the Kenya National Maize Program (KNMP) approached the KSC to propose that the KSC take on the commercial production of the new hybrid maize varieties that the KNMP had been breeding since 1955.

The first commercial hybrid maize seed production by the KSC in 1964 yielded 270,000 kilograms. The KNMP maize breeders worked closely with the KSC in an effort to develop hybrid maize seed production techniques capable of producing quality seed economically. The KSC's rapid growth since the mid-1960s is almost entirely due to the growth of hybrid maize seed sales both in Kenya and in neighboring countries.

The KSC began by allocating a seed quota sufficient to produce 10 acres of hybrid maize seed to each of their 30 growers. By closely controlling growers, and limiting their quantities of hybrid maize seed production, the KSC gradually resolved the problems attendant to quality commercial-seed production. The main challenge remained how to market hybrid maize seed to the small farmer.

KSC's decision to target marketing efforts toward the small farmer was explained by W.H. Vergerht, former managing director of the KSC. "In 1962, small farmers cultivated approximately 600,000 hectares of maize versus an estimated 30,000 to 60,000 hectares of maize by large farmers. In a year of favorable maize prices, large farmers would expand their production to 60,000 hectares, while in an unfavorable year reduce maize hectarage to 30,000. Thus if the KSC were successful in capturing only 10% of the small-farmer market, it would account for an equal or greater amount than the entire large-farmer market. The small-farmer market was potentially ten times as large as the large-farmer market."

The KSC began its marketing effort in the most densely populated rural areas, starting with the farmers closest to the main roads, as well as market places. The KSC then began appointing retail stockists, small-scale African shopkeepers selected for their location, reputation, and interest. These stockists were given the exclusive right to buy seed at wholesale prices from wholesale agents. This network spread until by 1980 the KSC had over 6,000 registered stockists, one for every 72 hectares of maize planted. Stated Verberght, "In accordance with the KSC philosophy we decided that we would sell the farmers what they wanted, not what the KSC or the government of Kenya determined was good for the farmer. Consequently, the KSC decided that they would market only white maize in Kenya, which was the preferred type. Moreover, the KSC allowed farmers to select the variety of white maize that they preferred. We found that, in some cases, the farmers would opt for a more attractive grain type, even though another variety was available that might yield up to 5% more."

Maize Research in Kenya

Basic varietal research for maize was performed by the Kenya Maize Research Program (KMRP). The KMRP conducted breeding programs for five distinct agroclimatic regions. Breeding catering to the high-potential, maize-growing areas of Western Kenya, comprising the Nyanza, Western, and Rift Valley Provinces, was centered in Kitale on the National Agricultural Research Station. This area was characterized by altitudes from 1,000 to 2,000 meters and a long rainfall season of 750-1780 millimeters over six to eight months. Maize suitable for this zone would require six to 11 months for maturity depending upon altitude. Breeding objectives for Western Kenya included high yield potential, stalk strength, disease resistance (blight, rust, and stalk rot), and stalk-borer resistance. In Embu the KMRP conducted maize research for most of the Central Province as well as for Embu and Meru Districts in the Eastern Province, where there is adequate rainfall of 750-1780 millimeters falling in two seasons. To make possible two maize crops, the maize in this area requires a maturation time of five to six months.

The semi-arid maize-growing regions of Machakos and Kitui are served by the early-maturity maize program based in Katumani. These districts receive low, erratic rainfall varying between 250 and 400 millimeters and lie at 900 to 1,800 meters above sea level. This region requires a maize type that, by flowering within 60 to 65 days and maturing within four to five months, can escape drought.

The coastal maize program is based at Mtwapa. This program serves the lowland coastal strip characterized by hot and humid conditions and receives 1,000 to 1,250 millimeters of rainfall in six to eight months. Maize grown in this area should mature within four to five months and be able to germinate under very high soil temperatures.

The maize breeding program at Nyandarua Agricultural Research Station in Ol-jororok is developing high-altitude maize for cool, high-rainfall areas of Kenya above 2,000 meters. This region covers the slopes of Mts. Elgon, Kenya, Timbora, Aberdares, and parts of Molo and Nyandaina, and represents approximately 10% of the total area of Kenya.

The stated overall objectives of the KMRP was to make research farmer-oriented. To this end the KMRP recently organized an Annual Maize Tour prior to the maize harvest each year. Members of the KMRP, the Kenya Seed Company, the Kenya Farmers Association, Ministry of Agriculture extension staff, and input suppliers toured the major maize-growing regions of Kenya. The tour interviewed farmers in an effort to find out which farming practices were being employed and what the major problems facing maize farmers were . The results of the tour were written up and used to orient maize breeding and agronomy research. The Kenya Seed Company limited its maize-research activities to applied research on seed production. The KSC had an experienced maize breeder on its staff whose major concern was the efficient commercial production of certified seed from the genetic material provided by the KMRP.

Preparation of Hybrid Maize Seed

The KSC contracted with local growers to secure its production of hybrid maize seed. To insure high-quality seed production, the KSC selected only growers who met the following requirements:

* The grower's farm must be clean and substantially free from sources of insect and disease contamination.

* The farm must be accessible to KSC's Kitale headquarters. Seed production must fit in conveniently with the existing farming program so that it receives proper management by the grower.

* The grower must understand the basic recommendations on crop husbandry and should be practicing those principles on his commercial crop.

* The grower must be honest and reliable and have sufficient finances to grow the crop in the correct manner.

Farmers applied to the KSC to produce seed. Applications were received by a panel of selectors consisting of representatives from the Agricultural Department of the Ministry of Agriculture, the Kenya Inspection Service, plant breeders, growers' representatives, and representatives of the KSC. On the basis of the KSC total-seed requirements, the panel assigned contracts to growers. New applicants were usually given limited acreage in the first year and were assigned a larger quantity only after they had proven their ability.

Production was, as far as possible, confined to a small area around Kitale so that field staff from both KSC and the Kenya Inspection Service could visit the fields frequently and economically. The production of hybrid maize seed required considerable supervision to ensure that the hybrid cross was properly executed.

To produce certified seed, maize was planted in the ratio of six female rows to two male rows. To execute the hybrid cross properly, all the female plants had to be detassled prior to pollination to ensure that the female parent would be crossed only to the male parent and no self-pollination would take place. After pollination the ears from the male plants were removed, leaving only the desired hybrid cross. It was essential that the female parent not be pollinated by a neighbor's maize crop. To prevent this, the KSC required its growers to plant a border of male parents and to keep a buffer zone of at least 200 meters between their seed crop and neighboring fields.

Hybrid maize seed was usually machine planted to ensure that all seed was at a uniform and sufficient depth. This resulted in even germination and helped protect the crop from drying out in case of inadequate initial rains. With machine planting, it was essential that all machines be meticulously cleaned prior to planting to avoid contamination. For hybrid maize, it was necessary for a competent person to supervise the operation at all times to ensure that the male and female lines were not mixed up. To facilitate this procedure the KSC colored its hybrid parent lines different colors so that they could be easily differentiated.

After harvesting, growers delived their wet maize to KSC's drying facility, Seed Dryers, Ltd. The KSC seed drying facility was established in 1975 to dry and shell maize seed. In 1980, the facility had a drying capacity of the equivalent of 200 tons of grain per day. Harvested ears were selected by KSC, dried for 72 hours, then shelled and processed. The procedure was capable of producing packets of maize seed from wet ears in four to five days.

Quality Control and Certification

In addition to KSC's own quality-control measures, the government of Kenya had established the Kenya Inspection Service (KIS) for seeds. The objective of KIS was to promote the provision, improvement, and use in Kenya of high-quality seed of superior, well-adapted varieties of important crop species. The KIS was a government agency within the Ministry of Agriculture, and responsible only to the Ministry of Agriculture. The government allocated funds to the agency, and in return received revenue from fees levied to seed growers for the services of field inspection, sampling, labeling, and sealing of approved seed lots. The KIS maintained a position of complete independence from all breeding and commercial interests.

When the hybrid maize seed crop was in the field, the KIS inspected the crop to verify that all female tassels had been removed. If more than 1% of the tassels had remained, the crop was rejected. Thereafter, the KIS checked to see that no male ears were left in the field to be later mixed with the hybrid cross. The KIS also performed extensive laboratory testing on all seed produced by KSC. Tests were conducted to verify quality, germination rates, and purity of type before the KIS would certify the seed for commercial use. Prior to shipment to farmers, the KIS repeated the quality and germination tests to ensure that the seed had not deteriorated during the intervening months between certification and sale to the farmer. Seed that had a germination of less than 90% was rejected.

Marketing, Distribution, and Sales

The KSC delivered the seed to the Kenya Farmers Association (KFA). The KFA procured farming inputs for its members and customers and assisted them in the marketing of their production. There were 42 KFA branches throughout Kenya, 25 of which were located within close proximity to a rail depot. KFA distributed the seed to farmers through its own outlets, or sold the seed to subagents, who in turn supplied registered KSC stockists or retailers. In 1980, there were approximately 6,000 registered KSC stockists, which included farmer cooperative societies and small shops (dukas), most of which were owned by persons of Asian descent (Exhibit 1).

In 1979, hybrid maize seed was sold nationwide at a fixed retail price of KSh 40 per 10-kilogram bag. This pricing policy of fixed and uniform prices nationwide was developed gradually through trial and error. Initially, KSC sold its seed to distributors at a fixed price from the KSC factory in Kitale. This system proved very difficult to manage, as each distributor added his own margin and retail prices, for seed varied considerably. Moreover, the quantity of stocks that each distributor was willing to carry varied greatly, causing continual outages in certain areas.

To overcome these difficulties, the KSC tried to devise a distribution strategy that would guarantee broad distribution of KSC seed to Kenyan farmers at a uniform price. Borrowing from the distribution strategies employed by Coca Cola and Wilkinson razor blades, the KSC concluded that the key to broad retail distribution was the retailer. By giving the retailer a substantial and fixed margin, the retailers would actively promote KSC Products. Moreover, with an equal pricing policy throughout the country, retailers could not increase their margins, nor would small farmers further from distribution outlets be discriminated against by having to pay more for their seed. Since transportation to wholesalers became a cost borne by the KSC, it was then in the KSC's interest to negotiate the lowest transportation rates possible.

Although various combinations of distribution were currently possible, the KSC typically sold hybrid maize seed to the 25 KFA railway branches at a price of KSh 33.50 per 10-kilogram bag. The KFA in turn transported it to one of its 42 outlying branches, where it was sold to stockists at KSh 36.50. Stockists then transported the seed to their retail stores, where they sold directly to farmers at KSh 40 per 10-kilogram bag (Exhibit 1). Stockists were required to order a minimum of 20 packets of 10 kilograms per order.

One of the elements of KSC's successful marketing to small farmers had been packaging. Instead of trying to market the standard 50- or 100-kilogram bag to the small grower, the KSC realized that the small grower would require a small package. Deciding that an appropriate size would be 10 kilograms, a quantity sufficient to plant half a hectare, the KSC originally employed local tailors to prepare thousands of 10-kilogram bags. In 1979, over 90% of KSC's sales were in 10-kilogram bags with the balance in 25-kilogram bags (Exhibit 2).

Another element that had helped to insure that overstocking and large carryover stocks did not exist had been KSC's policy of cash sales only, and no returns from subagents or stockists. Because stockists had their own cash invested in seed, they tended to buy only quantities they were certain of selling, since any unsold bags had to be carried over until the following season.

Movement of seed stocks began three to four months before expected planting dates and was followed up by field visits of the marketing staff. Agents and wholesalers were encouraged to order their quantities of seed and to take delivery as soon as conditions permitted. Following this, the retailers were visited and informed where they could obtain seed and were again urged to take at least some quantities in stock so that early farmers' demands could be met. Close contact was kept with the Ministry of Agriculture extension staff at all levels so that farmers were informed that seed was available and were advised to buy seed early in the season to avoid the last-minute rush just before planting.

During the entire year, marketing staff traveled throughout the country to try to improve the marketing of seed. Their reports included checks on available stocks, evaluation of the efficiency of the various distribution points, and an assessment of the popularity of the different hybrid maize varieties. The government played an important role in marketing seed to farmers through the efforts of the agricultural extension service.

The extension service conducted farm visits, demonstration plots, and fertilizer trials to bring the message of hybrid maize to Kenyan farmers. In a 1971 farm-level survey, every one-third of farmers questioned reported that they had first heard about hybrid maize from an extensionist.

The package of practices recommended to maize farmers was developed by the KMRP. The package recommended:

- early planting -- coinciding with the start of the rains;
- sowing with the correct maize variety for the area: hybrid in adequate rainfall areas, and composite maize in marginal areas;
- planting with a high density (except in marginal areas);
- control of weeds and pests;
- application of phosphatic and nitrogenous fertilizers: 80 kilograms P_2O_5 and 100 kilograms N/ha.

The increase in maize yields in Kenya in recent years has been a result not only of variety but also of earlier planting and more intensive weeding. A study[2] in the mid-sixties had shown that hybrid seed and fertilizer without early planting and weeding would increase yields by 66% (from 1957 kilograms per hectare to 3246 kilograms per hectare), whereas more intensive husbandry alone, with local maize varieties and no fertilizer, increased yields by 148% (to 4723 kilograms per hectare). Combined intensive-husbandry hybrid seed and fertilizer were calculated to increase yields by 307% (to 7958 kilograms per hectare).

The KSC saw seed as a vehicle to interest the farmer in planting early and weeding. It was important for the farmer to practice more intensive husbandry to obtain the maximum benefit from his hybrid seed. As an early KSC promotional slogan stated, "If you're not a good farmer, we'd rather you didn't buy our seed."

The use of hybrid maize under good management practices normally accounted for a 30% increase in yield over a nonhybrid or synthetic maize. The additional expense involved in planting a hectare with hybrid seed was the cost of 25 kilograms of hybrid seed less the cost of 25 kilograms of local seed. At current prices this amounted to approximately KSh 75 (KSh 100 less KSh 25).

A recurring problem that the KSC experienced was a last-minute rush every year to transport seed to the KFA branches during the prime selling season. Since the KFA had only a limited amount of storage at each branch, the vast majority of seed stocks were stored in the KSC warehouse in Kitale. When the selling season began, stocks at the KFA branches were quickly depleted, leaving KSC with the problem of keeping the KFA stores stocked with seeds by sending smaller shipments by truck. This was undesirable, since it was much more costly to ship by truck than by rail, and invariably resulted in frequent KFA shortages, contributing to a continual crisis atmosphere prior to the planting season. To alleviate this problem, the KSC was contemplating the construction of regional

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(2) A.Y. Allan, 1973. "District Husbandry Trials in Western Kenya, 1966 and 1967."

warehouses adjacent to each of the 25 KFA railway-depot branches. This would enable the KSC to begin shipping by rail to the regional warehouses as soon as the seed was produced. Almost all stock could be stored in the field, eliminating the need for more storage space in Kitale. Furthermore, adjustments could be made during the selling season by trucking seed from surplus to deficit KFA branches.

KSC sales of hybrid maize seed were seasonal and had two peaks coinciding with the two planting seasons in Kenya. In the highlands of Western Kenya, where most of Kenya's maize was grown, the rainfall pattern made it feasible to plant only one crop of maize. Farmers typically planted from mid-March to mid-May and harvested their crop from November to December. Sales of hybrid maize seed to farmers in Western Kenya, comprising 80% of KSC's domestic maize seed sales, were distributed as follows:

Month	Percent
January	10
February	10
March	30
April	30
May	20

In Eastern Kenya (east of the Rift Valley) farmers generally planted two crops of maize. The first crop was typically planted in late March and the second in early October. Hybrid maize sales in Eastern Kenya, while spread throughout the year, were concentrated in the preplanting months as follows:

Month	Percent
March	25
April	10
September	20
October	15

Export Sales

Sales of hybrid maize seed outside Kenya were becoming an increasingly important component of the KSC's business. The KSC charged Ksh 46 per 10-kilogram bag, plus transportation costs from Kitale. Good-quality hybrid maize seed was in short supply in Africa and the next best alternative to KSC seed would likely be seed from Zimbabwe that sold for approximately Ksh 80 per 10-kilogram bag. Zimbabwe maize seed was in short supply, and was only occasionally available.

Current company policy was to sell seed to the export market only after all domestic seed needs were met. In years of slow domestic demand, the KSC promoted exports more aggressively to increase sales and reduce their carryover stocks of seed.

Exports of hybrid maize seed were mainly to Uganda, Tanzania, Ethiopia, Zambia, and the Sudan. While annual export sales had never before exceeded 1,000 tons, in 1979-80, exports were projected to reach 3,000 tons by the end of the fiscal year.

Production and Marketing of Maize in Kenya

The area planted to maize in Kenya was estimated in 1976 to be approximately 1 million hectares, about 35% of the country's total cropped area. It was estimated that 428,000 hectares were planted with hybrids, 88% of this being planted by small farmers who typically farmed from one to 10 hectares. Hybrid yields averaged from two to four tons per hectare; the maximum-yield potential of the hybrid was eight to 10 tons per hectare. National maize production in 1978 totaled 2.35 million tons (Exhibit 3). Sixty to seventy per cent of the maize crop remained on the farm for consumption. The maize-marketing system handled about 760,000 tons, or 8.4 million bags in 1975.

The maize-marketing system had two distinct subsystems: the interdistrict, regulated trade organized by the Maize and Produce Board (MPB), and an informal, largely unregulated system of local marketing. The MPB handled 60% to 70% of all maize traded, with the remainder traded intradistrict in rural markets, where volumes and price varied according to local supply and demand.

The Maize and Produce Board was a parastatal marketing organization with a legal monopoly to trade all maize in Kenya. The MPB's objectives were stated in the Maize Marketing Ordinance: to regulate and control the maize market, to trade in maize for the benefit of producers and consumers, and to advise on the production and foreign trade of maize. To achieve the first objective, the chief mechanism employed by the MPB was fixing prices. The MPB also issued movement permits regulating all interdistrict maize shipments and the board-owned and -operated stores at about 30 locations, where individuals could sell or buy maize at guaranteed prices.

It was the policy of the government to protect both farmers, by acting as a buyer of last resort, and consumers, by maintaining a strategic maize reserve of at least 100,000 tons. In early 1977, when the government boosted its offering price for maize by 23% to Ksh 80 per 90-kilogram bag, both maize plantings and KSC sales of hybrid maize seed reached historic highs. However, when harvest time came, the government was unable to purchase all the maize offered by farmers, leading to an increase in on-farm stocks, a decrease in the free-market price of maize, and decreased plantings for 1978. By harvest time in late 1978, the MPB was unable to purchase even a small amount of the 1978 crop, since its storage bins were still full from the previous year's crop.

In an effort to curb this situation of overproduction, in early 1979, the government lowered the price of maize back to Ksh 65 per 90-kilogram bag. It was hoped that a lower MPB offering price would discourage the overproduction and bring supply and demand back into balance. Farmers responded by significantly reducing maize plantings. Maize production, hampered by poor rains, fell by more than 20%, drastically reducing national maize reserves. To rebuild maize reserves to acceptable levels, the government announced an increase in the guaranteed price to Ksh 90 per 90-kilogram bag, prior to planting the 1980 crop.

KSC and the Success of Hybrid Maize

In the 18 years since its inception, the KSC had experienced continual and rapid growth. For the year ending July 31, 1979, KSC sales were over Ksh 98 million, with profits after tax of over Ksh 3 million. This compared with sales of Ksh 23 million and after tax profits of Ksh 1.8 million for the year ending July 31, 1973 (Exhibit 4).

The impact of the hybrid maize on maize production in Kenya had been dramatic: in the 10-year period from 1963 to 1973, over 80% of all farmers in Western Kenya's major maize-growing regions adopted the use of hybrid maize seed. This adoption took place at a rate faster than the adoption of hybrid maize in the U.S. corn belt in the 1920s and 1930s, according to some studies by Gerhart and Griliches. Gerhart observed: "large commercial farms reached almost 80% usage within five years. Hybrid use on the smaller, but still relatively large, commercial, maize-growing farms in the neighboring areas also spread quickly, but was soon matched and even slightly overtaken by the smaller subsistence farmers in the high rainfall areas."

The KSC Experience from 1963 to 1969

When W. H. Verberght reflected upon his experiences as Managing Director of KSC from 1963 to 1969, he emphasized that both the private seed industry and the government had each performed essential functions that had made possible the production and successful distribution of quality seed in Kenya. Verberght stated: "The main reason for the success of the Kenya Seed Company has been an almost perfect understanding between research, extension, and the Kenya Seed Company about what each group had to do to successfully promote maize production in Kenya. Once basic research is carried out publicly, the private sector can be given the task of adopting or selecting the varieties which have the most economic potential. It is up to the public sector research effort to improve the biological potential of varieties, while it is up to the private sector to perform applied resarch aimed at improving the economic viability of the farmer.

"An essential government function with respect to seed is certification and inspection. To make an inspection by the government viable, you need to have an independent or third-party certification body. Having a third party inspect the seed not only protects the buyer of the seed, but it also protects the seed company. For example, the KSC has a production contract with one of the Ministers of the government. With a third party performing the inspection function, the Minister cannot use political pressure to make the Kenya Seed Company accept seeds of inferior quality. Quality control in the seed industry is so important that it is now above politics in Kenya, at least for the time being, since Kenya has set up an independent government seed certification organization.

"Why should the private sector perform the seed multiplication and distribution function? To perform the seed multiplication and distribution function properly requires immediate commercial decisions which involve a significant element of risk taking. An example of the typical decision which involves risk is: How much to produce? In a developing country, especially one in which you are the sole source of seed, you must not produce too little. Politically, adequate seed production is a sensitive issue. Personally, I find it easier to argue with my banker than to argue with the Assistant Secretary in the Ministry of Agriculture. That's one reason we choose to over-produce and go to the banker when we have problems financing our inventory of seeds.

"You can't build up the long term capital investment required by a seed distribution company without a stable permanent business. This is one reason why we decided to target our efforts toward building a broad stable base with the small farmer.

"Hybrid varieties in maize have a distinct economic advantage. With the F-1 generation the farmer, under good management practices, will receive a 20% to 30% increase in yield over the local variety. This increase in yield is usually independent of fertilization practices. This yield increasing characteristic of hybrid seed is a marvelous marketing device. Well-organized marketing efforts are the crucial complement to plant breeding and extension. Government-run seed companies can tend to be more production-oriented rather than market-oriented.

"I have always believed that one should have an economic motive. On paper it must look like a paying proposition. We have never had a year in which we didn't make a profit. As a simple rule of thumb, we calculate that the wholesale price should be 50% over the contract price for seed. Out of this 50% markup, comes our cost of processing, distribution, and our return on investment.

"Does the profit motive conflict with decisions which are agriculturally sound? Of course, you don't want your distributor recommending varieties which are not agronomically appropriate, just for the purpose of increasing his sales. Because we have a tightly-controlled distribution network, and offer attractive margins to the retailer, we have some control over him. If a retailer steps out of line with our policy and adopts sales practices which are not agriculturally sound, we can and will withdraw his license. It has been our company policy to always establish two or three distributors in each village to avoid a local monopoly and to promote competition.

"Governments, especially governments of developing countries, are by nature not overly cooperative with private enterprise. The Kenya Seed Company has been fortunate to find a government as pragmatic and sympathetic toward business as Kenya's. Many countries, after finding oil and mineral resources, ignore their agriculture. Why dig for it? . . it's all in the top five inches."

Government Relations

The Price Control Act of Kenya of 1975 gave the government of Kenya explicit authority to control the prices of all basic foodstuffs and necessities. While the price of seed was not among the items explicitly controlled by government, the KSC had always had a gentleman's agreement with the Ministry of Agriculture to pre-advise it of any impending changes in the price of seed. In practice, the KSC had petitioned the Ministry of Agriculture for approval of any increase in the price of maize seed because of its economic importance and political sensitivity.

Stated B.K. Gakonyo, KSC's Managing Director: "Anyone who operates in the agricultural sector in Kenya is dependent upon government policy. To survive, you must establish a good working relationship with the government and its policymakers. While we don't engage in the practice of lobbying, we do feel that we must make our case known to the government."

KSC Management Concerns in 1980

In early 1980, the KSC management had three major concerns as they looked toward the future: the alarming increase in KSC bank overdrafts, pricing policy for KSC hybrid maize seed, and the future availability of land suitable for seed production.

Bank Overdrafts

Sudden changes in the government price for maize had made it very difficult for the KSC to estimate the demand for seed. The KSC management felt that a sharp drop in maize plantings in any given year would be eventually offset by a sharp increase in subsequent years. The KSC's response to fluctuations in demand had been to keep good relations with growers by maintaining seed purchases from growers at a relatively steady level.

This policy, while allowing KSC to maintain good grower relations, had recently resulted in the alarming buildup of seed inventories as well as the corresponding increase of bank overdrafts to finance them. From July 31, 1977, to July 31, 1979, bank overdrafts had risen from Ksh 6.4 million to Ksh 47.2 million. Corresponding bank interest charges rose from Ksh 1.77 million in 1976-77 to Ksh 4.09 million in 1978-79.

Hybrid Maize Seed Prices

During the first 10 years of hybrid maize sales, from 1962-63 to 1972-73, price inflation had been low and was offset by KSC's decreasing unit costs due to the economies associated with larger production volumes. The situation changed dramatically in 1973-74 when a tripling in the price of OPEC oil initiated a period of double-digit inflation.

In 1973, KSC petitioned the Ministry of Agriculture for its approval to raise the price of a 10-kilogram bag of seed from Ksh 19 to Ksh 21. The Ministry of Agriculture granted approval for an increase only to Ksh 20. In every subsequent year, the KSC submitted a new petition for a price increase that the Ministry of Agriculture either rejected or granted only in part (Exhibit 9).

KSC's desire to increase the maize-seed price stemmed from its desire to fulfull its responsibility to its shareholders to earn a reasonable return on employed assets. KSC management felt that an after-tax surplus of 10% per year on shareholders' funds would give shareholders a fair return and allow the company to expand as it should. Management wished to avoid further increases in bank overdrafts. Moreover, the KSC wanted to begin paying a 10% dividend to its shareholders, a previous impossibility owing to KSC's need for capital to expand its operations.

For the year ending July 31, 1979, the KSC generated a profit after tax of Ksh 3,057,369 on shareholder funds employed of Ksh 63,492,689, an after-tax return of less than 5%. KSC calculated that domestic hybrid maize-seed sales were being heavily subsidized by other activities in 1980. From a corporate point of view, KSC management felt that all activities should justify themselves economically to ensure the long-term economic health of the company.

The KSC management felt it was necessary to offer its seed growers a price increase to stimulate increased plantings of hybrid maize seed. Seed grower prices had been held constant for the last two growing seasons as KSC, with large reserves of seed maize, had had no need to increase its production. Now with maize-seed sales once again increasing, the KSC wanted to ensure that its production in 1980-81 would be sufficient to maintain its reserve stocks. To support its argument for higher seed prices, the KSC cited that in other countries hybrid maize seed sold for five to 10 times the price of grain. Moreover, in early 1980, the KSC had marketed a small quantity of a new experimental hybrid line at a 25% premium to the standard lines. The entire stock was sold by the end of January.

Future Availability of Land for Seed Production

The third issue of concern to KSC management was a more distant one: how to ensure the future availability of sufficient land suitable for seed production. Because of the strict requirements for isolation, seed was most efficiently produced on large farms in areas of dependable rainfall. With hybrid maize, the isolation requirements made it necessary to maintain a border of at least 200 meters around the seed crop to prevent contamination of the seed crop by neighboring fields of the same species. Thus with even a relatively large farm of 350 hectares, only 30% to 50% of the total area might be available for seed production in any given year. For maize seed production the recommended five-year crop rotation in Kenya was:

1. Pasture grass
2. Pasture grass
3. Seed maize
4. Wheat or sunflower
5. Seed maize

All seed maize was produced in the Kitale area due to the favorable climate, the proximity to KSC headquarters, and the proximity to the drying and processing facilities. The KSC was utilizing the maximum possible area on the nine ADC farms in the Kitale area for maize-seed production. With increasing seed requirements in the future, the only way to expand production in the Kitale area would be to enlarge the management service or encourage ADC to purchase additional large farms to increase their seed production capacity. Another less desirable alternative would be to expand production outside of the Kitale (Trans Nzoia) area. For reasons of quality control and costs, the KSC wished to restrict its seed production to an area within a 40-kilometer radius of the Kitale headquarters. It was estimated that seed production for 1980-81 would be distributed as follows:

		Percent
ADC		40
KSC Management Service		30
Large-scale farmers		30

KSC management was concerned that continuing future fragmentation of large farms, coupled with increasing demands for seed production, would soon make the availability of suitable land a constraint to seed production. By law, farms over 350 hectares cannot be sold or divided without the sanction of the Kenyan Land Control Board. In practice, however, many large farms once formed as cooperatives, partnerships, or public companies were no longer being managed as single-farm units, as the joint owners had informally assigned themselves areas that they could farm as individuals. It was in an effort to make viable these large absentee, multiple-owner farms that the KSC had formed the Management Service in 1975.

In the Nairobi Office

The meeting between Mr. Ted Hazelden and Mr. Ben Gakonyo in KSC's Nairobi office was almost over.

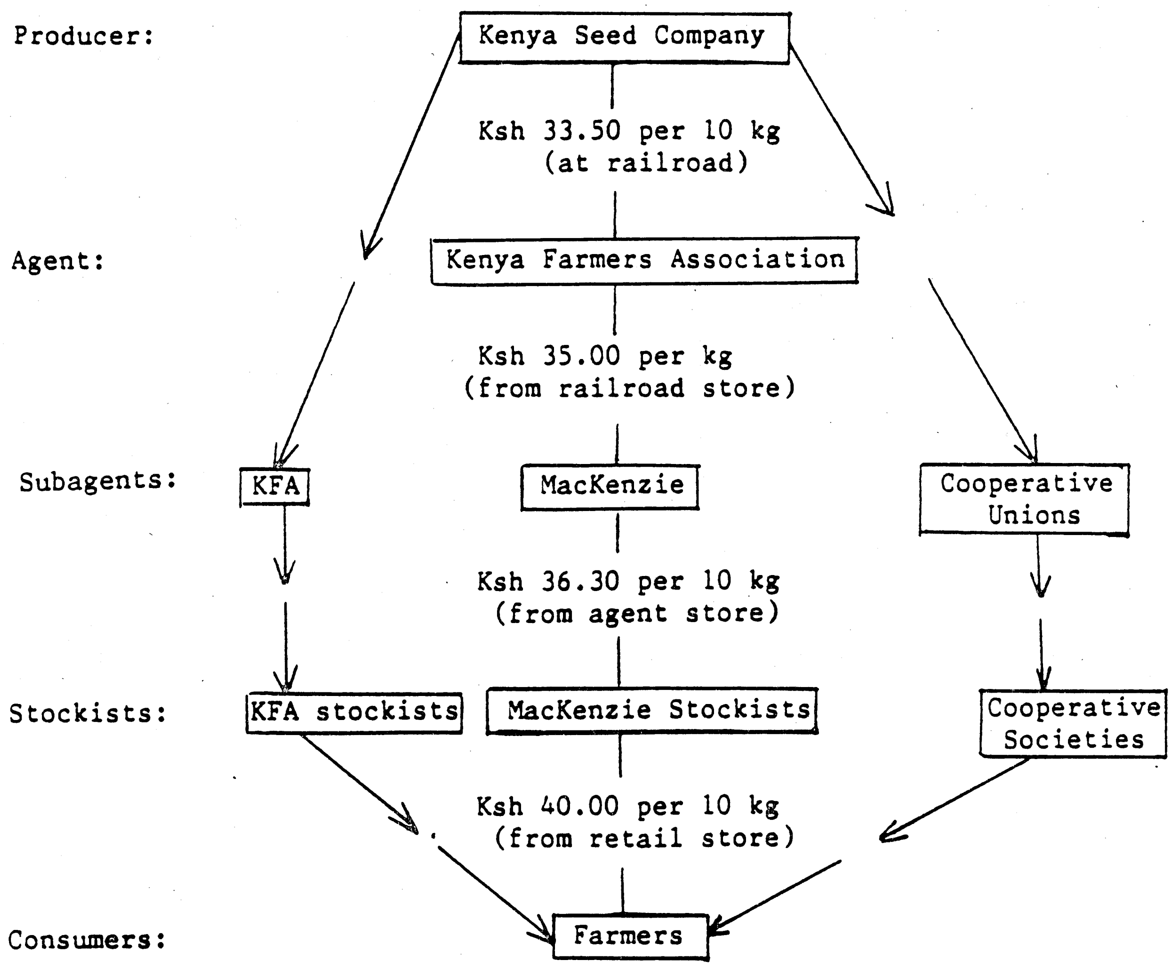
"Before you leave, Ted," said Mr. Gakonyo, "let me just mention that while we're engaged in discussions with representatives of the ADC, the MPB, and other government agencies, we've also got to prepare ourselves for the upcoming annual stockholder's meeting. Our Board of Directors will be especially concerned about the high level of bank overdrafts and will want to see a well-defined plan for reducing the level of the overdraft. We should also be prepared to discuss our strategy in the event that our current negotiations with the government regarding seed prices are not successful."

"Right, Ben. There's a lot to be decided in the coming weeks. Please call as soon as you hear anything on the seed prices." At that, Mr. Hazelden sprang from his chair, shook hands with Mr. Gakonyo, and dashed out the door to begin his return trip to Kitale.

Exhibit 1

KENYA SEED COMPANY

Distribution Network for Hybrid Maize in Kenya
1979/80



Source: Kenya Seed Company.

Exhibit 2

KENYA SEED COMPANY

KSC Hybrid Maize Sales in Kenya, 1962-63 To 1978-79
(in tons)

Year	In 10-kg Bags (tons)	In 25-kg Bags (tons)	Total
1962-63	0.1	4	4.1
1963-64	18	290	308
1964-65	203	553	756
1965-66	382	647	1,029
1966-67	1,166	1,388	2,554
1967-68	1,283	913	2,196
1968-69	1,607	988	2,595
1969-70	2,434	1,118	3,552
1970-71	3,367	1,433	4,800
1971-72	4,626	1,661	6,287
1972-73	5,943	1,199	7,142
1973-74	6,566	881	7,447
1974-75	7,908	1,139	9,047
1975-76	9,427	1,273	10,700
1976-77	10,740	1,484	12,224
1977-78	10,196	725	10,921
1978-79	8,689	504	9,193

Source: Kenya Seed Company.

Exhibit 3

KENYA SEED COMPANY

Kenya Maize Production

Year	Area (1,000 hectares)	Yield (kg/ha)	Production (1,000 tons)	Net Imports (1,000 tons)	Population (100,000)
1961	1,100	1,090	1,200	100	73
1962	1,000	1,000	1,000	-35	80
1963	1,000	1,050	1,050	-87	88
1964	1,050	1,100	1,150	-1	91
1965	1,050	1,050	1,100	88	94
1966	1,000	900	900	141	96
1967	1,050	1,140	1,200	-135	99
1968	1,072	1,250	1,343	-281	105
1969	1,072	1,330	1,425	-190	101
1970	1,100	1,270	1,400	10	112
1971	1,100	1,360	1,500	29	117
1972	1,100	1,510	1,660	-19	121
1973	1,100	1,180	1,300	-229	125
1974	1,250	1,120	1,400	-60	129
1975	1,250	1,280	1,600	-121	134
1976	1,250	1,240	1,550	-113	139
1977	1,250	1,360	1,700	-8	148
1978	1,490	1,580	2,350	-180	149
Rate (percent)	1.65	1.96	3.65	--	3.79

Source: FAO.

Exhibit 4

KENYA SEED COMPANY

Kenya Seed Company, Ltd: Seven-Year Summary: 1972-73 to 1978-79
(in thousands of Kenyan shillings)

	72-73	73-74	74-75	75-76	76-77	77-78	78-79
Turnover[(1)] (sales)	22,989	36,273	50,023	66,000	91,079	99,661	98,710
Profit before tax	2,893	5,945	5,511	5,129	5,661	3,133	6,987
Profit after tax	1,790	3,273	2,972	2,982	3,004	2,060	3,057
Dividends to shareholders	388	492	499	718	889	897	1,795
Bank overdraft	2,748	1,838	3,768	6,421	14,130	32,768	47,188
Profit after tax (percent) as a percentage of sales	7.8	9.0	5.0	4.8	3.3	2.0	3.0
Bank overdraft as a percentage of sales	12.0	5.0	7.5	9.7	15.5	32.9	47.8

(1) Turnover is the equivalent of gross sales.
Source: Kenya Seed Company

Exhibit 5

KENYA SEED COMPANY

Prices of Maize and Maize Seed in Kenya,
1972-73 to 1980-81
(Ksh per kilogram)

Year	MPB Price for Maize Grain	Retail Maize Seed		KSC Price to Seed Growers
		Actual Price	KSC Petition for Increase	
1972-73	0.39	1.90	--	1.00
1973-74	0.39	2.00	2.10	1.05
1974-75	0.56	2.00	2.40	1.20
1975-76	0.72	2.30	2.50	1.50
1976-77	0.72	2.70	3.55	1.50
1977-78	0.89	3.20	3.85	1.80
1978-79	0.89	3.70	3.90	1.90
1979-80	0.72/0.89	4.00[1]	4.50	1.90
1980-81	1.00[2]			

(1) Seed price as of March 15, 1980.

(2) Announced price for 1980-81 harvest.

Source: Kenyan Government, Maize and Produce Board.

Chapter 7

SABRITAS, S.A.

SABRITAS, S.A.:
A Management Commentary

"Sabritas, S.A." tells the story of a private-sector company that was forced to enter into agricultural research in potatoes, a crop that was a low priority for the government, but essential for the company's continued success. Sabritas manufactured snack food, the most important of which was potato chips, and found its growth constrained by an inadequate supply of potatoes. In response, Sabritas eventually expanded into potato research, seed multiplication, seed distribution, and extension services, all of which were areas in which the company had no prior expertise at the time it became involved in the activity. Sabritas did what dynamic organizations often do: it moved into activities that it had not anticipated or planned to enter in order to meet needs that otherwise were not being satisfied.

The case shows how, when linked with a partnership perspective, the public and private sectors can prove compatible and mutually supporting. The government, for example, supported Sabritas by training staff, supplying germ plasm, and quarantining the land immediately around the company's research facilities. With a partnership perspective, each sector can also become involved in activities traditionally associated with the other sector. Sabritas, for instance, was involved in defining sanitary standards for food, a task usually associated with the public sector. Thus, the private and public sectors can share the tasks associated with increasing agricultural development. One sector does not have to assume the task alone. In fact, by permitting the private sector to be involved and to focus its resources on selected tasks, the public sector has more resources to focus on unmet areas of need to which it gives high priority.

Dividing or sharing the task of agricultural research, however, will create unnecessary tensions and problems if either sector becomes overly concerned with what the other is getting out of the collaboration. The more important question is what each sector is contributing to the endeavor and to its success.

The relationship between Mexican government agencies and Sabritas showed that when moving into an area, product, or service that others are neglecting, partners are important and can enhance the effectiveness with which the tasks are accomplished. It is the responsibility of an organization, when it undertakes a challenge, to identify and secure the support of those partners or potential partners who can contribute to the success of the undertaking.

The case also demonstrates that the government, the public sector, is not a monolith. Parts of the government were supportive of the efforts of Sabritas, and parts were opposed. A partnership perspective segments the different elements and institutions in an environment and develops a series of strategies for involving or relating to each.

The Sabritas story documents that success changes the environment. Hence, Sabritas, by its activities, created changes to which it then had to respond and adjust. A partnership perspective realizes that relationships evolve with changes in the environment and that the roles played by members of the public and private sectors also change over time.

SABRITAS, S.A.: A Case Study

by S. Huntington Hobbs IV

"We believe in Mexico," said John Warner, Chief Executive Officer of Sabritas, S.A. "Our key to accelerated growth has been to bring and implement modern potato technology to this country. Mexico has advanced technology in maize, wheat, rice, but not in the potato. Adapting modern potato genetics is our basic contribution to Mexican farming. Higher agricultural yields lead to farming efficiency and expansion of processing opportunities. The government needs foreign companies that help with advanced technology, that can help produce more per hectare, that can provide nutrition, that can make better products, and can contribute to Mexican agricultural development. We have applied our knowledge as a base for future business. Anybody can fry potato chips, but we have brought potato genetics and agribusiness management in potatoes to Mexico." In January 1980, Mr. Warner was reviewing the achievements of the first six years of the Potato Improvement Program of Sabritas. Sabritas was the leading producer of potato chips and other snack foods in Mexico. Mr. Warner considered the Potato Improvement Program had been essential to the company's growth. In 1979, Sabritas processed more potatoes in one day than it had in all of 1966. Of particular concern to Mr. Warner was the continued success of the Potato Improvement Program, the transference of the critical success factors of the Potato Improvement Program to other products in the Sabritas line of snack foods, and the development of an increased consumer awareness of the nutritional content of the potato.

SABRITAS, S.A.

The history of Sabritas, S.A., began in 1947, in the home kitchen of Pedro Noriega. Mr. Noriega prepared snack foods which he sold to street vendors who distributed the produce on bicycles. Mr. Noriega soon bought a small van and initiated direct distribution to retailers. In the 1950s, Mr. Noriega launched the Sabritas' brand of potato chips, and within ten years Mr. Noriega was the leader in snack food sales in Mexico. In 1966, PEPSICO INC. bought a modest manufacturing facility and a strong brand name in potato chips from Mr. Noriega. PEPSICO installed John Warner as President and Chief Executive Officer of the new company, and in 1968 renamed the company, SABRITAS, S.A., and inaugurated the most modern food processing factory in Latin America. The first factory, which had the largest potato-processing volume in the world, was built in the Federal District, a second factory was built in Guadalajara, Jalisco, in 1972, and a third factory was being built in Saltillo, Coahuila, in 1980 (Exhibit 1). By 1980, Sabritas had grown to become one of the top 40 private companies in Mexico. Company sales had increased over 50% in 1979 to near 3 billion pesos,[1] and in 1980, plans were being made to build three additional manufacturing facilities by 1985.

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(1) Before 1976, US$1 = 12.50 pesos. After 1976, the peso was floating versus the US dollar and stabilized during 1979 near US$1 = 22.50 pesos.

Sabritas manufactured and distributed snack foods such as potato chips, popcorn, corn curls, corn chips, tortilla chips, cheese puffs, and pork rinds. Sabritas products were packaged in colorful cellophane bags with a strong brand identity. Any given brand, such as Sabritas(R) potato chips or Doritos(R) tortilla chips was presented in a variety of sizes and flavors. In 1979, Sabritas sold over a billion bags of snack foods and held nearly 65% of the Mexican snack food market.

Potato Production in Mexico, 1964 - 1974

During the early 1970s, Sabritas found its growth constrained by an insufficient supply of frying potatoes. Production of potatoes in Mexico was lagging behind market demand. Annual per capita consumption of potatoes in Mexico had increased from 9.7 kg in 1964 to 11.2 kg in 1974 (Exhibit 2). The population was growing at an annual rate of 3.4%. Yet the Ministry of Agriculture estimated that the area planted in potatoes had decreased from 43,800 hectares in 1964 to 32,200 hectares in 1974.

The area planted in potatoes was decreasing due to the golden nematode (Heretodera rostochiensis), a potato parasite. The golden nematode causes root knots and shrivelled tubers and, once introduced into the soil, will persist indefinitely. Furthermore, agronomists found that some farmers were unknowingly helping to spread the disease. A healthy potato when planted can yield eight to 12 large healthy potatoes. An infected potato when planted can yield some large healthy potatoes and some shrivelled potatoes that carry the golden nematode. Since only the large potatoes were commercially acceptable, farmers were selling the large potatoes and keeping the shrivelled infected potatoes as seed. The infected seed yielded fewer healthy potatoes, more shrivelled potatoes, and the cycle continued until the farmer abandoned potato farming.

As the quality of available potatoes declined, and the area planted in potatoes continued to decrease, the management of Sabritas decided in 1974 to initiate a Potato Improvement Program to help assure the company's potato supply.

The Potato Improvement Program

The Potato Improvement Program presented the management of Sabritas with a difficult challenge. It called for Sabritas becoming involved in seed research, seed multiplication, and agricultural extension, areas in which the company had no experience. Furthermore, as a private manufacturing concern, Sabritas was prohibited by Mexican law from farming or importing seed. In order to find a vehicle for implementing the Potato Improvement Program, Sabritas management sought the advice of various organizations. The Rockefeller Foundation; Frito-Lay, the U.S. snack food subsidiary of PEPSICO; L.E. Tibert Co., an American seed company; and various ministries of the Mexican government.

(R) = Registered trademark.

Seeds for the Industry, S.C.

After receiving the support of the Sub-Ministry of Patrimony and Industrial Promotion, Sabritas founded Seeds for the Industry, S.C., a nonprofit organization. As a nonprofit organization, Seeds for the Industry, S.C. (SISC) would be allowed to import potato seed and rent farmland for agricultural research. SISC established its first potato research center in Tinguindin, Michoacan (Exhibit 1). Although Michoacan was not a traditional potato-growing area, potato adaptation tests conducted there by the Rockefeller Foundation in 1959 had proven that the cool high-altitude climate was ideal for potatoes. Indeed, researchers found wild species of potato growing in the area. The municipality of Tinguindin was chosen as the area was found to be free of the golden nematode. The Ministry of Agriculture sent seed to Tinguindin from its own potato research program, agreed to train SISC personnel, and prohibited commercial potato farming in the Tinguindin area in order to help prevent the spread of potato diseases onto the research center. SISC divided its work into four areas: seed research, seed production, development of new areas, and the partnership program (Exhibit 3).

Seed Research

The potato (Solanum tuberosum) is indigenous to the Americas. Wild species are found throughout the continent, some at altitudes as high as 4,800 meters. The potato is an annual plant that grows underground and reproduces vegetatively by means of tubers. The tuber (the potato itself), often called a seed, is actually the stem of the plant. The growing points for the new crop are the 'eyes' of the mature tuber which produce lateral buds (Exhibit 4). Tuber stems will sprout lateral buds if at least one 'eye' is planted. Research on tubers is commonly known as seed research.

There are three basic methodologies to conduct potato seed research: clonal selection, crossbreeding, and stem-cutting.

In clonal selection, as the plants grow, the above-ground components are examined and unsuitable plants are discarded. After harvest, the potato tubers are examined for form, size, and number of tubers per plant. Unsuitable tubers are discarded. This process is repeated as often as the scientists consider necessary.

In crossbreeding, the pollen of one plant is used to fertilize another. After cross-pollination, real seeds are extracted from the small tomato-like fruits the potato plant produces. To produce plant embryos, these fruit seeds are carefully nurtured, sometimes in test tubes. During 1978, at the International Potato Institute in Peru, only 352 embryos survived out of 2,557 attempted crosses. At times, the pollen from plant A is used to fertilize plant B, or the pollen from plant B is used to fertilize plant A, and the results can be very different. Successful embryos produce miniscule tubers the first year. After two or three years, crossbred tubers can achieve full size and can then be improved by clonal selection.

In stem-cutting, the health of the entire plant is laboratory tested by examining a leaf for harmful pathogens. The reproduction of a healthy plant can then be accelerated by cutting off the shoot apex, the tip of the plant where undifferentiated cells are formed. Cutting off the apex brings out the lateral shoots from the flowering stem of the plant. The lateral shoots are cut when they reach a length of 30 cm, and are then placed in a greenhouse where they develop roots and full-grown tubers.

SISC used the clonal-selection method. In the first year individual tubers were planted a meter apart. The wide distance between tubers helped assure that the scientists could move around the plants without accidentally brushing and potentially transmitting a disease from their clothes to the plant. Though many farmers often cut the tubers into 'seed pieces' to decrease the number of tubers required per hectare, the SISC scientists did not cut their tubers to avoid any possible damage to the tubers. Typically, out of 3,000 tubers planted during a first testing, only 900 would be accepted by SISC for further research. Though three potato crop cycles can be grown in a year, the Tinguindin Research Station was rain-fed and only one crop cycle was grown per year.

In the second year of testing, tubers were planted in 'families' of 20, a 'family' consisting of tubers of one variety. If five plants in a family proved unacceptable, the whole family was discarded. After the second year of harvest, the best families were selected with particular emphasis on average yield per family, and then from within the best families the best tubers were selected.

The selected tubers were planted in families of 40 the third year, during which the strictest standards were enforced. After the third year, the Seed Research Unit turned the highly selected tubers over to the Seed Production Unit as foundation seed.

SISC began its potato seed research in 1974, with the Mexican variety Alpha. In 1975, SISC first imported seed, but the imported varieties proved to be diseased and had to be destroyed under the direction of the Department of Plant Sanitation. In 1976, SISC imported several varieties from the USA and Holland. The varieties from Holland adapted better to Mexican growing conditions, and it was found that Mexican consumers preferred the yellow color of the potato chips derived from the Dutch varieties over the white color of the potato chips derived from the American varieties.

SISC agronomists were trained for four years at company expense, one year at the Potato Research Unit of the Ministry of Agriculture, two years of field training, and one year of specialization in Holland or the USA. In 1980, one SISC scientist was in the USA specializing in stem-cutting which SISC wanted to initiate at Tinguindin.

Seed Production

SISC produced certified seed for farmers at three different locations: Tinguindin, Michoacan (150 hectares), Tapalpa, Jalisco (250 hectares), and Huasca, Hidalgo (50 hectares) (Exhibit 1). The foundation seed provided by the Seed Research Unit was multiplied for three consecutive years under strict government guidelines to produce certified seed for commercial release. The National Service of Inspection of Certified Seed (NSICS) only certified seed that could be guaranteed for purity and quality.

Under NSICS guidelines, land for potato-seed multiplication could only be sown with potatoes every third year to ensure varietal purity and to help contain the transmission of disease. To minimize land costs, SISC rented a given land plot only every third year. Farmers renting land to SISC typically followed a pattern of renting the land one year, planting a maize crop the second year, and leaving the land for pasture the third year.

To ensure high yields, SISC used 1,200 kg of fertilizer per hectare. High nitrogen applications have also been found to reduce the sugar content of potatoes. Low sugar content was a desirable characteristic of commercial frying potatoes.

Between crop cycles, SISC tubers were stored in refrigerated warehouses at four degrees centigrade. A month before planting, warehouse temperatures were allowed to rise slowly and lights were turned on to induce the tubers to germinate before planting. Planting was in May, harvest was in October-November. After harvest, the seed that was certified was shipped directly to farmers participating in the Potato Partnership Program.

Potato Partnership Program

The Potato Partnership Program (PPP) was responsible for contracting farmers to produce quality frying potatoes for Sabritas. The PPP offered seed, financing, technical assistance, and a guaranteed market to farmers. Farmers who joined the PPP received potato seed from SISC 'in partnership', free of charge. SISC personnel estimated that seed accounted for 40% of the costs of potato production. Furthermore, SISC agronomists would visit the farmer's potato fields once a week, and would be present at harvest time. Additionally, Sabritas agreed to purchase all of the farmer's crop that met Sabritas quality-control specifications, and agreed to help find a purchaser for the produce Sabritas rejected. In exchange, the farmer agreed to follow the recommendations of SISC agronomists, give 40% of his crop to Sabritas 'in partnership', and to sell the other 60% to Sabritas at a prearranged price.

Farmers participating in the program had average yields of 20 tons per hectare, while average potato yields in Mexico were 11.3 tons per hectare (Exhibit 4). As an incentive to increase yields further, the PPP stipulated that 70% of the production above 20 tons per hectare belonged to the farmer and 30% belonged to Sabritas in partnership. SISC had a long list of farmers wanting to join the PPP. In 1979, Sabritas had received 35% of its potato requirements through the PPP, and expected the percentage to increase to 70% in 1980.

The requirements to join the PPP were that a farmer have sufficient land, be mechanized, be familiar with potato cultivation, and have irrigation if possible.

SISC had attempted to include small-scale farmers and ejidatarios[2] in the PPP. In 1970, ejidatarios had accounted for 44.4% of the area sown

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(2) Ejidatarios received 'use-rights' on Agrarian Reform lands but did not have the rights to sell, rent, or bequeath the property.

with potatoes (Exhibit 4). Nevertheless, SISC found that the lack of sufficient water and adequate machinery, and the dispersed plots of these farmers made their participation in the PPP unprofitable.

Potato farming was capital intensive. A 1976 study by the Ministry of Agriculture estimated that the costs of production of efficient large-scale potato farmers were 47,483.90 pesos per hectare, excluding the cost of land (Exhibit 5). The study indicated that the average agricultural bank loan extended in 1976 had been 992 pesos per hectare, and the average bank loan to potato farmers had been 12,416 pesos per hectare, second only in annual crops to tomato farmers (Exhibit 6). Jaime Alvamez, President of SISC, and the person who had created the Potato Partnership Program, stated, "We are really financiers, not farmers."

Development of New Areas

The development of new potato-growing areas was considered an important program in cost reduction. The PPP was attempting to match potato production with potato chip demand by contracting farmers in different climatic regions. A year-round supply of freshly harvested potatoes for Sabritas would decrease storage costs and potato spoilage. In 1979, Sabritas received freshly harvested potatoes from January to May and from September to November. Finding areas that could harvest potatoes in July and August had proven difficult due to heavy rains during those months that made harvesting difficult and induced potatoes to rot. Finding a December source of fresh potatoes was also considered critical as potato chip comsumption increased in December. Furthermore, SISC was attempting to develop new potato areas close to Sabritas processing plants in order to decrease transportation costs.

Production of Potato Chips

Sabritas quality standards demanded that 75% of all potatoes delivered to their processing plants be greater than 45 millimeters. All potatoes had to appear healthy and without cuts. Potatoes were sampled for color, sugar content, and potato solid content.

Potatoes were washed and peeled by strong hot water jets. As potatoes with deep 'eyes' did not peel well, these potatoes were also rejected. Washed potatoes were automatically placed on a conveyor belt where they were inspected once again. Unhealthy-looking potatoes were discarded, and overly large potatoes were chopped. Large potatoes made large potato chips which filled the cellophane bags with too few potato chips, and furthermore, large potato chips tended to break in handling, leaving a bag full of broken potato chips which consumers did not like. Special machines cut the potatoes into flat or 'ruffled' patterns, and the potatoes were fried in oil and salt at 160 degrees centigrade.

Potatoes that had a sugar content of over 1% were rejected because the sugar burned in the frying process, leaving a brown-shaded potato chip that consumers disliked. After frying, the potatoes were cooled, bagged, inspected, and placed in cartons ready for distribution. The entire process from washing to bagging took less than five minutes. In 1979, Sabritas processed 50,000 tons of potatoes, used 12,000 tons of cooking oil, 4,000 tons of cellophane, 1,000 tons of flavors including salt, and employed 4,500 people.

Distribution and Marketing of Sabritas Potato Chips and the Mexican Snack-Food Market

Cellophane-bagged potato chips have a maximum shelf-life of six weeks. In order to reach as many consumers as possible with a fresh product, Sabritas had built a fleet of 2,000 sales vehicles that serviced 240,000 retail outlets throughout the country. A distinctively painted Sabritas vehicle visited each retail outlet two to three times a week. At each retail outlet the Sabritas sales-driver would take inventory of the Sabritas rack that Sabritas provided. Outlets that had a large volume, or were increasing their volume, were automatically provided with larger racks. After taking inventory, the sales-driver restocked the rack, and collected for the product sold since the previous call. The product mix on each rack was tailored to each outlet to maximize sales per rack and prevent spoilage. Slow-moving brands were rotated to outlets where they did well, and spoiled product was immediately withdrawn from the rack. Sabritas warehouses contained a maximum of three days' inventory.

In 1966, the Mexican snack-food industry amounted to 37.5 million pesos in sales, and by 1979, industry sales had increased to 5,625 million pesos. Sabritas projected snack-food volume to increase 38% in 1980. They held an estimated 65% share of the snack-food market and competed against two other national brands, and a host of regional and no-name brands. Though the two other national brands had increased their combined share of the market from 15% in 1976 to 25% in 1979, their growth had come at the expense of the regional brands. One national brand had initiated direct distribution to retailers in large cities, and all other competitors distributed through wholesalers.

A major study of the snack-food industry conducted by the National Institute for the Protection of the Consumer indicated that Sabritas brands were the only ones that could be guaranteed safe for humans to eat. Regional brands were found to be particularly susceptible to contamination. Though there was no legislation in Mexico regulating snack-food standards, Sabritas applied the standards of the Federal Food and Drug Administration of the USA in its plants.

Sabritas advertises principally on television, and the Sabritas slogan ("Bet you can't eat just one") and Sabritas' logo had become synonymous with snack food in Mexico.

Snack Foods as Nutrition

The nutritional value of snack foods was being questioned in Mexico. A spokesman for the National Institute of Nutrition stated, "The intention of snack foods is not nutrition, but pleasure. From that point of view they serve their purpose very well since they have an agreeable flavor, and it is indeed difficult to 'eat just one'. But definitely they are very far from being nourishing food." Furthermore, the Mexican Government's Food Self-Sufficiency Plan for 1980-82 stated that one of its goals was "eliminating widespread patterns of valueless, transnationally marketed food consumption."

Mr. Warner considered 'snack foods' a nutritional food. "Snack foods satisfy a food need, they are not purely a recreational satisfaction," he stated. "The 'siesta' has disappeared in Mexico. Mexicans are on the move, and they grab a snack to satisfy hunger."

Data provided by the National Institute of Nutrition indicated that potato chips compared favorably with principal foodstuffs for nutritional value. A 100-gram serving of Sabritas potato chips contained more calories than a 100-gram serving of apples, oranges, tortillas, black beans, fresh milk, or eggs (Exhibit 7). The protein content of potato chips was higher than apples, oranges, and fresh milk, but lower than tortillas, black beans, and eggs. Potato chips did contain a much higher level of fat, 33.9 grams, than the next highest foodstuff, 9.8 grams for eggs (see Exhibit 7). The fat content of potato chips was derived principally from the 30% oil content of potato chips. Mr. Warner explained that Sabritas only used vegetable oils. "Currently we use only pure refined sesame oil," he stated. "It is polyunsaturated. Its frying benefits are well known; it is the ideal oil, the best to be found anywhere." A spokesman for the snack-food industry stated, "The fats of potato chips, being from vegetable sources, are free of cholesterol. Because potato-chip making is quick and simple, most of the potato nutrients are conserved. Fresh potatoes are 80% water. In the quick frying of chips, 97% or more of the water is boiled off. The finished chip is a dehydrated potato. A typical serving of 100 grams of potato chips has the nutritive value of 350 grams of fresh potatoes." On an area basis, potatoes were considered to yield the highest level of nutrition among major world crops (Exhibit 8).

Sabritas had an ongoing program to enhance the nutritional content of snack foods. The program included sending young Mexican food engineers for specialized training in the United States. "It would be easy to spray vitamins on the snacks," explained a Sabritas food engineer, "but many people cannot digest the chemical additives. We use only natural ingredients, basically potatoes and cereals. We are closely monitoring the development of high-protein potatoes at American universities."

The Future of Sabritas

The Potato Improvement Program had permitted Sabritas to become one of the fastest-growing companies in Mexico. Sabritas was considering extending its agricultural research to other crops. "We want to stay in Mexico," stated John Warner, "We have the infrastructure in agriculture and the people." Besides potatoes, Sabritas also processed wheats and corns. "We have an opportunity in corn," stated John Warner. "Mexico used to import all the corn used in popcorn. We have currently been testing one variety for adoption in Northern Mexico." It was important that the critical success factors of the Potato Improvement Program be identified before launching the popcorn program.

Exhibit 1

SABRITAS, S.A.

Map of Mexico

★ Sabritas processing plant

■ Seed for the Industry, S.C. (SISC) potato center

Exhibit 2

SABRITAS, S.A.

Per Capita Consumption in Kilograms
of Selected Crops in Mexico

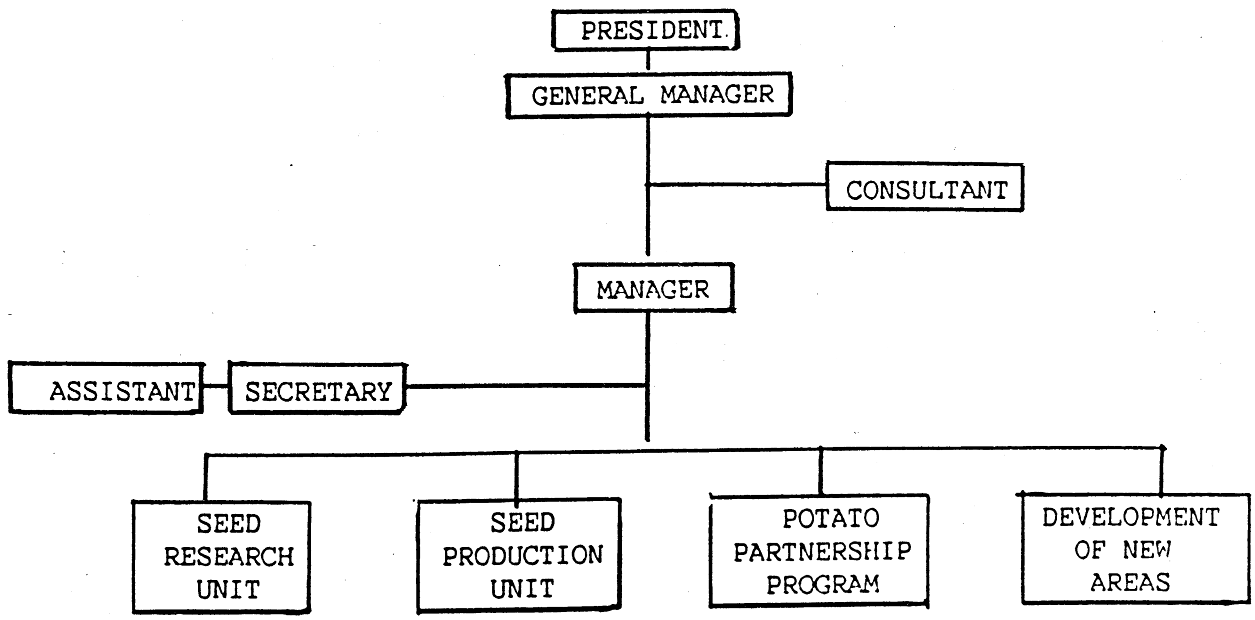
Year	Maize	Wheat	Black Beans	Oranges	Apples	Potatoes
1944	153.8	29.9	9.7	11.8	2.0	5.2
1954	181.2	34.8	12.4	19.6	2.0	5.7
1964	178.0	39.8	18.6	21.0	2.6	9.7
1974	181.3	48.8	17.8	30.1	4.0	11.2

Source: Ministry of Agriculture.

Exhibit 3

SABRITAS, S.A.

Organizational Structure of Seeds for the Industry



Source: SISC.

Exhibit 4

SABRITAS, S.A.

Average Yields for Selected Crops and
Percentage of Area Planted by Type of Land Tenure

CROP	YIELD* (kg/ha)	PRIVATE FARMERS** Percent of Total Area	EJIDATARIOS** Percent of Total Area
Potato	11,282	55.6	44.4
Tomato	15,998	57.9	42.1
Orange	10,359	59.6	40.4
Apple	7,594	71.6	28.4
Wheat	3,078	63.4	36.6
Maize	1,224	35.4	64.6
Black Beans	539	42.3	57.7
National Average		41.2	58.8

* 1976
** 1970

Source: Ministry of Agriculture.

Exhibit 5

SABRITAS, S.A.

Costs of Potato Production for Large-Scale
Mechanized Farmers with Irrigation*
1976-1977 -- In Pesos

Yield: 20,000 tons
Price: 4,000 pesos per ton

ITEM	COST PER HECTARE	DAYS OF LABOR
Total	47,483,90	
Land Preparation	1,618,20	
Furrowing	350,00	0.20
Harrowing	350,00	0.12
Levelling	400,00	0.20
Fertilization	293,20	0.40
Plowing	100,00	0.10
Irrigation	125,00	1.50
Planting	1,000,00	
Planting	900,00	8.65
Cover	100,00	1.00
Labor	1,900,00	
Irrigation	400,00	5.00
Land Preparation	100,00	0.12
Weeding	1,080,00	10.80
Application of Fungicide	195,00	
Application of Insecticide	125,00	
Inputs	34,417,70	
Seed (3.166 tons)	29,193,70	
Fertilizer		
(500 kg Urea)	1,330,00	
(250 kg Phosphorous)	650,00	
(500 kg Triple 17)	975,00	
Fungicide (2 kg)	120,00	
Insecticide (1 liter)	331,00	
Water Quota	568,00	
Wood Racks (500)	1,250,00	
Harvest	5,900,00	
Cutting	200,00	0.12
Uncovering	500,00	0.40
Picking and Racking	5,200,00	50.00
Other	2,648,00	
Road Quota	20,00	
Rehabilitation	100,00	
Production Tax	960,00	
Land Tax	25,00	
Interest	447,00	
Planting Permit	10,00	
Insurance	1,000,00	
Social Security	86,00	

* Excludes cost of land.

Source: Ministry of Agriculture.

Exhibit 6

SABRITAS, S.A.

Agricultural Bank Credit by Crop
Mexico 1976

ANNUAL CROP	PESOS PER HECTARE
Tomato	14,817
Potato	12,416
Cotton	9,976
Chili	7,318
Rice	5,366
Wheat	3,994
Maize	2,147
Pasture (perennial)	480
National Average	992

Source: Rural Bank of Mexico (Banrural).

Exhibit 7

SABRITAS, S.A.

Nutritional Value of Various Foodstuffs
per 100 grams

ITEM	SABRITAS POTATO CHIPS	APPLE	ORANGE	TORTILLA	BLACK BEANS	FRESH MILK	EGGS
Calories	557	53.5	33.5	394	322	58	140
Protein (grams)	5.8	0	0.6	10.7	17.5	3.4	11.3
Carbohydrates (grams)	52.3	13.3	8.9	47.8	55.4	3.5	2.7
Fat (grams)	33.9	0.7	0	1.5	1.5	3.4	9.8

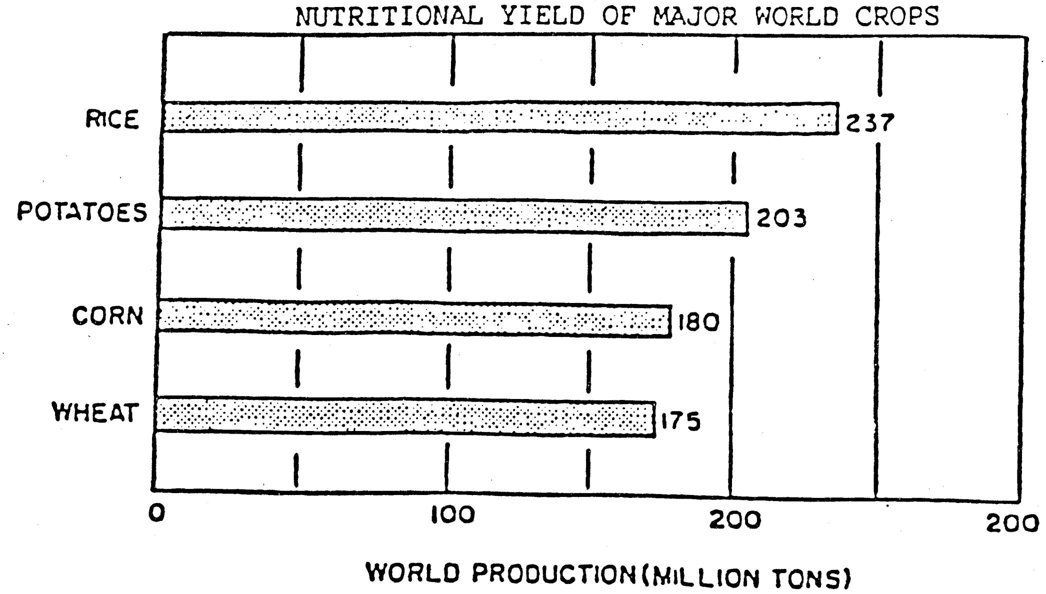
Source: National Institute of Nutrition.

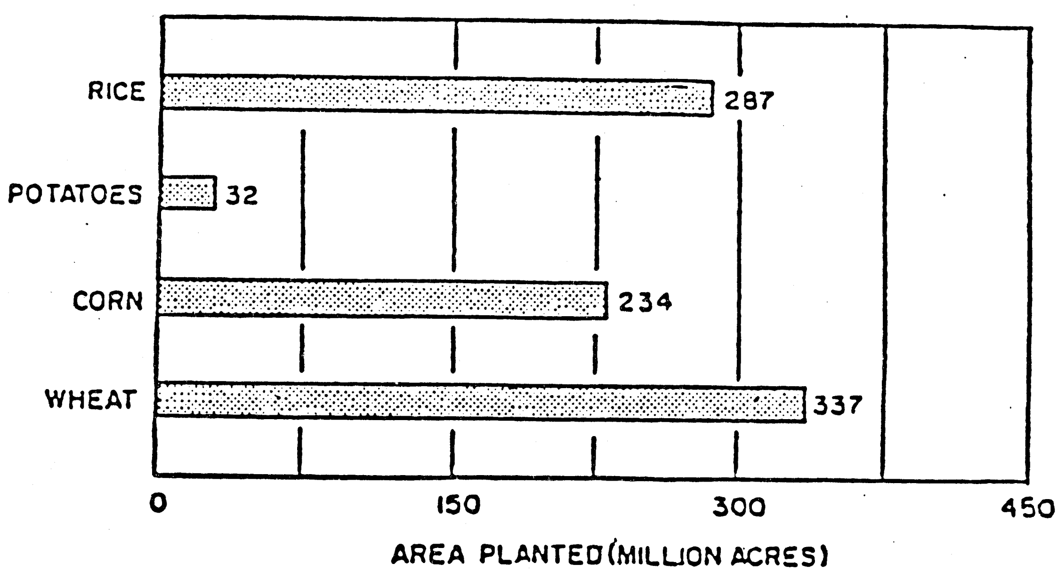
Exhibit 8

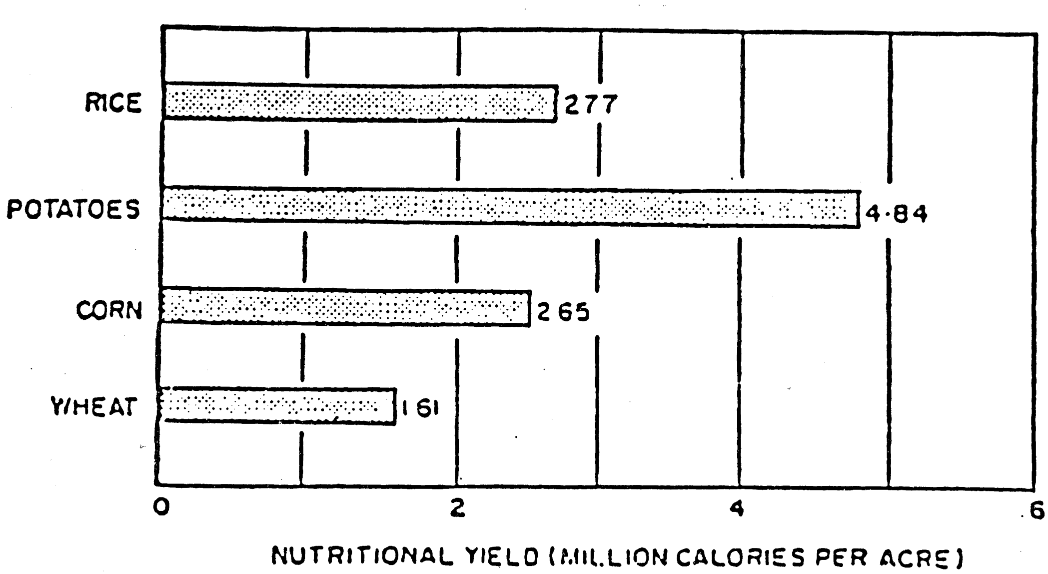
SABRITAS, S.A.

National Yield, World Production and Area
Planted of Major World Crops

NUTRITIONAL YIELD OF MAJOR WORLD CROPS







Chapter 8

BIOTECHNOLOGY - THE CHALLENGE TO BOMBALAYA

BIOTECHNOLOGY - THE CHALLENGE TO BOMBALAYA:

A Management Commentary

The case "Biotechnology: The Challenge to Bombalaya" encourages today's agricultural research manager to consider the challenges of tomorrow. The agricultural research managers of today will have to begin to provide the answers in the context of the circumstances of their countries and their personal professional aspirations. A partnership perspective can help them prepare for this future.

The agricultural research manager in developing countries likely has been awarded his position of leadership in large measure because of the excellence of his scientific work. The agricultural research manager probably has had little or no formal training in management; his training and experience have been in science. This background has served him well in the past. It may, however, be inadequate for the future.

Future agricultural research managers may need stronger backgrounds in biology than do today's research managers, who generally are trained in botany. Researchers with livestock backgrounds and, thus, greater preparation in biology, may be better prepared to respond to the research management challenges that will be offered in the future by biotechnology and the predicted "bio-revolution."

It appears that the private sector will play a much larger role in the generation and transfer of technology, because of the greater control that biotechnology offers the private sector. The exercise of this control will require management capabilities. It is possible the agricultural research manager of tomorrow will be chosen for his managerial skills, rather than for his understanding of an agricultural science.

Contemporary developments in biotechnology raise many unanswered questions. The most important questions include: What will be the role of biotechnology in national agricultural research systems in developing countries? What export commodities are threatened by this technology? What new opportunities will biotechnology open? What kinds of agricultural research systems will developing countries need in the year 2000? What kinds of skills will be required by the national agricultural research systems? What will be the roles of the national and the international private sectors in agricultural research? How will national research systems acquire access to the products of biotechnology?

The agricultural research manager in this case is facing the challenge of establishing three different kinds of linkages. The first is to establish the linkages that will facilitate an effective national debate as to what the country should do to prepare for the changes that biotechnology may bring. The second is to the linkages that will enable the national agricultural research system to stay informed and up to date on developments in biotechnology. The third is to begin to build the appropriate linkages to the sources of biotechnology. A partnership perspective is a prerequisite for establishing these linkages.

BIOTECHNOLOGY - THE CHALLENGE TO BOMBALAYA:

A Case Study

by S. Huntington Hobbs IV

On May 15, 1984, an airplane was approaching Lahamurti, capital of Bombalaya. The emerald isle could be seen through the windows on one side of the airplane, and through the other side the undulating ocean became evermore closer. "A tiny country with great problems," said one passenger. "A country with hundreds of problems and only dozens of answers," stated another passenger. "Development on this island is one big festival," asserted a third passenger, "a lot of loud music, a lot of movement, and at the end everyone is in the same place where they started, but exhausted and with a headache not even the International Monetary Fund can make go away."

It bothered Ramesh Dixit, who was listening, that they should speak like this about his country. So much had been achieved since Independence in 1952, and there was so much hope. Through the window he could now see the dry and unproductive vegetation that surrounded Patan Airport. "Someday we will have the technology to replace that brush and to harvest protein from these lands," thought Ramesh Dixit. Science and technology, diffusion of innovation, adapting, adopting, and transferring technology were themes that worried Ramesh Dixit as Director of Research of the Ministry of Agriculture.

The airplane landed, decelerated on the runway, and finally arrived at its destination in front of the terminal building. The passengers became impatient to exit through the hatch that was being opened, letting in the heat of the East Indian Sea.

Ramesh Dixit felt that his head was on fire, but not from the heat he had begun to feel. Two hours before, at thirty-three thousand feet over sea level, Ramesh Dixit had seen the future.

Ramesh Dixit had pulled from his briefcase an article that had been given to him at a chance encounter in the Calcutta airport with a former professor. The professor had supervised Ramesh Dixit's PhD thesis at Reading University in the United Kingdom, and thought the article would be of great interest to Dixit. The article was entitled "From Green Revolution to the Biorevolution in the Third World."[1] Ramesh Dixit had read the article with ever-increasing interest and alarm. The article described some of the promises and pitfalls of agricultural research in the next decades, and it left Dixit trembling with apprehension.

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(1) This case includes as an annex the article "From Green Revolution to Biorevolution in the Third World," which is a version edited by ISNAR of the study entitled "From Green Revolution to Biorevolution: Some Observations on the Changing Technological Bases of Economic Transformation in the Third World," by Frederick H. Buttel, Martin Kennedy, and Jack Kloppenburg, Jr. The article appeared in the Cornell Rural Sociology Bulletin of July 1983, and is used with permission.

"Bombalaya is doomed," he thought. "Sugar, our key export product, is becoming obsolete. The international agricultural research centers, on whom we have depended so much for breeding materials, also may become obsolete. The multinationals are going to become even more powerful."

Dixit moved down the aisle toward the sun that blinded him. "I've got to distribute this article," he thought. "I am going to disseminate this information through my entire staff because it has enormous implications for a developing country like Bombalaya. What should we do to prepare ourselves for the changes that are on the horizon?" Ramesh Dixit climbed down the aircraft stairs and touched ground. "I must discuss this article with my researchers, with the university people, with the Minister. We must issue some specific recommendations to the Technical Secretariat of the President. If our sugarcane industry is being threatened, the President himself must be informed as soon as possible. If the multinationals are going to control the agricultural technology that reaches Bombalaya, we must prepare some legislation to protect ourselves. We may need some kind of policy on science and technology. We may have to expand our scientific capabilities. We must be ready to affect change before change affects us."

In the office of Ramesh Dixit, Director of Research

"Agricultural research cannot be limited to biology because behind each plant is a farmer." Ramesh Dixit was dictating to his secretary in his office in the Ministry of Agriculture. He was preparing a speech to deliver to the graduating class of Bombalaya Agricultural University.

"In this country technology must benefit the small-scale farmers," he continued. "The small farmers are the soul and stomach of Bombalaya. We cannot impose technology on the small-scale farmers; that has become very clear. What is not at all clear is how we are going to impose the needs of the small farmer on the agricultural technology that looms on the horizon. We must keep our efforts focused on the needs of the small-scale farmers, or we are working in the clouds." Research directed towards the small-scale farmer had enjoyed high priority in the Department of Agricultural Research during the two years that Ramesh Dixit had been its director.

"But we may be losing our independence for scientific pursuit," continued Ramesh Dixit. "In the past we have been able to pursue some lines of independent inquiry. We have had some problems in rice, cassava, coconut, and jute, to which no one else was paying much attention, so we have done a bit of basic research. But the days are rapidly going when thousands of dollars was enough. The equipment and procedures are becoming much more complex and expensive. The minimum critical mass necessary to do research is rapidly growing way beyond our means. We will not even be able to do adaptive research."

"The technology of the near future will be proprietary, owned by the multinationals. Those companies and several countries already are demanding patent protection for seeds. We will be relegated to testing their materials. If they suit our agronomic requirements and can be sold at a profit, we will receive the use of the technology. If the technology is inappropriate for our needs, we will have to do without, because Bombalaya will be seen as too small a market to warrant multi-million dollar research."

"We are still trying to cope with the Green Revolution. Yields on small farms are still far lower than the yields we get on the research stations. We live in an era where science advances more and more rapidly, and the small-scale farmer is left further and further behind. The sophisticated science of the developed countries, so sophisticated and so expensive that it is out of our reach, is opening the way to new agricultural technologies, so sophisticated and so expensive that only the most knowledgeable and wealthy farmers will be able to use them. There are very, very few Bombalaya farmers who will be able to buy and use these new technologies, but these few farmers will reap great benefits, widening even more the gap between large and small scale farmers. Let us not forget that in our country, the typical farmer, by an overwhelming number, is one who farms on a medium or small scale. Who is going to design a technology that these farmers can use? How are the great advances of modern science to reach the small, poor fields of the Bombalaya farmers? We do not have large expanses of land, we do not have oil, we do not have great research laboratories, we do not have Nobel scientists, but does that mean we must be forever dependent? I would like to guarantee that in 10 years we will be less dependent. We must get ready. But how?" Dixit stopped, at a loss how to finish his speech.

The Department of Agricultural Research

The Bombalaya Department of Agricultural Research (DAR) had been created in 1958. By 1986, the DAR had one national research center, two regional centers -- one for the northern part of the country and another for the southern part -- and 13 experiment stations for commodities, such as rice, tea, and jute. The research stations were also used as yield nurseries of genetic material released by international agricultural research centers, such as the International Rice Research Institute (IRRI) based in the Philippines. "For now, our principal sources of genetic material are the international centers," said Ramesh Dixit. "We are participating in the international programs, and with the nurseries we can evaluate yields under the conditions we consider most critical. The international centers do the crosses and we test the F-3 materials, that is, third-generation materials, to evaluate their potential. We are obtaining magnificent results. We receive the material, free of any charge whatsoever, and we adjust the technology. Our only limitations are budget and personnel."

The DAR received approximately 0.3% of the national budget, and had been able to increase its budget by preparing projects with the Asian Development Bank, and the governments of the USA, the United Kingdom, and the Federal Republic of Germany. Additionally, the DAR was seeking to increase the availability of human resources by decentralizing agricultural research and inviting the participation of universities and the private sector. "For example," said Ramesh Dixit, "we must take maximum advantage of the personnel of the Bombalaya Agricultural University and of the resources of the private sector."

Sugar Production in Bombalaya

Sugarcane was the principal crop in Bombalaya. In 1983, sugarcane covered nearly 35% of the land in agricultural production in the country, representing more than three times the land area of the next most important crop, rice. Though the international price of sugar had varied sharply in recent years, sugar exports during the past five years had represented roughly 60% of the country's total export earnings. Total exports from Bombalaya in recent years had been nearly one billion United States dollars per year. Bombalaya faced an increasingly competitive international sugar market. Other developing countries had continued to increase their production, but consumption in developed countries had declined due to changing consumer preferences and the increasing use of alternative sweeteners, such as fructose and noncaloric additives.

Some Alternatives for Ramesh Dixit, Director of Research

Ramesh Dixit felt in a quandary as to how to alleviate his growing apprehension about the future impact of biotechnology in Bombalaya. After all, as the Director of Agricultural Research, he felt responsible for the present and future state of agricultural research in the country. Ramesh Dixit realized that his new-found concern about biotechnology would find strong and immediate support in the newly formed Ministry of Science and Technology. Everyone in the Ministry of Science and Technology seemed to talk about biotechnology.

However, people in the Ministry of Agriculture seemed to consider the creation of the Ministry of Science and Technology a most unwelcome development, particularly since the new ministry appeared to be trying to take over research on sugarcane, the principal export of Bombalaya. Ramesh Dixit certainly did not want to be seen as a traitor in the Ministry of Agriculture.

Ramesh Dixit had found out that the Minister of Agriculture himself had recently prohibited the importation of frozen livestock embryos by a private company. The threat of unknown and unverifiable diseases entering the country had been cited in the rejection, though some did say it was done to protect the leadership of the Minister's breeding herd. Ramesh Dixit feared that his mounting anxiety about biotechnology would not be shared by the Minister of Agriculture. On the other hand, Ramesh Dixit could go with his concern directly to the Technical Adviser to the President, who was his cousin.

Ramesh Dixit could not shake the issue from his mind. He had considered anonymously circulating the paper he had read, or circulating it only within the Ministry of Agriculture over his signature. He also had thought of rewriting the paper as a newspaper article. His wife's brother would publish it at once in the Bombalaya Times. He had tried to think whether there was some way he could try to bridge the gulf between the Ministries of Agriculture and Science and Technology. Perhaps a joint seminar on biotechnology could start things going in the right direction. They could invite one of the authors of the paper to speak.

The issue became further complicated by three visitors to Ramash Dixit's office. The first was the general manager of the company that had been refused permission to import frozen embryos. His purpose was to see whether there was anything Dixit could do to help. The man, who stated that several private-sector companies, including his own, were attempting to import the latest technologies to Bombalaya, criticized the government for impeding progress. Then the Dean of Horticulture of Bombalaya Agricultural University came to request Ramesh Dixit's support for establishing a tissue-culture laboratory. Finally, the Director of Sugarcane Research also dropped by to voice his concern about falling sugar exports to the United States. He had heard upsetting rumors that the Bombalaya sugar quota to Europe was to be cut. He was uneasy as well about a proposal of the Ministry of Science and Technology to restructure the country's export industries.

Ramesh Dixit sat in his office wondering what he should do. He felt like flying away to another seminar in Singapore, or Delhi, or anywhere. The sun started to set over the East Indian Sea. He thought of visiting the family farm. He wondered what the effect of biotechnology would be on his family's agricultural operation. The telephone rang, disturbing his thoughts. The Minister wanted to see him.

BIOTECHNOLOGY - THE CHALLENGE TO BOMBALAYA

Annex

FROM GREEN REVOLUTION TO BIOREVOLUTION[2]

Some Observations on the Changing Technological Bases
of Economic Transformation in the Third World

by Frederick H. Buttel
Martin Kennedy
Jack Kloppenburg, Jr.

Introduction

The theory and practice of rural and agricultural development in the Third World for over a decade have revolved largely around alternative postures regarding the so-called Green Revolution. Proponents of the Green Revolution have argued that productivity improvements from the transfer of Green Revolution practices have far outweighed socioeconomic dislocations (Hayami and Ruttan, 1971; Meier, 1976:561-562).[3]

Green Revolution detractors, on the other hand, have placed major emphasis on these dislocations. These critics have rejected the assumption that underdeveloped nations can or should develop along the same path as the present industrial/high-income countries (Lipon, 1977; de Janvry, 1981; Galli, 1981). They have argued that the Green Revolution strategy has exacerbated class inequality or differentiation and led to "premature" rural emigration and urbanization (Cleaver, 1972; Griffin, 1974; Pearse, 1980).

Positions taken by Green Revolution advocates and critics have become somewhat less polarized in recent years. There has been increased targeting of the smallholder sector for special research and extension attention (through, for example, farming systems research) by USAID, the World Bank, the international agricultural research centers (IARCs), and comparable agencies (World Bank, 1982:81-83; McDowell and Hildebrand, 1980; Harwood, 1979). Likewise, critics of the transfer of high-yield varieties (HYVs) and petrochemically based technolgies to the Third World have come to recognize the importance of stimulating productivity improvements in underdeveloped regions of the globe (de Janvry, 1981; Ghai et al., 1979).

Disillusioned by the failures of "appropriate technologies" to provide productivity improvements -- and by the increasingly remote prospects for meaningful land reform -- many critics of the Green Revolution have accepted the need for increased energy and capital intensity in Third World agriculture as a means to increase production and provide for basic

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(2) Cornell Rural Society Bulletin, July 1983. Reproduced with permission.

(3) See end of case for reference notes.

needs. But there is growing evidence that the massive increases in agricultural productivity enjoyed by the advanced industrial nations since 1935 have slowed or even leveled (Cochrane, 1979), that the Green Revolution has been stalled, far short of its productivity potentials, in the developing world (de Janvry, 1981). Many analysts speculate that the yield-enhancing potentials of mechanical and petrochemical inputs may be largely exhausted. There is concern that past levels of agricultural performance may be increasingly difficult to sustain (The Rockefeller Foundation, 1982; Ruttan and Sundquist, 1982; Lewis, 1982). Coupled with fears of continued population growth, the evidence of lagging productivity has focused attention on support for agricultural reseach and on recent advances in applied genetics and molecular biology, which appear to contain the potential to support a new era of productivity gains in both developed- and developing-nation agricultures.

The principal argument of this paper is that the technological pivot of international agricultural and rural developement is being superseded by new technical forms that will alter the context within which technological change in the Third World is conceptualized and planned. We suggest that the cluster of emergent techniques known as "biotechnology" will be to the Green Revolution what the Green Revolution was to traditional plant varieties and practices.

Biotechnology and the coming "Biorevolution" will intensify differences in theoretical viewpoints regarding the Green Revolution, since -- as we shall argue -- the ramifications of biotechnology for Third World agriculture will reinforce trends associated with the Green Revolution.

On the other hand, the Biorevolution will exhibit some significant differences, most notably in the geographic and sectoral breadth of its impact, in the respective roles of private-capital and public agencies in its guidance, and in the creation of entirely new production processes for many agricultural commodities produced for export.

Biorevolution Technology and Its Development

Biotechnology is defined as the manipulation of living organisms in order to alter their characteristics, either to encourage them to produce some desired product, or to use them as a component of a broader production process. Such a definition can apply to traditional plant and animal breeding and to the fermentation of such products as beer, cheese, and yogurt. This "old" biotechnology depended largely on selection to obtain desired traits; the "new" biotechnology uses an understanding of the molecular constitution of organisms to achieve alteration at the cellular and molecular levels (Baltimore, 1982). Biotechnologists now have access to the building blocks of life itself; the "new" biotechnology is a qualitative advance over the old.

In its present usage, the term biotechnology refers to a cluster of techniques of current vintage.

Recombinant DNA Transfer

The most prominent and potentially the most powerful of these is recombinant DNA transfer. This involves the insertion of genetic material from one organism into the genetic code of another, thereby causing the "genetically engineered" organism to exhibit a trait that is not characteristic of members of the species that occur naturally. This opens remarkable possibilities in both agricultural and industrial production. Plant and animal varieties can incorporate useful characteristics of other varieties or species; microorganisms can be programmed to manufacture large quantities of substances not easily or economically extractable from their natural sources; "bioengineered" bacteria can convert one organic chemical to a more valuable one -- such as conversion of methanol to single-cell proteins.

Plant Cell and Tissue Culture

Along with the breakthroughs in molecular biology that led to the development of DNA techniques came important advances in plant cell and tissue culture. Plant cell fusion is another method to get around the rigid parameters of speciation and sexual compatibility. In this process, cells from different organisms are stripped of their walls and fused one to another. The resulting hybrid contains genetic material from both entities; such a combination would not be possible in traditional sexual interchanges of genetic material. Tissue culture may permit regeneration of a complete plant from such an operation, and this process can also provide new genetic variation. Breeders can perform mutagenesis and screening procedures on a growing mass of cells in a Petri dish rather than on whole organisms, with enormous savings in time and space. Tissue culture may also be used to produce large quantities of undifferentiated cells of slow-growing plants and animals from which useful chemicals can be extracted (Graff, 1982). This provides an opportunity to produce the desired cells within a factory located anywhere in the world.

The Major Vectors of Change

These advances in the life sciences are now on the verge of being commercialized. We feel that there are four major vectors of technological change that will affect global agriculture:

(1) plant genetic manipulation and breeding;
(2) industrial tissue culture;
(3) animal applications of embryology and genetically engineered products;
(4) the use of genetically manipulated microorganisms to produce or displace agricultural products.

Each of these broadly defined areas subsumes numerous products and processes. In many cases, the areas of innovation are mutually reinforcing. These means of producing novel life forms promise to revolutionize chemical and pharmaceutical production, pollution and waste management, energy generation, food processing, and plant and animal breeding.

The complexity of plant and animal genetic engineering has led some to argue that the effects of biotechnology on agriculture are far in the future (Borlaug, 1983). A number of biotechnologies will affect Third World agriculturalists in both animal and plant husbandry within the next 10 years. Further, we will demonstrate that the Biorevolution will be expressed in a cumulative and growing wave of applications.

The Corporate Response

The ultimate impact and value of biotechnology is the response which it has engendered in the world corporate community. Biotechnology appears to be commercially exploitable over a broad range of areas, and businesses have invested heavily in the new technologies. Establishment of agricultural genetic engineering firms (Agrigenetics, Calgene, DNA Plant Technology, etc.) has been rapid in the last few years. Transnational corporations have also established a presence by purchasing equity interests in firms, by enhancing or establishing their own research capabilities (see Table 1), and by arranging research funding with universities engaged in biotechnology research (see Table 2).

Table 1.
In-House Corporate Life Science Research:
Description and Location

Corporation	Area of Interest	Description	Location
Monsanto	Agriculture	US$40 million invested in research	Missouri
Chevron	Agriculture	US$38 million facility	California
Pfizer	Agriculture	20 Ph.D. researchers	Missouri
ARCO	Agriculture	15 scientists, 57 employees	California
Du Pont	Life Sciences	US$85 million investment	Delaware

Note: These data are presented for illustrative purposes only. Other companies that have important in-house agricultural research activities include Eli Lilly, Sandoz, and Ciba-Geigy.

Table 2.
Industry-University Contracts:
Cost, Duration, and Areas of Research

Corporation	University	Cost (in US$ millions)	Duration (years)	Areas of Research
Monsanto	Harvard	23	10	Molecular Biology
Monsanto	Washington	23.5	5	Biomedical
Monsanto	Rockefeller	4		Plant cell biology
Corning Glass Union Carbide Kodak	Cornell	2.5 each; 7.5 total	6	All aspects of biotechnology
Hoechst	Mass. Gen. Hospital	70	10	Genetics
W.R. Grace	MIT	8.5	5	Biotechnology
Bendix General Foods Koppers Mead Noranda Mines Elf-Aquitaine	Univ. of California, Berkeley; Stanford	2.4	4	Biochemical engineering
Du Pont	Harvard Medical School	6	5	Genetics
Celanese	Yale	1.1	3	Enzyme research
Allied Chemical	Univ. of California, Davis	2.5		Nitrogen fixation

Note: These data are presented for illustrative purposes only.

Many of the corporations now investing in biotechnology have also attracted attention for their acquisitions involving American and European seed industries. These acquisitions were motivated initially by considerations relating to rising world food demand and the introduction in law of plant breeders' rights (which confer patent-like protection on new plant varieties). Synergies between biotechnology, seeds, and agrichemicals made this corporate strategy even more attractive in the late 1970s (Kloppenburg and Kenney, 1984).

Those corporations which appear to be best situated to dominate the new era of biologically based agricultural productivity growth are those which combine in-house research capabilities, interests in genetic engineering firms, seed company ownership, and access to university research via funding arrangements. For example, the Swiss pharmaceutical transnational, Sandoz, in addition to in-house research capabilities, owns the biotechnology firm, Zoecon, as well as more than half a dozen American and Europeen seed companies. Connections to Michigan State University researchers through Zoecon complete the pattern of integration.

Third World Applications of Agricultural Biotechnology

Biotechnology will have as profound effects on Third World agricultural production as on agriculture in industrialized societies. Transnational pharmaceutical and chemical companies, genetic research firms, and university laboratories are pursuing the development of bioengineered varieties across the spectrum of world crops. Principal areas of research include yield improvement, the achievement of nitrogen fixation in nonleguminous crops, the enhancement of photosynthetic activity, the manipulation of growth regulators, improved stress tolerance (to cold, moisture, drought, salinity, and other soil conditions), pest and pathogen resistance, and plant architecture.

Achievements in any of these areas will have profound impacts. For example, in Southeast Asia alone there are 86.5 million hectares of soils with conditions unsuitable for HYVs bred by traditional means (Swaminathan, 1982). Achievement of nitrogen fixation in such crops as rice or maize could greatly reduce capital expenditures for fertilizers, and pest-resistance characteristics could reduce need for other chemical inputs. Development of varieties that use water more efficiently would enable certain marginal bioclimatic and soil regimes to become productive agroecosystems without costly irrigation schemes. Forest species, genetically engineered for rapid growth or other quality characteristics -- such as soil stabilizing capacity -- and multiplied by clonal progagation could greatly alleviate fuelwood, deforestation, and erosion problems (Farnum et al., 1983).

In almost every aspect of economic cultivation, there are tantalizing prospects for biotechnology to enhance yields, renewable resource-based production, and human welfare. But the deployment of a new technology is rarely socially neutral, as became apparent during the Green Revolution.

* Have the lessons of the Green Revolution truly been learned?

* Will the coming Biorevolution have a more equitable impact than did its predecessor?

* Will the improved plant varieties emerging from the Biorevolution be designed with the peasant farmer in mind, or will they contain a bias towards the sophisticated and well-capitalized "progressive" farmer?

Initial answers to these types of questions are ominous. Unequal access to the new technologies is becoming apparent; in the absence of precautions, implementation could become a zero-sum game. For example, the first genetically modified field crop varieties to be commercialized are expected to be types resistant to various herbicides (Barton and Brill, 1983). The reasons for breeding herbicide resistance are linked to important economic interests chemical companies have in merchandising herbicides. This strategy, if successful, will lead to increased use of commercial herbicides and greater dependence upon the agrochemical suppliers.

The Structures of the Green Revolution and Biorevolution

The emergent Biorevolution differs in form from the Green Revolution in several important ways. First, Green Revolution strategy focused on the use of traditional plant breeding to improve yields by developing varieties on the best available land (Plucknett and Smith, 1982). Breeding goals often assumed the use of irrigation, and Green Revolution HYVs were generally limited in the geometeorological zones in which they could be grown. Vast areas of poorer land in the Third World have not been planted with the improved varieties (Brady, 1982). Biotechnology will certainly be used to improve cereal grain varieties in the zones now favorable to intensive cultivation. However, the Biorevolution also promises to expand the geographic sphere in which technological research and development can be applied to agricultural production.

Where the Green Revolution led to large gains in cirumscribed areas, the Biorevolution will permit the extension of commercial agriculture to all regions, including those chacterized by marginal soils where subsistence and petty commodity production have persisted unchallenged. The impacts of the Biorevolution have the potential to encompass the entire rural population of the less developed countries (LDCs).

The Green Revolution was limited in the number of commodities to which it was targeted; efforts were focused largely on the improvement of maize, wheat, and rice. The first International Agricultural Research Centers (CIMMYT and IRRI) have been joined by other research centers responsible for other crops (e.g., CIAT, IITA, CIP), but returns on their research have been less dramatic. A large number of minor and agro-export crops receive little or no research attention.

By contrast, one of the principal features of biotechnology is its generality, its possible applicability to any living organism. Researchers in corporate labs are working on the genetic improvement of the entire range of world crops, from redwoods to pyrethrum.

The defining feature of the Biorevolution, and that which differentiates it most sharply from the Green Revolution, is its predominantly private character. The Green Revolution was conceived and implemented within an institutional structure comprised mainly of public and quasi-public organizations. The international agricultural research centers (IARCs) have been funded by grants from developed-country governments, developing-country governments, private foundations (especially Rockefeller and Ford), and multilateral development banks. The technical expertise of the 13 IARCs remains closely tied to the public agricultural research institutions of the developed countries, especially those of the United States.

Private interests, particularly agrochemical transnationals, benefited from the spread of the Green Revolution. But they did not themselves spearhead the Green Revolution, take responsibility for technology transfer, or play a determining role in shaping research priorities. There were several reasons for this. First, the research base for the principal Green Revolution crops (maize, wheat, rice) was developed in public agricultural institutions of the advanced industrial nations. Private industry had no critical contributions to make to the research process (Ruttan, 1982). The agrochemical firms stood to benefit automatically from IARC varietal development, which incorporated developed-nation assumptions regarding the need for fertilizer, herbicides, and pesticides. Moreover, because wheat and rice could not be successfully hybridized, seed companies had little interest in Third World markets. Without breeders' rights legislation or the natural proprietary protection conferred by the inbred parents of a hybrid, seed prices could not diverge far from bulk grain prices, nor could farmers be brought into the seed market each year.

We do not wish to imply that the Green Revolution was initiated and implemented autonomously by the IARCs; that is clearly not the case. Nevertheless, the strong public-sector overlay of the Green Revolution at least theoretically assured public participation in the setting of research priorities. This was not sufficient to avoid serious problems (Jennings, 1974; Pearse, 1980), but the dislocations stimulated by the inequitable deployment of Green Revolution technologies could have been considerably worse had the IARCs not been committed to a mission-oriented ideology of "public interest."

The private and proprietary nature of agricultural biotechnology research in the developed countries has become especially marked. There are several reasons for this. First, the publicly funded land-grant universities' traditional dominance in agricultural research is being eroded. Corporate-sponsored research into agricultural biotechnology is now frequently being contracted outside the traditional agricultural research community to private universities, whose programs are superior in the parent disciplines of biotechnology, cellular and molecular biology. Second, fiscal austerity in national and state governments has limited the ability of the land-grant universities even to maintain conventional breeding programs, much less expand their biotechnology research effort (Pardee et al., 1981). Third, passage of the Plant Variety Protection Act (U. S. Congress, 1980) and the recent U. S. Supreme Court decision permitting the patenting of genetically modified life forms have increased the attractiveness to private industry of both conventional and biotechnological modes of plant breeding. The land-grant universities are under increasing pressure to withdraw from the release of finished plant varieties and to limit their efforts to the maintenance, evaluation, and improvement of germplasm.

The center of gravity of breeding activities in the United States is shifting away from public agencies and towards the private sector. This trend has important implications for the shape of the Biorevolution. The IARCs no longer have a strong, unrivaled public agricultural research sector in the United States to rely upon for crucial expertise in the new technology. The IARCs themselves are facing financial difficulties.

In contrast with the Green Revolution, it is clear that private capital is willing to act as the principal agent of technological transfer and development. In biotechnology, industry finds itself in a superior technological position vis-a-vis the IARCs and the national programs of the LDCs. Moreover, the plane of competition in the agro-inputs industries has become increasingly international. The Third World offers untapped sales potential, and many firms see their future in the LDCs (Farm Chemicals, 1982). Since the advent of the Green Revolution, seed companies and their transnational parents have established footholds in most LDCs. For example, Pioneer Hi-Bred now has sales outlets in over 90 countries and has breeding and research facilities in Brazil, Argentina, the Philippines, India, and Thailand (Gregg, 1981).

It is possible that the bulk of technology transfer in the Biorevolution will bypass the IARCs and national programs and occur in the context of competitive market consolidation under the aegis of private capital. A possible prototype for the private transfer of biotechnology to the LDCs may be that of a joint venture between an agricultural genetic engineering research firm (International Plant Research Institute U.S.A.) and one of the largest agricultural and industrial conglomerates in Southeast Asia (Sime Darby Berhad of Kuala Lumpur, Malaysia). They have announced the formation of the ASEAN Biotechnology Corporation and the ASEAN Agro-Industrial Corporation. The former will "apply genetic engineering and recombinant DNA technology to a broad range of tropical crops, and will allow for the introduction into Southeast Asia of technologies developed at the IPRI laboratories in California" (Genetic Engineering News, 1982). The latter will manage and market the products of this collaboration.

The Biorevolution mode of technology transfer will differ from Green Revolution practice in two other ways directly involving private interests. Instrumentation, facilities, and, above all, personnel required for biotechnology research, development, and production are extremely expensive by comparison with Green Revolution technology. Tissue-culture and monoclonal-antibody labs are relatively cheap, but scaling up to production is costly -- recombinant DNA facilities would entail a US$6 million investment (Kenney et al., 1982), and to create the infrastructure to produce for the market is at least one order of magnitude more expensive.

The International Center for Genetic Engineering and Bio-Technology, which has been proposed by the United Nations Industrial Development Organization, is projected to have a budget of $8.6 million a year and a staff of 168, including 50 PhDs (Zimmerman, 1983). The leading genetic engineering research firm, Genentech, alone accounts for a staff of 350, of whom 70 are PhDs; its annual research and development budget is US$21 million (Abelson, 1983). The leading 50 genetic engineering firms have attracted a total capital investment of over $1 billion. There can be little doubt that the vast proportion of products emerging from biotechnology labs will be privately developed. Biotechnology, it would appear, is likely to broaden still further the scientific and technological gap between LDCs and advanced industrial nations.

The Biorevolution also brings the problem of patents and proprietary information into the process of technology transfer. With public agricultural research agencies producing new varieties in the Green Revolution, there was no difficulty in arranging for the release and exchange of germplasm in the public domain. As measures are taken to protect proprietary genetic information (such as in the Plant Variety Protection Act and similar legislation) scientific intercourse has been slowed. The Union for the Protection of Plant Varieties is taking action to persuade LDCs to institute variety protection legislation; such legislation would ease access to LDC seed markets and help create the conditions for enhanced profits.

Of far deeper significance is the U.S. Supreme Court decision upholding the validity of patents on genetically engineered organisms. Should a company make a breakthrough, such as inserting the nitrogen-fixing-gene complex into the genetic code of a maize variety, that variety could presumably be patented. It would be available only to those willing and able to pay a royalty fee. Biotechnology thus promises to exacerbate what has long been a major point of contention in the North/South debate: the problem of the free flow of scientific and technical information and patenting.

Industrial Tissue Culture

Industrial tissue culture introduces the possibility of eliminating the need for the complete plant. This is possible due to advances in the ability to sustain life in plant or animal cells separate from the organism from which they have been removed. If, for example, the root cells of a plant contain a chemical that is a desirable flavoring ingredient, tissue culture would allow the root cells to be cultured in a fermentation vessel and the desired chemical to be extracted from those cells. There are, of course, drawbacks to this process, the foremost of which is its high cost. A recent estimate is that the material to be produced through tissue culture must be worth over US$300 per pound. Yet it seems reasonable to expect this break-even figure to decline significantly in the next decade.

Numerous companies, large and small, have embarked upon research programs aimed at developing industrial-scale processes for extraction of chemicals from tissue cultures. Corporate research in both Japan and England is under way to grow huge quantities of tobacco cells to replace or supplement leaf tobacco in tobacco products (Fishlock, 1982). The areas that would appear most promising economically in the near future include naturally occurring drugs, flavors, fragrances, dye stuffs, and crop protection chemicals (Fowler, 1983).

Cell tissue cultures essentially transfer agricultural activities into the factory. Previous uncertainties due to weather, pests, labor problems, and transport interruptions can be eliminated by operating within the confines of an industrial factory, and the traditional dependence on potentially unreliable raw material suppliers or producer states is minimized. With most plants, cultivation is seasonal, and the harvest must either be stored (which frequently leads to a loss of potency) or must be immediately processed (requiring an oversized factory designed for peak loads). Tissue culture eliminates the seasonality of production and assures the availability of raw material. Finally, by eliminating the need for planting and harvesting, tissue-culture production lowers the labor requirements of production.

Industrial tissue culture also yields products that are more easily purified. The fact that only the desired cell or group of cells is cultured ensures both quality and quantity. Manipulation of the environment in the tissure-culture factory allows for high yields and production of raw materials far from the source of the origin.

The impact of tissue culture will not be sudden, yet the markets for many of the Third World's primary products will begin eroding. Some Third World countries are already developing a counter strategy by starting local tissue-culture laboratories with the aid of developed countries. For example, Indian and German universities have initiated joint projects to tissue culture rare Indian medicinal plants. This agreement provides training for Indian scientists, but simultaneously provides German pharmaceutical companies with access to numerous valuable drugs. A crucial contradiction presented by these arrangements is that the LDCs (the sources of the plants to be cultured) will, if they initiate tissue-culture production, be competing with their own primary products. Furthermore, the size of the resources required to develop and commercialize the tissue-culture products will limit the participation of developing countries. The final result might even be that the original producer countries will be forced to import from developed producers a commodity that these Third World countries formerly exported.

Animal Husbandry

In sharp contrast to the Green Revolution, the Biorevolution will not be confined to plants. There are numerous important new biogenetic products and services now being developed to increase the productivity of animals. Although domesticated animals are more biologically complex than plants, animal research has been undertaken for many years by scientists attempting to improve human health. This has led to an impressive body of knowledge that is being devoted to biotechnology for animal agriculture. It is probable that the first commercially successful agricultural biotechnology products will be for animals. These products can be divided into three categories: hormones, vaccines, and reproductive technologies.

The most important animal hormones under development are those that encourage growth. For example, bovine growth hormone in recent tests has increased milk output 10-15% while neither requiring more feed nor lowering the quality of the milk (Peale et al., 1981). The recent development of a chicken growth hormone provides the potential to speed broiler growth and thereby reduce the turnover time for broilers (Boone et al., 1983). The growth hormones offer the possibility of significantly lowering the costs of poultry and dairy production and thereby increasing the availability of these products.

Animal losses to disease are very significant for developing country farmers, and numerous biotechnology companies are searching for appropriate vaccines. Of particular importance for LDCs are the new genetically engineered disease vaccines which need not be refrigerated. The successful commercialization of this vaccine would significantly enhance the livestock production and processing industries of several developing countries, making possible increased exports.

Finally, techniques for transplanting and sexing embryos are making possible much greater specificity in reproduction. Commercializable techniques have been developed to secure the survival and development of numerous fertilized ova from a desirable cow. These ova can be frozen and transported internationally for transplantation into a surrogate mother from which they acquire her environmentally specific immunities. The ability to preserve cattle embryos cryogenically makes possible a world market in cattle genetic material and provides the potential for less developed countries to upgrade their herds. Other techniques have been developed to determine the sex of the embryos, allowing specificity in choice of dairy or meat cattle (Pramik, 1983). These sexing techniques ensure that embryos of the desired sex can be purchased. Similar techniques are being examined for swine (Immunogenetics, 1981), and in all likelihood will follow for other commercially significant animals.

The potential effects of these technologies will differ throughout the developing countries. For much of the Third World, livestock products are primarily items of luxury consumption or are produced heavily for export. Typically, livestock production involves an extensive use of agricultural resources and reflects the legacy of inegalitarian landholding systems that restrict peasant access to land for subsistence or commercial production. Under these circumstances productivity improvements in livestock production may make little direct contribution to feeding the hungry and, at worst, may make livestock (especially cattle) production sufficiently profitable so that it will further displace labor-intensive production of subsistence food crops on small plots. On the other hand, the potential effects could be more positive in Africa where livestock are pivotal in providing traction, transportation, milk, clothing, fertilizer and so on, in addition to meat.

Genetic Manipulation and Agricultural Products

Any production process based on living organisms could be affected by biotechnology.

Perhaps the most instructive example of the power of biotechnology is the tremendous growth in the use of high-fructose corn sweetener which is produced through the use of immobilized enzyme technology. The high-fructose corn sweetener industry has had remarkable success in both the US and Japan, even though it is only 15 years old (Casey, 1976). Predictions are that by 1985 corn sweeteners will have captured 10% of the world sweetener market and over 45% of the U.S. market (Vuilleumier, 1981). Rather than disappear, the current world sugar glut will, in all likelihood, continue, and only the low-cost cane sugar growers will remain competitive on the world market. Corn sweeteners produced by immobilized enzyme technologies probably represent the first example of the potential biotechnology has for displacing a major tropical product.

Feed protein for animals is another product that may be replaced by a process that uses genetically engineered organisms. The USSR is aiming to be self-sufficient in animal feed by 1990 through increased production of single-cell protein. Exporters of soybeans and peanuts will soon face a shrinking market.

Biotechnology offers promise for LDCs as well. For example, Brazil is replacing oil imports using the microbial tranformation of sugarcane juices into ethanol. This process could be speeded up with genetic engineering. Genetic engineering also holds the promise of converting the abundant biomass available in the tropics to feedstock.

Conclusion

We have indicated important areas of research and application of these new productive forces. Further, we have indicated the overwhelmingly private character of these technologies and their applications and suggested some likely consequences of this private mode of R&D and technology transfer. It is very likely that less developed countries will become increasingly dependent upon technology owned by companies located in developed countries. This observation is, of course, not novel: as noted earlier, recognition of this problem has led UNIDO to sponsor the establishment of the International Center for Genetic Engineering and Bio-Technology dedicated to research into applications in the Third World context. The proposal has received support from nearly all countries with the exception of Japan and the United States, the two leaders in biotechnology (Zimmerman, 1983). But whether a research institution, with a yearly budget of US$8.6 million, can compete with companies such as Cetus or Genentech (two of the largest US biotechnology companies, with research budgets of over US$20 million each) and the large transnational corporations, with their huge research budgets, is certainly open to question. The situation is especially problematic when nearly all of the companies are attempting to patent processes so as to require other users to pay royalties.

The need for some mechanism for delivering the benefits of biotechnology to the less developed countries is clear. This issue has recently been dramatized by a clash between the public good and private interest in the international arena over the effort to develop and produce a vaccine for malaria, which kills two million persons annually. New York University (NYU) researchers with U.S. Agency for International Development and World Health Organization (WHO) funding have developed the basic knowledge needed to create a malaria vaccine. The university contacted Genentech to proceed with the necessary research to bring the vaccine into production. But after two years of negotiation, Genentech balked when the WHO refused to extend an exclusive license to the company (Marshall, 1983). John Maddox (1983), the editor of Nature, has written that negotiations with another company could delay the project by two years. Genentech's concern -- in effect, that it would be unable to collect monopoly rents on the production of malaria vaccine -- does not augur well for the UNIDO-sponsored international center. The center's research breakthroughs, like those of the NYU malaria vaccine researchers, will require scale-up. Whatever the final outcome in the case of the malaria vaccine, a chilling precedent has been set in cautioning researchers that commercialization of breakthroughs targeted to the poor will be problematic. Furthermore, the incident dramatizes the fact that research alone does not create products; the expertise for scaling research discoveries up to the production stage is crucial, and the transition from innovation to scale-up is not only expensive, but the expertise and financial capacity are also concentrated in only a few companies and countries.

The Biorevolution will have a far greater span of applications (and hence impacts) than did the Green Revolution. Moreover, the infrastructural investments involved in biotechnology R&D are considerably greater than those incurred by the IARCs at the outset of the Green Revolution, and the Biorevolution is emerging in a backdrop of exclusionary legal arrangements (plant variety protection and the ability to patent novel life forms) that played a very small role in the early activities of the IARCs.

The implications of the divergences between the institutional structures of the Green and Biorevolutions are potentially quite dramatic. As long as the IARCs enjoyed virtually unrivaled dominance in international agricultural research by virtue of their technical expertise and the unattractiveness of Third World-oriented agricultural research for private investment, international agricultural research goals were at least theoretically a matter of public participation and debate. We emphasized earlier, for example, that the IARCs, despite their tendency toward inertia in responding to criticism, have begun to take modest strides toward research targeted to the needs of smallholders and oriented to the perfection of labor-intensive technologies in labor-surplus economies (see, for example, Ruttan, 1982: Chapter 5). This shift of research emphasis was clearly made possible by the fact that the IARCs are quasi-public institutions and that their activities are subject to public scrutiny. But if, as we suspect, neither public agricultural research institutions in the developed countries nor those of the "international public sector" (i.e., the IARCs, the UNIDO-sponsored International Center for Genetic Engineering and Bio-Technology) can retain their supremacy in agricultural R&D, control over research goals will shift toward the private sector. In some instances, and under certain conditions, this shift from public to private control will be beneficial, or at least benign. The weakness of this largely private system of R&D and technology transfer, however, will be in ensuring that there is sufficient attention paid to the technical needs of peasant smallholders and the rural poor in general, who will lack the purchasing power to constitute an attractive market. Will the rapid deployment of malaria vaccines, the development of high-yielding, disease-resistant strains of cassava, or research into vaccines against pervasive infectious diseases of cattle in Africa, be delayed because of corporate fears about inadequate market potentials? Will exclusionary legal arrangements lead to the withholding of technical information from the IARCs, or to the extraction of monopoly rents from peasant purchasers of agricultural inputs? Will the timing of technological transfer of biotechnology to the Third World be perverse -- that is, will the highly profitable initial products of biotechnology (e.g., industrial tissue culture production, immobilized enzyme-based production of sugar substitutes, improvements in livestock health and reproductive performance) cause significant harm to the Third World's poor before the biotechnologies of more direct benefit to the poor come on line? These questions, although largely hypothetical at this point, raise profound issues about how the public interest will be affected by the ongoing reorganization of international agricultural research and development.

A final, ironic consequence of the restructuring of international agricultural R&D relating to biotechnology may be a significant shift in the politics of the IARCs and the Consultative Group on International Agricultural Research (CGIAR). Heretofore, the critics of technological change in the Third World have directed their attacks against the IARCs.

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SECTION THREE

A SYSTEMS PERSPECTIVE: MEETING THE CHALLENGES OF A CHANGING ENVIRONMENT

AN INTRODUCTION TO A SYSTEMS PERSPECTIVE: MEETING THE CHALLENGES OF A CHANGING ENVIRONMENT:

A food system, as defined by Davis and Goldberg in their pioneering work, A Concept of Agribusiness,[1] encompasses all persons and institutions involved in the production, processing, and marketing of an agricultural commodity. The system extends from the generation of production technology to the utilization of the commodity by the ultimate consumer.

A food system is a dynamic, ever-changing entity. It is a complex mechanism continuously being influenced by the environment and also influencing the environment. The effective manager of agricultural research needs to understand the food system of which he is a part. He must monitor changes occurring in that system, for they affect his managerial tasks and the organization for which he is responsible.

To analyze a food system the manager needs to understand the participants in the system, the linkages and mechanisms that interrelate the participants, and the environmental forces that shape and change the system. The participants in a system can be divided into two broad categories: primary participants and secondary or supportive participants. The primary participants generally consist of five major groups: consumers, distributors, processors, farmers, and input suppliers. Some of these major groups can be broken down further into more than one subgroup. For example, food distributors may include wholesalers and retailers; retail distributors may include small retail stores, supermarkets, and restaurants.

To understand the roles of the primary participants, one needs to ask four major questions: What are the characteristics of each participant? What functions does each participant perform in the system? What benefits do they derive from participation in the system? And what risks do they take? Sometimes a participant performs more than one function. For example, a farmer may sell vegetables at his farm gate directly to consumers. In this instance, he is both the producer and retailer. With this kind of information on participants, the manager begins to understand the functioning of the food system in which he is participating.

The secondary or supportive participants, as the name implies, play less significant roles in the system than do the primary participants, but their roles nonetheless are essential. Secondary participants can vary significantly from food system to food system. They provide such support services as extension, credit, storage, transportation, grading, and packaging. At times, some of these supportive functions are provided by primary participants. For example, food processors may provide extension services to farmers who supply them with fresh vegetables.

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(1) Davis, John H. and Ray A. Goldberg. A Concept of Agribusiness. Boston: Harvard Graduate School of Business Administration, 1957.

Once the participants in a system and their characteristics and functions have been identified, the next step in system analysis is to identify the linkages and mechanisms that interrelate the participants and coordinate the system. These can take many forms. The linkage may be a contract. A food processor may have a contract with a farmer, and the farmer in turn may have a contract with a trucker. The contracts can be either formal or informal, the latter generally being a verbal understanding between the parties.

The coordinating force may be a company or a farmers' organization. A processor, for example, may decide to participate in producing its supply requirements; that is, to integrate backwards and produce its own fresh vegetables for processing. Or a cooperative may coordinate the marketing for all of its member farmers. The food processor situation is an example of vertical coordination since it relates functions at different levels within the system, one at the processing level and one at the production level. The cooperative, on the other hand, is an example of horizontal coordination. The cooperative coordinates the activities of farmers whose functions are at the same level in the system.

The coordinating mechanism may be a government organization, such as a marketing board or a government food authority that purchases and distributes imported food supplies. The mechanism may be an agreement, such as a trade treaty.

A food system will have a variety of coordinating linkages and mechanisms, and no one correct way exists for achieving coordination. Coordinating devices that may be effective in one system or one environment may not be appropriate in another food system or environment. Identifying and understanding the coordinating mechanisms and linkages that exist in a system is a prerequisite to participating effectively in that system.

No food system functions in isolation. It is continuously interacting with, and being affected by, outside forces. These forces may be other food systems, government policies, economic activities, technology, the aspiration of consumers, or tradition. These kinds of forces exert an impact on a food system and can alter who the participants are, what functions they perform, or how the system is coordinated. Analyzing these forces expands one's understanding of the system and also helps to anticipate change.

Food systems generally transcend sectorial barriers. Some participants are from the public sector, some from the private sector. Food systems also transcend national boundaries, and what happens in one part of the world can have an impact on the food system in another part of the world. For example, an agricultural research breakthrough that reduces costs and prices in one country can affect the international demand for the export product of another country.

Efficient food systems are market oriented. This means that the system is designed to serve the ultimate consumer of food, an increasing percentage of whom are located in urban centers.

A food systems approach offers major benefits to the manager of agricultural research. First, it gives him a perspective on the tasks and the role of his organization. When a manager has analyzed the participants in a food system, the linkages and mechanisms that coordinate the system, and the environmental forces that affect the system, he then understands how the system functions. More important, he understands how his organization and its activities fit into the total system.

Second, a systems analysis enables the manager of agricultural research to identify the leverage points in the system. His analysis has shown him who controls the system, the mechanisms used to achieve that control, and the weaknesses in the system. This knowledge helps the manager to identify more precisely what his institution should be doing, and how he and his associates should be disseminating their research results if they wish to maximize their impact on the system or change the system.

Third, understanding a system stimulates thinking. The manager begins to see how the same tasks can be carried out in different ways. This can lead to the formulation of new approaches to the generation or transfer of technology. Understanding the system also underscores that whenever a research manager or some other participant changes the way his institution does things, the change has an impact in many places in the system and these need to be anticipated.

Fourth, a systems approach helps the manager of agricultural research be more focused and efficient in utilizing resources. A manager with a systems understanding moves toward a greater client orientation and finds ways of achieving a multiplier through other participants in the system. The manager who understands the system may that find certain activities of other participants coincide with his in such a way that an opportunity for collaborative endeavor is created. Or he may discover that some of his functions are being performed by other people in the system. He then may phase out those activities and focus his resources on more distinctive endeavors.

Fifth, understanding a system better equips the manager to meet the challenges of a changing environment. A systems approach helps the manager to develop greater sensitivity to change and strengthens his ability to anticipate the impact of possible future change on his institution and its mission and activities.

The systems approach does not tell the agricultural research manager what to do. It is an analytical tool for the manager. The better the systems analysis is, the wider the perspective and the greater the understanding by the manager of a decision-making situation. This should make for improved decisions and enhance the relevance and impact of the decisions made by the agricultural research manager.

Chapter 9

CASHEW NUT RESEARCH IN THE TANZANIAN AGRICULTURAL RESEARCH ORGANIZATION

CASHEW NUT RESEARCH IN THE TANZANIAN AGRICULTURAL RESEARCH ORGANIZATION:

A Management Commentary

The situation described in "Cashew Nut Research in the Tanzanian Agricultural Research Organization" underscores the vital role of linkages if agricultural research endeavors are to have an impact on a commodity system. By 1982, cashew production in Tanzania had fallen to 30,000 tons from a 1974 high of 145,000 tons. Beginning in 1974, the Tanzanian government with funds from the World Bank and the Bank of Sicilia had substantially expanded the country's cashew nut processing capacity. Currently, much of this capacity was idle because of low cashew nut production. A cashew research project launched by the government, with Italian support during this period, had had no visible impact on production levels.

Agricultural research does not increase production *per se*; it is merely the first step. Its impact is not seen until it is linked to the total commodity system. In this instance, the impact of cashew research outside the research environment itself was limited because of the lack of effective linkages to other parts of the system. For instance, the researchers had no direct links with the farmers who were to be the major beneficiaries. Furthermore, advice to the farmers was given by village extension workers, a group with whom the researchers also had no direct contact and who were employees of another government body.

The Tanzanian Agricultural Research Organization (TARO) carried out the cashew research. The Cashew Nut Authority of Tanzania (CATA), however, was responsible for extension and the purchasing, processing and marketing of cashews. Effective linkages that facilitated the flow of information and the development of understanding between these two government bodies were weak.

Also, the stated goals of the two government groups were in conflict. The goal of CATA was to produce "as many cashew nuts for processing and export as possible," and its extension workers emphasized practices designed to achieve this short-term goal. The perspective of the researchers of TARO, in contrast, focused on the longer-term needs of revitalizing the tree crop. Their research goals, though worthy, appeared to be formulated apart from the needs of CATA, the industry's major coordinating body. The result was that the research team produced interesting results and new knowledge, but these research discoveries were not considered immediately relevant by CATA and, thus, had little impact on the system. In this instance, the research function was isolated from the total system and its impact on the system was minimal.

The case describes a survey of village leaders that was designed to contribute understanding to the reasons for the decline of cashew production. This research endeavor among those who knew the farmers was an effective way of understanding the thinking of farmers, often the targeted beneficiaries of agricultural research. However, the survey information does not appear to have been used by TARO in its research endeavors nor by CATA in coordinating the industry.

The Tanzanian cashew situation also demonstrates the interrelationships among commodity systems within a country. The Tanzanian farmers who grew cash crops, such as cashews, began to place more emphasis on the production of staple food crops when the food crops became in short supply and were not available for them to purchase. Thus, reduced production in one commodity group can have an impact on the production level of another crop.

The case demonstrates that effective linkages are as important as appropriate research in seeking to increase agricultural production. Also, understanding the interrelationships among commodity systems is essential if agricultural research is to achieve its goals.

CASHEW NUT RESEARCH IN THE TANZANIAN AGRICULTURAL RESEARCH ORGANIZATION:

A Case Study

by Marie de Lattre

It was difficult to avoid the potholes in the road and simultaneously to point out the cashew trees in the countryside. Mr. Shomari, the Director of Naliendele Agricultural Research Institute and the Coordinator of the Cashew Research Project in Tanzania, was driving. "You see these cashew trees," said Mr. Shomari. "Just looking at them you can understand the whole situation. Cashew trees grow on sandy soils and they are drought resistant. They are often seen as a gift of nature that requires minimum tending. Therefore, farmers tend to forget them. They do not weed their fields and no longer collect the fruit. For all sorts of reasons, the farmers and the government seem to have lost interest in cashews."

In 1982, 30,000 tons of cashew nuts were bought from the farmers. In 1974, cashew nut production had been at a peak of 145,000 tons, and Tanzania was a major world producer of raw nuts. Cashews had been an important source of foreign exchange. Yet in 1982, coffee, tobacco, and cotton were the major sources of foreign exchange.

Mr. Shomari went on, regularly shaken by jolts so that his head banged against the roof of the Land Rover. "Like the trees, the Cashew Research Project is neglected. The Institute, as you are well aware, is in a poor and remote part of the country. Fortunately, we have a good research team. It is composed of six Italians and two Tanzanians. We have obtained satisfactory results, but our recommendations are not applied. Even more frustrating is that despite the decline in yields and production, it is difficult to obtain funding because research on cashews is no longer a government priority. Great hope had been put in the processing of an expanding cashew crop, but the factories that were built at the peak of the production curve are now idle. We, the researchers, are blamed for this situation. The months ahead are going to be decisive for the cashew research project. The government is concerned about the idle factories because cashew exports could considerably improve the Tanzanian balance of payments. A serious evaluation of the situation is necessary. I must do something for my program. I must act and make recommendations to the Director General of the Tanzanian Agricultural Research Organization."

The Tanzanian Agricultural Research Organization (TARO)

During the colonial era, the agricultural research programs in what today is Tanzania were aimed at solving the problems faced by plantation farmers. The principal crops of these farmers were coffee, cotton, cashews, tea, and sisal. During the post-Independence period, emphasis shifted to diversified crop production and the integration of cash crops with food crops. In 1979, an effort was made to consolidate all agricultural research activities under the Ministry of Agriculture. A reorganization program was carried out which resulted in the establishment of the Tanzanian Agricultural Research Organisation (TARO), the Tropical Pesticides Research Institute (TPRI), and the Uyole Agricultural Centre (UAC).

In 1980, the "TARO Act" was passed, but the organization really became operational in 1982. TARO was one of the 14 parastatal organizations in the field of agriculture. It comprised 12 research institutes which were responsible for 20 research projects. Naliendele and the Cashew Research Project were under the authority of TARO. The senior research officers under the Director General of TARO were directors of institutes and program coordinators.

As a parastatal agency, TARO was funded annually and had discretion to disburse funds on to its institutes. TARO recently had changed the budgeting procedures. Formerly the institutes were funded through the Ministry of Agriculture on a "one-line-vote" system; funds were given to the director of each institute who was responsible for distributing the funds to the various programs undertaken in his institute. Under TARO, funds were primarily being alloted to programs. The programs had been prioritized. Maize research was number one, national soils survey was number two, then came bananas and tobacco. Cashews were not mentioned on the priority list. Requests for funds for top-priority programs were satisfied before those for other programs. TARO also had the power to enter into agreements with international agencies without referring to the treasury.

History of Cashew Research in Tanzania

The institute was ahead on the right side of the road, which was lined with wonderful palm trees. As the Land Rover shuddered to a halt in front of the main building of the Naliendele Agricultural Research Institute (ARI) the employees picked up on the way got out of the vehicle. In front of Mr. Shomari's office three people were waiting. In Swahili, Mr. Shomari told them to come back later. In his dusty office, he described the history of cashew research. "Research on cashews in Tanzania began at Nachingwea in the southern part of Tanzania in 1954. The trials on groundnuts that the British were doing had failed; therefore, they decided to switch to cashews. The British cashew research program was fairly comprehensive; it included plant improvement, agronomy, plant protection, and farming systems. In 1954, research on cashews was at a very early stage. It was considered that cashew crops had been detrimental to the population of Mozambique where cashew-apples had been used to produce alcoholic drinks, spreading alcoholism. The government of Mozambique had decided to limit production, thus creating an obstacle to the advancement of scientific research on cashews. Another problem was a misconception that cashew trees could be grown under poor environmental conditions and did not need much attention. Because of the lack of basic information regarding good cashew husbandry, each farmer adopted his own way of producing the crop.

"When research was started in Tanzania, technological know-how was low. The British began their research by selecting plant material from cashew producing countries. Material came from India, Mozambique, Brazil, Sri Lanka, Malaysia, Zanzibar, and Trinidad. Material was brought from 19 regions in Tanzania and a National Cashew Nut Collection was created. The researchers studied the plantation establishment methods and spacing, and also had a breeding program. After independence in 1961, the British left Tanzania, and little research in cashews was conducted until 1968. At that time, research activities were shifted to Naliendele by the physical transplantation of cashew trees. ARI was closer to the local airport than Nachingwea, and the site was thought to be better suited for cashew research."

Naliendele Agricultural Research Institute (ARI)

Though close to the local airport, ARI was quite difficult to reach. It was situated in the Mtwara district. Planes came irregularly from Dar es Salaam and the road from the airport could only accommodate four-wheel-drive vehicles.

When research materials had been transferred to Naliendele, only one agricultural research officer had been assigned to the project, and therefore, from 1968 to 1978, research activities had been stagnant. In 1978, the Tanzanian government had signed a bilateral agreement with the government of Italy. Italy agreed to provide technical assistance in the form of a research team and equipment to carry out cashew research. "It is a little bit difficult to work with the Italians; their English is not perfect and I can't learn Italian," Mr. Shomari admitted, as he was walking towards the cashew research program office. "Dr. Conticini is the team leader; he is a breeder. There is also an entomologist, a pathologist, a pedologist, an agronomist, and an economist. Two Tanzanian counterparts work on the project: an entomologist and a pathologist. Neither of them speak Italian. I am not quite sure how they communicate, but they seem to manage. To work here we have to be trilingual: Swahili, English, and Italian."

Research was carried out at the institute itself and at two substations -- Nachingwea and Mtopwa. The stations were about 120 kilometers from Naliendele and dependent on the institute.

The institute had 400 hectares at its disposal and no irrigation system. Forty hectares were devoted to research on cashews and 20 hectares to research on annual crops, such as oil seeds, maize, and legumes. The rest of the land was unutilized bush forest. It cost about TSh 5,000 per hectare(1) to establish a new cashew plantation. The institute had two tractors, but few spare parts and petrol.

As the Director of Naliendele ARI, Mr. Shomari was responsible for the activities carried out in the institute and for administering the budget (the Tanzanian part of the budgets for cashews, and for research on annual crops at Naliendele). Every year he submitted budgets to TARO for the research programs and the recurrent costs.

Mr. Shomari also was responsible for the definition and the execution of the nation's cashew research. In this capacity he submitted budgets for supporting the cashew program and for developing its activities.

Because there was an overlap between institutes and programs, a meeting at TARO was held in January each year to balance the requests.

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(1) In April 1983, the official exchange rate was US$1.00 = TSh 9.83. In the parallel market, the US$ had a premium of 400%.

"When time comes for the budget," said Mr. Shomari, "I decide on the allocation of funds. As I pay all the bills, it is not too difficult to know how much each program needs. Unfortunately, we are never given enough. We always lack funds for staff salaries, for spare parts, and for petrol."

Italian Aid in Cashew Research

As the team leader, Dr. Conticini had a private but small office. The other researchers were assigned to share the same table, four chairs, and two microscopes. With elaborate hand gestures and a Mediterranean accent, Dr. Conticini described the work of the team. "At our arrival in 1979, we found data that had been collected since 1969, but not analyzed. Therefore, we spent the first three years analyzing the records. We could not rely totally on the data, because we were not sure of the research methods which had been used, but the data gave us some indications. We carried on the work on the National Cashew Nut Collection initiated at Nachingwea. The economist in our team has calculated the minimum economical production for farmers. It was about 10 kilograms per tree. The local varieties usually produce three to four kilograms per tree. They are far from the minimum economical level."

Suddenly, the electricity went off. The fan stopped and the air became very hot. "We have to work under difficult conditions; electricity comes and goes. There has been no running water for the last three weeks. Living, and especially working here, is not easy. Despite these problems, we have obtained some good results. We have identified the 12 best clones. We have done a thorough pedological survey and have prepared maps with our institute, the Oltramare, in Bologna. We also know the incidence of pests and diseases and how to fight them. We have a cashew seed garden."

"Last year, we sold seeds to the Cashew Nut Authority of Tanzania (CATA). They are responsible for the purchase, processing, and sales of the nuts, as well as extension. Unfortunately, the extension workers never distributed the seeds to the farmers. It is a pity that our working relations with CATA are so poor. CATA has a short-term approach to cashew production, whereas we have a long-term approach. We think that the problem lies in the plantations. We have a package of recommendations ready. Seeds from the best varieties are waiting to be planted and large establishments should be created. This would allow the spraying of the cashew fields in case of pest or disease attacks without harming the farmers. But this is a long-term solution. First, fields must be cleared; then seeds will have to be planted, and it takes at least five years to begin to collect a good crop. We think it is the only viable solution. We try to make the government and CATA understand that, but they do not implement our recommendations. CATA has not cooperated with us as much as we had hoped. At Naliendele, we organized courses for the extension workers, but none came. The problems with CATA are related to communication and financial matters. CATA should provide us with funds for research but they use the money for their own research on cashews."

Then Dr. Conticini explained the status of the research team. The little office was becoming a sauna. "Our government and the Tanzanian government sign three-year contracts. The first contract was from 1978 to 1981. The second one is from 1981 to 1984. For the contract to be renewed, Tanzania has to ask the Italian government for an extension, and the Italian government has to agree. But funds are becoming scarce in Italy too. So we will see what is decided in 1984. We feel that we have executed our mandate, and that it is now the duty of the Tanzanians to continue and carry out the cashew research program."

Italian aid paid for its researchers and provided for some equipment, but the host government was expected to cover the costs of housing, the salaries of the local counterparts, the research budget and the recurrent costs. "Having to rely on Tanzania for the budget makes it difficult to operate," said Dr. Conticini. "Every year, Mr. Shomari, as Director of Naliendele, submits the institute budget to TARO. As the Cashew Research Program Coordinator, he also submits a budget for cashew research (Exhibit 1). Therefore, the present situation is that Mr. Shomari is responsible for the budgets of both the whole research institute and the cashew research project, and he does not find it possible to allocate a specific amount to each team leader at the beginning of each year. Things would be somewhat better if the cashew research team had its own budget. We would always know how much would be available. We could plan and set priorities, but we report to Mr. Shomari who pays all the bills related to cashew research and transmits the results of the research to CATA and TARO."

The Cashew Nut Authority of Tanzania (CATA)

Before 1974, the purchase and sales of all crops in Tanzania were under the authority of the National Agricultural Products Board. As work began to be too cumbersome, in 1973 the Board was dissolved and three new organizations were created: CATA, the National Milling Corporation (NMC), and the General Agricultural Export (GATEX). Like TARO, CATA was a parastatal agency. Its head reported to the Ministry of Agriculture.

The offices of the CATA were in downtown Mtwara in a four-storey building whose construction had been financed by the World Bank. It was so large that finding a particular person's office was difficult.

CATA was created to promote the development and the improvement of the cashew nut industry. Other functions of CATA were to purchase the production from the farmers; to promote the activities of growers and producers of cashew nuts through extension; to stimulate the business of processing cashew nuts and of manufacturing products made from cashew nuts and kernels; to regulate and to control the marketing and export of cashew nuts, kernels, and by-products; and to advise the government on all matters affecting the cashew nut industry. There were five directorates: crop development and extension, factory operations, marketing, finance, planning, and administration.

Mr. Mwenkalley, Crop Development Manager of CATA, and Mr. Mushubi, Marketing Manager, were sitting in comfortable black leather sofas in an air-conditioned office. Mr. Mwenkalley explained, "Those Italian researchers tell us that CATA should plant new cashew trees in the form of large establishments, and that we should encourage replanting to the farmers. We think it is too early to replant. Replanting means uprooting trees, and the labor cost for such an operation is very high. Furthermore, farmers do not like to uproot. They prefer to get a little bit of money every year than nothing for five years, with the eventuality of earning more later. Our main concern is to obtain as many cashew nuts as possible, as soon as possible. Research does not give us what we want. As the recommendations made by the researchers do not satisfy CATA, I am obliged to carry out my own research. I work on the possible rehabilitation of the existing trees. I think that what the researchers at Naliendele are proposing is good, but it is not solving the problem of declining production."

CATA had three types of extension staff. There were two officers at the headquarters, 13 in the branch offices, and 217 extension workers in the villages and wards. The extension workers in the villages advised the farmers on how to grow the cashew trees scientifically. They pointed out the importance of spacing, explained how to combat pests and diseases, and supervised the purchase of raw cashew nuts. Only the officers at the branch and headquarters level had any contact with the researchers at Naliendele.

The purchase of the nuts was made in each village. CATA got an overdraft from the bank and sent the money to the cooperative society in each registered village. The cooperative bought on CATA's behalf. "The problem," explained Mr. Mwenkalley, "is that the cooperative does not always use the money to buy the nuts. The village can decide to use it to build a mosque or a church, or to buy a mill. Sometimes the money completely disappears. The extension workers are supposed to supervise the use of the money, but they do not manage to control everything. The final consequence is that sometimes the farmers do not get paid."

Agriculture in Tanzania

Prior to Independence in 1961, agrcultural production was centered on large-scale, privately owned commercial estates and subsistence production. After Independence, an attempt to change the subsistence production was made by introducing village settlement schemes and village farms. However, this was confined to a few areas.

As a result of the Arusha Declaration of 1967, more steps were taken, including the nationalization of some of the private, commercial estates/farms, the mobilization of peasants into villages where collective production was encouraged, and the establishment of state and parastatal farms.

In the villages, three forms of agricultural production existed, depending on the stage of development of the village. These were the homestead farm, the block farm, and the collective farm. The homestead farm varied in size from half an hectare to two hectares, depending on the availability of land, family labor and mode of production. Here the farmer could grow crops of his choice and the proceeds belonged to the family. The block farm was a large area of land subdivided into small holdings which were allocated to individual families resident in the village. The proceeds accrued to the families. The collective farm was a village government farm called the Ujamaa Village System where every able-bodied resident was required to work. The management of the farm was directed by the village government and part of the proceeds were shared out to "each according to his contribution," while some of the income was retained by the village government for financing village development projects. After the Arusha Declaration, peasants were advised to leave their farms and to live in the Ujamaas, where it was planned that they would have access to modern methods of agriculture, medical care, and schools, and could also easily market their surplus output.

The Cashew Tree in Tanzania

The cashew tree (Anacardium occidentale L.) is a tropical evergreen, native to Brazil, but now grown widely in the tropics for its edible nuts and the resinous oil contained in the shells. Under favorable conditions it can develop into a tall, single-stemmed, symmetrical tree with a large canopy, reaching a height of up to 15 meters. On poor soils, or when exposed to strong winds, it develops into a low-spreading bush. The trees, mostly seedlings, grow on wastelands with a minimum of care, reach full bearing at eight years of age, and may continue to bear for 20 years or more.

The fruit is a swollen peduncle known as the cashew apple and a kidney-shaped nut attached to the apex of the apple. Usually the fruits fall from the trees when mature and are gathered by local labor; the nuts are separated from the apples by hand. The apple and its juice can be consumed fresh as well as prepared into syrup, jams, or alcoholic beverages. Some of the apples are marketed locally, but most are wasted. The main product, however, is the nut. It can be eaten or used for the production of vegetable oil.

The cashew tree was introduced in southern Tanzania from Mozambique by prospecting farmers in the first half of the twentieth century. The bulk of the crop was concentrated along the coastal belt. The cashew-growing area had an average rainfall of 900 millimeters per year, with a rainy season from January to April.

Traditionally, cashew trees were grown by small farmers in the fields by their houses. The village creation policies increased the distance between the farmers' houses and the trees. In 1981, it was reported that 21% of the trees were within a one-mile radius of farmers' houses, 76% between one and four miles, and 4% between four and eight miles. The 1972 agriculture census reported that the total cashew area was about 240,000 hectares, of which 72% were entirely devoted to cashews, and 28% were intercropped with one or more other crops such as cassava, millet, and beans. The other important crops grown in the region were sisal and coconuts. The average size of a cashew farm was 2.2 hectares, of which 1.1 hectares was planted in cashews. The average age of trees was 19 years, and the planting density was 96 trees per hectare. According to a survey of cashew nut farming made by CATA, 40% of the trees needed immediate replacement, and more than one-third showed signs of pest and disease infestation.

Cashew Nut Trade

Until 1937, cashews were used only locally in Tanzania. The apples were farm-processed and eaten; the nuts were hand-processed to separate the kernel and the shell, and then eaten or used in the production of vegetable oil.

The export of nuts began in 1938. Nuts were exported in their raw form to India and processed there. Hand-processing in Tanzania began in 1956, and the first mechanical processing factory was set up in 1965. Until 1974, cashew production was increasing and government expected this trend to continue. During the same period, the world price of processed nuts was increasing more rapidly than the price of raw nuts. Therefore, the government of Tanzania, as part of its industrialization process, decided to develop the cashew nut processing capacity of the country. The loans requested by the Tanzanian government from the World Bank and the Bank of Sicilia were obtained to build cashew nut processing factories. Under the first phase of the project, which began in 1974, five factories were built. The country's processing capacity increased from 20,500 tons to 60,000 tons. The second phase of the World Bank loan began in 1978. The construction of three extra factories was undertaken, and the processing capacity increased by 30,000 tons. Simultaneously, the Bank of Sicilia had provided loans for the construction of two processing factories. By 1983, Tanzania had 12 factories and the capacity to process 113,000 tons of raw cashew nuts.

Since the early 1970s, Tanzanian exports of processed cashew nuts increased more rapidly than the exports of raw nuts. As processed nuts had a higher value added than raw nuts, the export of processed nuts was encouraged by the Tanzanian government. In 1974, the export price of one kilogram of raw nuts was US$ 1.97, and the export price of one kilogram of processed nuts was US$ 14.65. In 1981, raw nuts were exported for US$ 7.72 and processed nuts for US$ 28.61 (Exhibit 3).

"On the export market, the price of kernels fluctuates wildly from day to day and this is no wonder," said Mr. Mushubi from CATA. "The brokers speculate on the crops and buy futures. This aggravates a situation which is started by uncertainties in raw cashew nut production owing to variable weather conditions and the actions of farmers. These instabilities are reflected in the revenues from exports of the commodities."

In Tanzania, the price for cashews paid to the farmers was fixed by the government. Cashews had the lowest ratio of producer price to export value of all crops: 0.31. Unit export values experienced a much greater increase than producer prices. The grower's share of the average export value had been declining (Exhibit 4).

While the processing capacity was rapidly increasing, production declined, thus causing the factories to be underutilized. This surplus capacity was a heavy burden for CATA, which was responsible for maintaining the plants.

Cashew Production and Trade in Tanzania

In 1976, Tanzania was the second-largest producer of cashew nuts in the world. The other important world producers were Mozambique, India, and Brazil. Whereas the production of cashew nuts increased in Mozambique, Brazil, and Kenya over the next five years, it decreased in Tanzania (Exhibit 2).

In 1981, a survey of village leaders in the cashew growing areas of Tanzania was conducted. The village leaders were asked to give their opinions regarding the factors contributing to the decline in cashew production. The survey identified the following factors, which are ranked in order of the frequency with which they were mentioned:

1. low profitability
2. distance from house to trees
3. drought
4. overcrowding
5. diseases
6. pests
7. trees abandoned
8. bush fires
9. too much rain
10. not enough time to collect fruit
11. aging of farmers
12. poor extension
13. poor payment system

Farmers who grew cash crops with the expectation of exchanging part of their earnings for their families' food supply found that staple foods were in short supply. They also were not able to buy grain at all in a very poor year. This caused the farmers to grow more food crops when there were competing demands for planting, weeding, and harvesting labor.

The Future of the Cashew Research Program

The Prime Minister of Tanzania had been made aware of the extent of the decline in agricultural yields and productivity in the country and had asked the research and agriculture directors to think about the future agricultural policies of the country. "We had been assigned a difficult task," said Mr. Shomari walking in ARI's cashew field, "and we have obtained good results. I was hoping that our recommendations would be extended to the farmers. The government has managed to move people, so it should be able to encourage replanting of cashew trees. Yet, now that cashews are no more on the priority list for research, the researchers' task is going to be very difficult. Maybe we made some mistakes. We must analyze what we have done and, more important, decide what can and should be the future of cashew research in this country. The future of cashew nut production in Tanzania is at stake. Maybe we should distribute seeds to the surrounding farmers? Maybe we should end relations with the Italians? Maybe we should stop research on cashews? There must be solutions. I have to analyze the pros and cons of all the options and design a program for the future."

Exhibit 1

CASHEW NUT RESEARCH IN THE
TANZANIAN AGRICULTURAL RESEARCH ORGANIZATION

Cashew Research: Project's Financing 1981-1986
(In 000's T Sh)

	Tanzania	Italy	Total
Estimated costs	950	1,040	1,990
Cumulative expenditure up to 30.6.82		370	370
Approved budget		130	130
Planned distribution until completion			
1983/84	450	540	990
1984/85	420	0	420
1985/86	80	0	80

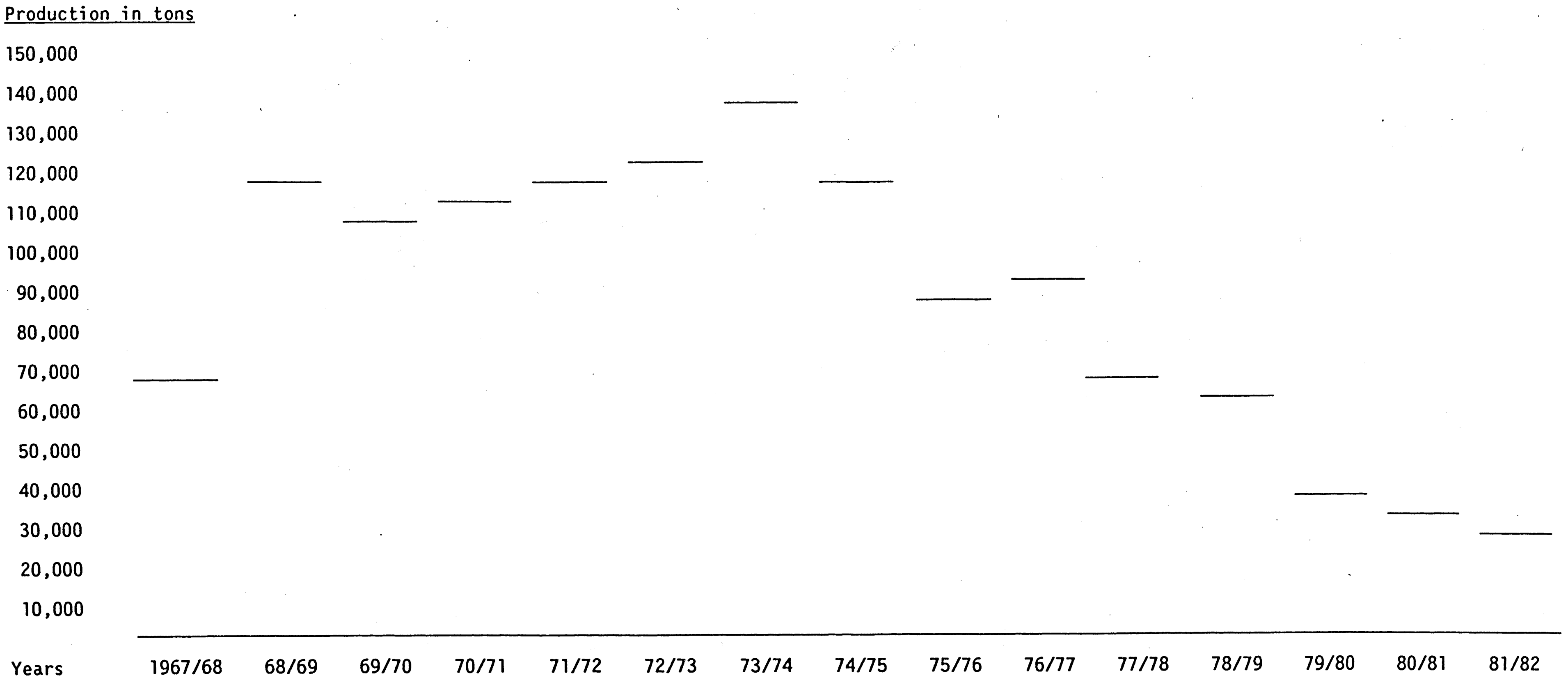
In April 1983, the official rate of exchange was US$ 1 = T Sh 9.83. On the parallel market, the US$ had a premium of 400%.

Source: TARO, Planning division.

Exhibit 2

CASHEW NUT RESEARCH IN THE TANZANIAN AGRICULTURAL RESEARCH ORGANIZATION

Production of Cashew Nuts



Source: Cashew Nut Authority of Tanzania.

Exhibit 3

CASHEW NUT RESEARCH IN THE TANZANIAN
AGRICULTURAL RESEARCH ORGANIZATION

Cashew
Evolution of Exports
Raw and Processed Nuts 1975 to 1981

	1975	1976	1977	1978	1979	1980	1981
Raw nuts							
Volume (indices)	100	70	50	34	21	32	16
Average price/kg Current prices - T Sh	1.97	2.59	3.68	4.41	6.97	11.48	7.72
Average price/kg Constant prices 1975*	1.97	2.24	2.69	2.88	4.31	6.78	4.18
	1975	1976	1977	1978	1979	1980	1981
Processed nuts							
Volume (indices)	100	151	79	101	89	156	163
Average price/kg Current prices - T Sh	14.65	20.91	21.27	20.12	28.61	39.89	28.61
Average price/kg Constant prices 1975*	14.65	18.11	15.58	13.15	17.69	23.57	15.25
	1975	1976	1977	1978	1979	1980	1981
Indices of revenues	1662	2891	1365	1426	1664	3893	2552

* Constant prices calculated with an implicit GDP deflator.

Source : Cashew Nut Authority of Tanzania (CATA).

Exhibit 4

CASHEW NUT RESEARCH IN THE TANZANIAN AGRICULTURAL RESEARCH ORGANIZATION

Changes in Producer Price and Unit Export Value Between 1970 and 1979

	% change in average producer price (PP) PP (1979) / PP (1970)	% change in unit export value (PE) EV (1979) / EV (1970)
Cashew	80	256
Cotton	117	228
Tobacco	71	158
Pyrethrum	63	97
Tea *	139	84

* A world boom in production in 1976 was followed by a collapse in world tea prices.

Source : Ellis, Effects of Agricultural Pricing Policy, 1970-79.

RATIO OF PRODUCER PRICE TO WORLD MARKET PRICE

Crop	1970/71	1978/79	% change
Cashew	0.695	0.352	- 49.4
Cotton	0.260	0.172	- 33.8
Tobacco	0.654	0.413	- 36.9
Pyrethrum	0.022	0.018	- 18.2
Tea	0.076	0.098	+ 28.9

Note : Producer prices are for buying season (July - June). The world prices are for the calendar year.

Source : Ellis, Effects of Agricultural Pricing Policy, 1970-79.

Chapter 10

NATIONAL WHEAT RESEARCH IN ECUADOR

NATIONAL WHEAT RESEARCH IN ECUADOR:

A Management Commentary

The Director General of the Instituto Nacional de Investigaciones Agropecuarias (INIAP) is concerned about the growing gap between wheat production and consumption in Ecuador and the decline in the country's wheat production. The case situation underscores the importance of a systems perspective in agricultural research management.

An agricultural research enterprise does not exist in isolation. It is buffeted by external decisions and activities over which its own management has no direct control. Yet, good management demands that the decision maker be knowledgeable about outside forces and take them into account in his own decision-making activities.

The perspective of the effective agricultural research manager extends far beyond the borders of his own research organization. He is constantly surveying the environment to identify and understand events and circumstances that affect his own organization and the nation's food policies. He is continuously scanning the entire food system with an integrated systems perspective.

The effective manager guards against having a perspective that is too parochial or too narrow. A narrow perspective can lead to management decisions that optimize short-term activities to the determent of long-term goals and concerns. A broad perspective, on the other hand, is sensitive to the ever-changing complexity of the research environment and can help achieve long-term stability with regard to an institute's research policies.

A systems perspective that gives breadth and understanding to the total environment of which the research enterprise is a part can only be nurtured and maintained if the manager develops effective linkages between his institution and others having influence on the food system. This case shows the importance of the linkages that an organization like INIAP must have with its clients, particularly those at policy-making levels in the government. All government food policies affect the institute, the priorities of its endeavors, and the demand for its outputs. Linkages must be constructed to facilitate the flow of information among the various participants in a food system. Poor or inadequate communication can result in inappropriate research endeavors and poor agricultural policies.

The effective agricultural research manager has both a public- and private-sector perspective and understands the relationships between the activities of the two sectors. In "National Wheat Research in Ecuador" the adoption of INIAP's research findings and cultural recommendations by farmers in the private sector are affected heavily by the activities of extension workers employed by the public sector and by the pricing policies for purchased inputs and wheat formulated by public-sector agricultural bodies.

The effective agricultural research manager continuously recognizes the interrelationships of factors affecting agricultural activities. In Ecuador, the government's wheat policy had a direct impact on barley and maize. The government was committed to expanding wheat production by reducing the area devoted to barley and maize cultivation. The demand for wheat was determined by many factors. These included the availability of farmers' credit, the availability and cost of purchased agricultural inputs, the commitment of the extension service to increased wheat production, the government's price to farmers for domestic wheat, the government's policy regarding wheat imports, and the price of wheat to urban consumers. None of these factors, despite their importance, was under the control of the Director General of INIAP.

It is not sufficient for the agricultural research manager to understand the food system of which he is a part; he also has the task of developing ways of entering into dialogue with policymakers and others in the system. This gives him the opportunity to discuss the impact of policies and other significant factors on the research endeavors for which he is responsible. In this way, the manager perhaps can influence decisions outside his control and help to create the kind of environment needed for his own organization to carry out its mandate and fulfill its role in the system.

NATIONAL WHEAT RESEARCH IN ECUADOR:

A Case Study

by James A. Lynch
Edward B. Tasch

In early October of 1976, Dr. Enrique Ampuero, Director General of the Instituto Nacional de Investigaciones Agropecuarias[1] (INIAP) in Ecuador, called a special all-day meeting of the directing staff of INIAP. The purpose of the session was to discuss the causes of the growing gap between production and consumption of wheat in Ecuador. During the last decade, consumption of wheat in Ecuador had increased by over 250%, from 103,000 tons in 1964-65 to 265,000 tons in 1975-76. National producton during the same period was unable to keep pace with the rapid growth in consumption. National production increased from 40,000 tons in 1964-65 to a high of 72,000 tons in 1969-70, after which production as a percentage of national consumption steadily decreased. In the 1975-76 crop year, national wheat production was 39,500 tons, only 14.9% of total domestic consumption.

The decrease in national wheat production was of particular concern to Dr. Ampuero and his staff since INIAP had assigned a high priority to wheat research. Approximately 10% of INIAP's professional staff and an equal proportion of its budget were dedicated to research in wheat and small grain cereals. Since 1963, INIAP had supplied local wheat producers with eight improved varieties, more than in all other crops.

In spite of INIAP's efforts to develop higher-yielding varieties and technologies, the average yields of national producers were far below the average yields obtained on INIAP's Santa Catalina Experiment Station. Although INIAP recorded average wheat yields of 4.1 tons per hectare, national growers averaged from 1969-73 only 0.95 tons per hectare, despite the fact that 80% of Ecuadorian farmers were using improved wheat varieties.

NATIONAL AGRICULTURAL RESEARCH INSTITUTE (INIAP)

Organization and Activities

In January, 1962, INIAP began operations as the prinicipal institution conducting agricultural research in Ecuador. To carry out the task of national agricultural research, INIAP established experiment stations and centers in strategic locations in the coastal, Sierra, and Orient regions of Ecuador. The first experiment station, Santa Catalina, was founded in 1962, followed by Portoviejo later in the year. In 1963, the Pichilingue Experiment Station passed to INIAP from the Interamerican Cooperative Agricultural Service, and the Santo Domingo Experiment Station was created. Subsequently, the Boliche station was established in 1969, and the Austro Experiment Center, in 1974.

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(1) National Agricultural Research Institute.

In its agricultural division, INIAP had programs for wheat, barley, oats, triticale, maize, sorghum, potatoes, legumes, coffee, cocoa, rice, cotton, oil-producing crops, and African palm. The livestock division had programs in beef cattle, dairy cattle, swine, and pasture grasses and forages. The six experiment stations concentrated on researching the crops of greatest economic importance in their respective regions (see Exhibit 1).

To complement the work of the crop programs, INIAP had eleven departments organized along functional lines: entomology, phytopathology, quality control, seed multiplication and processing, biometrics, soils, weed control, nutrition, agriculture, engineering, agricultural economics, and communications. The 11 support departments were located primarily in INIAP's headquarters in Quito and in the Santa Catalina Experiment Station, although the departments of soils, entomology, phytopathology, weed control, and seed production also worked at the other experiment stations (Exhibit 2).

Transfer of Research Results

INIAP promoted the diffusion or transfer of its research results primarily through field days, courses, publications, and regional demonstrations. In 1976, INIAP sponsored six field days; three presenting the new INIAP rice variety "INIAP-7", two presenting new INIAP soybean varieties, and one presenting an improved rotation of maize and soybeans. The six field days in 1976 were attended by a total of 1,100 farmers, agronomists, and agronomy students. Also, in 1976, INIAP organized several courses, conferences, special seminars, and international meetings to promote the diffusion of research findings.

INIAP annually conducted approximately 400 regional demonstrations throughout Ecuador to demonstrate results obtained on the experiment stations and to verify the responses of varieties, disease treatments, and fertilizer treatments in the distinct agroclimatic environments of Ecuador. The regional demonstrations were intended to verify the techniques developed on the experiment stations, as well as to provide local farmers with an illustration of the benefits to be gained by utilizing the improved technologies.

Wheat Research

Wheat research was the responsibility of INIAP's Cereals Program, Wheat Section, which had its center of operation at the Santa Catalina Experiment Station. INIAP's wheat research was conducted primarily on 30 hectares of the Santa Catalina station. The Santa Catalina station was located 14 kilometers to the south of Quito in the province of Pichincha in the Sierra, the major wheat producing region of Ecuador. The lands of Santa Catalina were located between 2,650 and 3,250 meters above sea level.

The Sierra region had traditionally been the granary of Ecuador. The cultivation of cereals was carried out in the valleys and hillsides of the Callejón Interandino[2], which was comprised of 10 provinces in the northern part of the country near the Colombian border. These provinces were characterized by a great diversity of microclimates, soils, and production practices (see Exhibit 3).

(2) Inter-Andean corridor.

The Sierra region was divided into the sierra baja, or low zone (below 2,800 meters above sea level), nd the sierra alta, or high zone (above 2,800 meters). Estimates of area sown and yields for wheat in the 10 provinces of the Callejón Interandino in the 1974-1975 crop cycle are presented in Exhibit 4. The annual precipitation in the region was approximately 1,200 millimeters and the climate was temperate to cold (median annual temperature was 11.7°C with an absolute minimum of 1.2°C). Wheat generally was planted in the months of November, December and January, and harvested during July, August, and September. Planting dates were quite variable, due to the varying agroclimatic conditions of the region's many small valleys.

The INIAP wheat program also conducted wheat research in other wheat growing regions of Ecuador. Two hectares in the Portoviejo Experiment Station were dedicated to research on tropical wheats suitable for dry areas at sea level. Research on tropical wheats had been conducted since 1971, and promising wheat varieties for cultivation in rotation had been developed. However, root rot continued to be a significant barrier to the production of wheat in the tropical areas of the coast. The Wheat Research Program also received the collaboration of El Austro Regional Experiment Center. El Austro had three hectares of wheat research plots oriented toward the problems of the southern provinces of Ecuador.

The organization of the INIAP wheat section is shown in Exhibit 5. The most important activity of the wheat program was plant improvement. Breeding priorities within the wheat program were improved yields, rust resistance (stem rust in the sierra baja and stripe rust in the sierra alta), and bread-making qualities.

Since wheat was cultivated at altitudes between 1,400 and 3,200 meters above sea level under varying climatic and soil conditions, the major thrust of the wheat program was to produce varieties which adapted to the wide range of agroclimatic conditions found in Ecuador. By the end of 1976, INIAP had produced eight improved varieties of wheat, five of which were suited to the sierra baja and three to the sierra alta (Exibit 6).

Wheat breeders at INIAP developed, selected, and tested new wheat varieties under the most favorable conditions obtainable on the experiment station in order to allow the varieties to express their genetic potential. It was believed that only under conditions of good soil fertility, moisture control, weed control, insect control, and optimum soil preparation would varieties with superior yield potential be best identified and selected. It also was believed that varieties which were superior under optimum conditions would be superior under less favorable or stress conditions.

Agronomic Recommendations

In conjunction with its varietal improvement program, INIAP published a package of agronomic recommendations to accompany wheat cultivation. In 1976, recommended fertilizer applications were 90 kilograms per hectare of nitrogen, 110 kilograms per hectare of phosphorus, and 35 kilograms per hectare of potassium, all applied at seeding except for one half nitrogen at tillering. Fertilizer recommendations were calculated on the basis of soil analysis, and a single general recommendation was made to cover the entire wheat growing area. As of late 1976, few fertilizer trials had been conducted. In addition to the application of fertilizer, INIAP recommended the control of weeds with applications of the herbicide 2-4D. Recommendations were also made regarding land preparation, timing and density of planting, and harvesting (see Exhibit 7).

Although the package of recommended agronomic practices which accompanied the improved varieties was compiled and published by the wheat program, the individual recommendations were formulated by the corresponding functional departments within INIAP. For instance, recommendations for fertilizer application were developed by the Soils Department and those for weed control by the Weed Control Department.

In the process of developing its recommendations, each department held all nonexperimental variables constant at "optimal" levels while verifying the experimental variable. In the course of developing fertilizer recommendations, for example, the Soils Department employed optimal levels of land preparation and insect and weed control, while varying fertilizer applications to determine which level of fertilizer application produced the highest wheat yield.

Seed Production

Within the Ecuadorian Wheat Program, the INIAP Seed Production Department and the Cooperative Seed Enterprise (CSE), a semipublic enterprise, were responsible for the multiplication and distribution of the seed of improved INIAP varieties. In the first stage of multiplication, the Seed Production Department of INIAP obtained limited quantities of breeder seed of a new variety from which it produced foundation seed. The foundation seed was subsequently delivered to the Cooperative Seed Enterprise, which in turn produced certified seed in conformity with the certification standards of the Ministry of Agriculture. The INIAP Seed Producton Department produced foundation seed of wheat, maize, barley, oats, and pasture grass.

The Cooperative Seed Enterprise was an autonomous, self-financed institution. The capital contribution of the CSE was composed of 79% state contributions and 21% private. The CSE was created in 1973 and was responsible for the production of certified seed for wheat, barley, oats, maize, rice, and beans. In 1974, the CSE produced 1,800 tons of wheat seed, of which 30% was "certified" and 70% "selected." Selected seed was produced from certified seed which had been cultivated by farmers and then subjected to a further selection in the field, keeping different varieties seperate.

Seed multiplication was performed by selected farmers under constant technical supervision regarding land preparation; the application of fertilizer, pesticides, and herbicides; and cultural practices. The participating farmers received a bonus of 15% over the commercial price of grain.

Once the grain had been classified as suitable for seed, it was sent to the processing plants which cleaned, graded, and disinfected the grain to produce certified seed. In 1974, the CSE had 14 distribution outlets for seed which were warehouses of the Ministry of Agriculture and of the

National Development Bank. The farmer obtained certified seed in three different ways: direct purchase from the CSE warehouses, as part of an agricultural loan authorized by the National Development Bank, and by means of a production subsidy for wheat, part of which could be received in the form of certified seed.

Extension

To complement INIAP's research and seed production effort, the National Grain Program, which was affiliated with the Ministry of Agriculture, was responsible for extension work in grains. The National Grain Program (NGP) provided technical assistance to wheat growers and helped foster the adoption of new wheat varieties and recommended practices (Exhibit 8).

The extension service of the National Grain Program was staffed by production agronomists, but it was often difficult for the NGP to hire and retain skilled production agronomists due, among other considerations, to restrictions on salary levels. Although it was difficult to assess the effectiveness of extension efforts, there was some concern that extension had not been utilized optimally to promote the adoption of new varieties and recommended practices.

WHEAT IN ECUADOR

National Production

During the crop year 1965-1966, 63,844 hectares were sown in wheat, producing a total of 60,520 tons, an average yield of 948 kilograms per hectare. By the 1974-1975 crop year, the wheat area had declined by 12% to 56,354 hectares, while national production fell 25% to 45,647 tons, with an average yield of 810 kilograms per hectare (Exhibit 9).

Farmers in the Sierra cultivated wheat as part of a flexible rotation which could include barley, maize, and potatoes. Wheat was typically sown during November-January and harvested in July-August. Barley, sown in November-February, was harvested in June-October. Maize was usually planted in September-October and harvested in June-July. Potatoes could be planted at various times during the year and harvested six months later.

Farmers normally planted wheat after potatoes to take advantage of the residual fertilizer, heavily applied to the potato crop. Wheat had the additional advantage of being able to withstand colder temperatures than either maize or potatoes.

From 1965 to 1975, barley production in the Sierra had declined by 30%; potato production had increased by 38%; and maize production had stayed the same (Exhibit 10). Costs, yields, and farm-gate prices associated with the commercial production of wheat, barley, maize (soft), and potatoes are shown in Exhibits 11 and 12.

Of 633,000 agricultural properties identified in the 1968 agricultural census, 407,000 (74.3%) were smaller than five hectares. These 407,000 farm units accounted for only 10% of the total area. Within this group, the average farm size was 0.68 hectares, the percentage of all farm units in the country that contained 10 hectares or less was 85%.

The trends from 1970-71 to 1974-75 in size of plots cultivated in wheat can be seen in Exhibit 13. Over the four-year period the number of wheat plots increased by 5%, while the average size of the plots decreased by 30%.

Production Systems

The National Grain Program identified three principal systems employed by Ecuadorian farmers to cultivate wheat: nonmechanized (which comprised 65% of the area cultivated in wheat); semimechanized (which comprised 25%), and mechanized (which comprised 10%). The three systems varied according to methods of land preparation, planting, cultural practices, and harvesting.

In the nonmechanized system, land preparation was performed with a team of oxen and involved an initial aeration of the soil with an iron-tipped wood plow followed by one or two passes with a spike-toothed harrow. Planting then was performed, followed immediately by fertilization, both by hand-broadcasting. The seeds were covered by one pass of the oxen-pulled harrow. Weed control in the nonmechanized system involved either hand weeding or an application of herbicide using a backpack sprayer. Finally, the wheat was harvested manually and transported by oxen cart to the threshing room where it was threshed by a stationary thresher.

The semimechanized system of production substituted tractor power for oxen and employed insecticides and certified seed. The mechanized system entailed mechanized planting, fertilization, herbicide application, and harvesting.

Based on 1975 prices of wheat and inputs in Ecuador, the net income per hectare of the nonmechanized, semimechanized, and mechanized systems was US$51.60, US$192.00, and US$368.70, respectively (Exhibit 14).

Adoption of Improved Technology

Fertilizer. Approximately 40% of the total area planted in wheat was fertilized during the period 1970-1975, although the average quantities of nutrients applied per hectare were very low. The most frequently used fertilizers were the compound fertilizers 10-30-10, 10-40-10, and 8-24-8. The average application on fertilized plots during the 1970-1975 period was 150 kilograms per hectare, or the equivalent of 15 kilograms of nitrogen, 45 kilograms of phosphorus, and 15 kilograms of potassium (Exhibit 15).

Fertilizer use tended to be more prevalent on larger wheat plots. Although only 50% of all wheat was sown on plots greater than 10 hectares in the 1973-74 and 1974-75 crop cycles, 80% of the wheat area fertilized was on plots of 10 hectares or more (Exhibit 16).

The risks associated with fertilizer use in Ecuador were considerable because of annual climatic variations. In 1964-1965, for example, due to a very irregular rainfall pattern, wheat yields dropped sharply, averaging 0.75 tons per hectare. In 1960-1970, an excessive and prolonged rainy period caused yield to drop to 0.90 tons per hectare.

Seed. The establishment of the Cooperative Seed Enterprise helped to increase the area sown with certified wheat seed from 3,522 hectares in 1973-1974 to 4,209 hectares in 1974-1975. Nevertheless, the use of certified wheat seed in the period 1970-1975 had declined as a percentage of total wheat sown, from 13.4% in 1970-1971 to 7.5% in 1974-1975. In the 1974-1975 agricultural year, only 1.5% of the wheat sown in plots of 10 hectares or less used certified seed (Exhibit 17).

Plant protection. During the crop cycles 1973-1974 and 1974-1975, approximately 5% of the wheat sown received herbicide treatments. During the same year less than 2% received insecticide treatments (Exhibit 18).

Mechanization. With the exception of threshing, the operations in cultivating wheat were by and large performed by hand and with animal power (Exhibit 14). However, given the current cost of mechanization versus hand labor and/or animal power, it was projected that mechanization would become more prevalent.

Agricultural Credit

The National Development Bank (BNF[3]) was the principal source of agricultural credit in Ecuador. Of the total US$159.5 million credit which was extended to the agricultural sector in Ecuador during 1974, 70% (the equivalent of US$111 million) was provided by BNF. It was expected that the equivalent of approximately US$146 million would be loaned by BNF in the sector in 1976 and that 60% of this credit would be short term. The other 40% would be medium- and long-term credit, principally for permanent crops, cattle, and machinery, etc. Although a fairly close relationship existed between INIAP and BNF, both agencies expressed a desire to improve coordination in the future, so that the results of INIAP research could better complement and support the credit provided by BNF.

Agricultural credit extended by the private sector in Ecuador represented less than 8.5% of the total portfolio of the private banking sector. Private agricultural loans were short-term, primarily providing working capital for harvesting and other cash-consuming operations.

Beginning with the crop cycle 1972-1973, the BNF, in accordance with government plans to promote production of basic foodstuffs, increased by over 470% its loans to wheat producers. Credit was extended in money and in kind and was issued through 50 branches and distributing agencies throughout the country. Credit in kind consisted of agro-chemical products as well as agricultural machinery. In 1976, 1,007 loans were extended to wheat producers; the total value of these loans was US$1.2 million.

Loans for wheat production were extended by means of a supervised credit system designed to meet the needs of small farmers and institutions serving the small farmers. The loan was administered in three stages: 40% for land preparation and planting, 40% for cultural practices, and 20% for harvest and transport to market. The BNF also offered technical assistance to its clients.

Domestic Wheat Marketing

Of the 46,000 tons of wheat produced in Ecuador in the crop year 1974/75, 40,000 tons were used for human consumption, 5,000 tons for seed, and 1,000 tons were lost to spoilage. Of the 40,000 tons for human consumption, 13,000 were consumed directly on farm while 27,000 were sold to millers for processing into flour (see Exhibit 19).

During the 1976-77 crop season, the National Grain Program (NGP) was responsible for supervising the commercialization of grain. During the wheat harvest, the NGP assigned a quality control engineer to each of Ecuador's 23 flour mills to ensure that the mills were paying for wheat in accordance with official quality standards. To receive the government support price of 200 sucres[4] per quintal,[5] grain had to meet the following standards: a weight of 75 kilograms per hectoliter,[6] with a

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(3) Banco National de Fomento.

(4) 1 sucre equals approximately US$0.037.

(5) 1 quintal = 100 pounds = 45.45 kilograms.

(6) 1 hectoliter = 100 liters.

moisture content of less than 14% and no more than 1% impurities. Producers were penalized 2.90 sucres per quintal for each unit shortfall in hectolitric weight and 2.80 sucres per quintal for each percent of excess humidity. When discounted for quality, the average price recorded at the mills in 1975-1976 was approximately 192 sucres per quintal.

Of the 27,000 tons of nationally produced wheat which was eventually sold to flour mills, farmers sold 60% directly to the mills, 30% to large intermediaries, 8% to small intermediaries and 2% was traded in local markets for other goods. Small intermediaries generally sold to larger intermediaries who in turn sold to mills.

Since most small wheat farmers in Ecuador typically did not have transportation facilities to transport their production of 5 to 20 quintals, they sold at the farm-gate to intermediaries, large and small, at a discount of at least 5 to 10 sucres per quintal below the government guaranteed price. However, intermediaries were widely believed to use scales which short-weighted the farmer by 10%. Thus an intermediary's margins on one quintal would be 5 to 10 sucres plus 5 kilograms (worth approximately 4 sucres per kilogram) for a total of 25 to 30 sucres per quintal purchased.

Subsidy to Producers

Commencing with the 1973-74 crop cycle, in addition to the official government price of 200 sucres per quintal, the government of Ecuador offered a subsidy to wheat producers of 50 sucres per quintal (US$44.00 per ton). The subsidy took the form of certificates which could be exchanged to purchase fertilizer and certified wheat seed. The certificates were awarded upon the delivery of wheat to the mill. For each quintal of wheat delivered, suppliers received two certificates: one worth 30 sucres toward the purchase of fertilizer from BNF and one worth 20 sucres toward the purchase of seed from the Cooperative Seed Enterprise. The subsidy scheme was initiated in part to help the BNF dispose of the sizable fertilizer reserves it had built up during 1972 and 1973, when it overbought in the face of predicted higher prices and future fertilizer shortages.

Wheat Consumption

In recent years, consumption of most agricultural products within Ecuador has experienced significant growth. The increase in wheat consumption was particularly significant during the period 1962-1972. Although the annual population growth during this period averaged 3.4%, the annual growth of wheat consumption was 7%. Four factors contributed toward making wheat one of the basic foodstuffs of the Ecuadorian diet, with an average per capita consumption in 1976 of approximately 39 kilograms per year: a positive and high income elasticity for wheat (approximately 0.60); increasing per capita income; low, stable prices for wheat since the early 1960s; and increasing urbanization fueled by rural migration (Exhibit 19).

Wheat flour was consumed primarily in the form of bread and noodles. Wheat consumed in Ecuador was milled domestically from a mixture of domestic and imported varieties. The relative percent of imported and domestic wheat which flour had to contain was set annually by the government according to the availability of domestic wheat and the domestic demand for flour. The percentage of domestic wheat production milled commercially had declined from 46.6% in 1969-70 to 17.7% in 1973-74. The relative mix of domestic and imported wheat used to produce flour also had changed substantially, from 47% domestic and 53% imported in 1969-70 to 15% domestic and 85% imported in 1973-74 (Exhibit 20).

Wheat Imports

Wheat imports to Ecuador had increased by 384% during the past decade, climbing from 59,000 tons in 1965-66 to 228,000 tons in 1975-76. Due to increasing prices for international wheat, the value of wheat imports had increased even more dramatically, climbing over 500% in the five-year period 1970 to 1975. Wheat imports totalled US$6.7 million dollars in 1970, climbing to US$37.1 million in 1976 (Exhibit 21). In 1975, Ecuador spent more on wheat imports than on all other food imports combined.

Subsidy for Imported Wheat

In October, 1973, the government initiated a policy aimed at subsidizing the price of imported wheat. The policy was aimed at protecting domestic consumers from the international wheat market's sharp price increases which had begun in late 1972 (Exhibit 22).

The subsidy called for a ceiling price on imported wheat of US$138 per ton (172.80 sucres per quintal). When the international price exceeded the ceiling price, the difference was paid by the national government.

From late 1973 to 1976, government subsidy payments for wheat imports totaled roughly US$40 million. Largely due to the subsidy for imported wheat, Ecuadorian millers and bakers were able to continue producing bread and noodles at government-controlled prices.

Government Goals for Wheat

In the General Development Plan for 1973-1977, the Ecuadorian government specified several national objectives involving wheat:

1) to increase domestic wheat production from 28% of total national wheat consumption in 1972-1973 to 60% in 1977-1978;

2) to expand the wheat area cultivated, primarily by reducing the area planted in barley and maize;

3) to utilize appropriate regions on the coast to cultivate wheat;

4) to increase wheat yields by the adoption of improved cultivation techniques, proper fertilization, weed control, and the use of improved varieties;

5) to increase the volume of agricultural loans and the speed at which they were processed;

6) to improve the marketing of wheat, circumventing the intermediaries and guaranteeing attractive prices to the farmers;

7) to orient technical assistance efforts toward the medium and small farmer.

To carry out the above-stated objectives, the government had proposed the development of a comprehensive national wheat production policy which would determine the appropriate zones for wheat production based on soil studies, meteorological data, land tenancy patterns, and other socioeconomic factors related to wheat production.

In addition to offering plans and policy guidelines, the government proposed the following concrete measures to provide institutional support for improved wheat production:

1) Within its Cereal Research Program, INIAP was to give special priority to wheat research.

2) The National Grain Program was to orient its activities toward promoting wheat production, giving special attention to medium and small producers.

3) The Department of Seed Certification of the Ministry of Agriculture was to ensure that there would be an ample supply of certified wheat seed.

4) The National Bank for Development was to increase its loans for wheat production, modifying its loan procedures if necessary.

5) The Enterprise for Storing and Marketing Grains was to ensure that producers, upon harvesting their wheat, would be able to sell it for a guaranteed price.

INIAP's Directing Staff Drafts Recommendations

As the all-day session of the directing staff of INIAP drew to a close, Dr. Ampuero requested each member of the staff to draw up within the next two days specific recommendations for actions which INIAP might take to improve national wheat production. Dr. Ampuero solicited recommendations with regard to possible amplification or modification of INIAP's Wheat Research Program, additional forms of cooperation with national and regional institutions, and any other measures which would enable wheat research efforts at INIAP to have a greater impact on national wheat production.

Exhibit 1

NATIONAL WHEAT RESEARCH IN ECUADOR

Location of INIAP Research Programs by Experimental Station or Center

Programs	Santa Catalina	Pichilingue	Boliche	Portoviejo	Santo Domingo	Austro
African Palm					x	
Banana		x	x			
Cattle		x			x	
Cereals(1)	x			x		x
Cocoa		x				
Coffee		x				
Cotton			x	x		
Dairy Cattle	x	x				x
Legumes	x		x			
Maize	x			x		x
Oil Crops(2)		x	x	x		
Pasture Grass	x	x	x	x	x	x
Potato	x					x
Rice			x			
Sorghum				x		
Swine	x		x		x	
Vegetables	x					

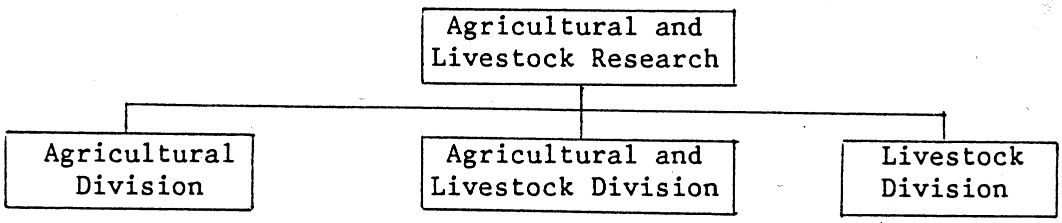
(1) Wheat, barley, oats, and triticale.
(2) Soybeans, groundnuts, sesame.

Source: INIAP Annual Report, 1977.

Exhibit 2

NATIONAL WHEAT RESEARCH IN ECUADOR

Organization of Research Activities in INIAP



Agricultural Division	Agricultural and Livestock Division	Livestock Division
<u>Breeding Programs</u>:	<u>Departments</u>:	<u>Breeding Programs</u>:
Wheat	Soils	Dairy Cattle
Barley	Entomology	Beef Cattle
Oats	Phytopathology	Swine
Maize	Quality	Pasture & Forages
Potato	Seed Production	
Legumes	Biometry	
Coffee	Weed Control	
Cocoa	Nutrition	
Rice	Agricultural Mechanization	
Cotton	Agricultural Economics	
Oil-Producing Crops		
Banana		

Source: INIAP Annual Report, 1977.

Exhibit 3
NATIONAL WHEAT RESEARCH IN ECUADOR

Climatic Conditions in the Ecuadorian Sierra

PROVINCE	CANTON	ALTITUDE	RAINFALL IN ML		TEMPERATURE DEGREES C		DRY MONTHS	
		metres	Annual mean	During dry period	Annual mean	In the driest month	No.	Months
CARCHI	Especjo (el Angel)	3,055	910.2	22.4	11.6	11.6	2	7 & 8
	Montufar (San Gabriel)	2,860	961.2	----	12.0	----	-	-----
	Tulcán	2,950	835.7	----	10.5	----	-	-----
IMBABURA	Ibarra	2,228	589.3	47.5	15.4	15.6	3	7 to 9
	Cotacachi	2,556	-----	----	----	----	-	------
	Antonio Ante (Atuntaqui)	2,350	782.7	27.4	15.4	15.6	2	7 & 8
	Otavalo	2,556	734.8	28.5	14.4	14.3	2	7 & 8
PICHINCHA	Quito (Tumbaco)	2,348	1,037.7	30.2	16.7	16.6	2	7 & 8
	P. Moncayo (Tabacundo)	2,960	880.1	32.9	13.0	12.9	2	7 & 8
	Cayambe (Ascázubi)	2,601	798.4	15.8	15.1	15.7	2	7 & 8
	Rumiñahui (Conocoto)	2,340	1,368.0	44.2	15.2	15.4	2	7 & 8
	Mejfa (Uyumbicho)	2,720	1,710.4	13.7	----	----	-	------
COTOPAXI	Lataeunga	2,796	469.7	46.7	13.0	12.6	3	7 to 9
	Salcedo	-----	-----	----	----	----	-	------
	Saquisilf	-----	-----	----	----	----	-	------
	Pangua (El Corazón)	1,500	2,267.9	38.6	17.7	17.9	2	7 & 8
	Pujilf	2,500	1,408.5	18.0	12.7	12.5	1	8
TUNGURAHUA	Ambato	2,540	435.6	86.9	12.6	13.0	4	2 & 7 to 9
	Pillaro	2,003	783.5	----	13.5	----	-	------
	Pelilco (Patate)	2,360	528.2	81.4	15.6	16.3	3	12 to 2
	Baños	1,043	1,309.7	----	16.7	----	-	------
CHIMBORAZO	Riobamba	2,796	406.8	70.7	13.4	13.9	4	1 & 7 to 9
	Guano	3,020	-----	----	----	----	-	------
	Guamote	3,020	575.0	36.5	13.7	12.8	2	7 & 8
	Colta	2,750	-----	----	----	----	-	------
	Chunchi	2,254	-----	----	----	----	-	------
	Alausf	2,356	428.4	98.5	14.7	15.5	5	5-7 & 9-12
BOLIVAR	San Miguel	2,700	1,443	24.1	13.0	12.7	2	7 & 8
	Guaranda	2,600	788	7.7	13.4	13.4	1	8
	Chimbo	-----	---	----	----	----	-	------
	Chillanes	2,309	899	71	13.3	13.4	5	6-9 & 11
CANAR		3,104	495.3	36.9	10.8	10.4	2	7 & 8
AZUAY	Cuenca (Ricaurte)	2,562	839.6	43.6	13.9	13.1	2	7 & 8
	Sta. Isabel	1,590	445.1	144.6	19.5	20.4	8	5 to 12
	Paute	2,209	719.5	-----	17.1	----	-	------

Source: Instituto Nacional de Meteorología (INAMHI), ten-year average.

Prepared by: Ing. Cesar Caceres R., Depto. Superv. y Estudios - DDA.

Exhibit 4

NATIONAL WHEAT RESEARCH IN ECUADOR

Wheat Production, Area Planted, and Yields by Province in Ecuador
1974 - 1975

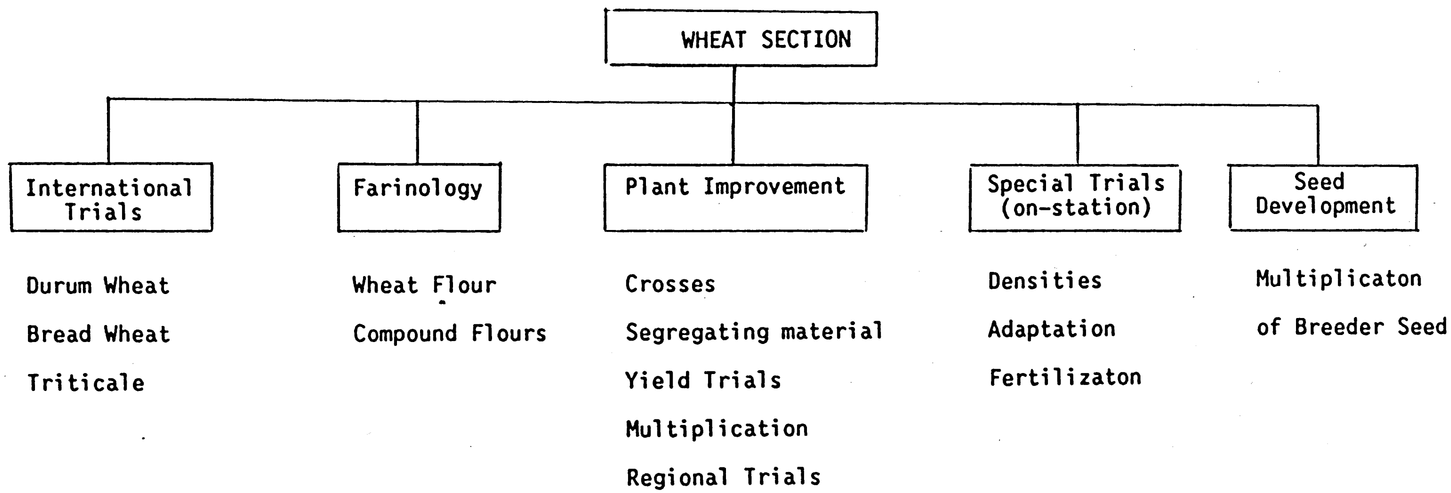
Province	Production (tons)	Area Planted	Yield (tons/hectare)
Carchi	2,328	2,136	1.09
Imbabura	5,593	4,780	1.17
Pichincha	9,343	7,474	1.25
Cotopaxi	1,627	1,643	0.99
Tungurahua	1,244	1,003	1.24
Chimborazo	9,628	11,067	0.87
Bolivar	13,941	13,803	1.01
Cañar	2,182	2,078	1.05
Azuay	2,731	3,331	0.82
Loja	6,314	8,769	0.72

Source: National Grain Program, National West Production Survey, Agricultural Year 1974-1975.

Exhibit 5

NATIONAL WHEAT RESEARCH IN ECUADOR

Organization of Wheat Research at INIAP



Source: INIAP, Annual Report, 1977.

Exhibit 6

NATIONAL WHEAT RESEARCH IN ECUADOR

Characteristics of Improved Wheat Varieties Released in Ecuador

Variety	Recommended Altitude(1)	Experimental Yields(2) (tons/ha)	Rust Susceptibility(2) Stripe	Leaf	Stem	Milling and Bread Making Characteristics
BONZA	2,000-2,800	2.3	medium	very low	very low	Good
CRESPO	1,400-2,800	3.2	med/low	very low	very low	Good
AMAZONAS	2,000-2,800	4.0	low	very low	very low	Good
ROMERO 73	2,000-2,900	4.0	very low	low	low	Good
RUMINAHUI	2,000-3,000	3.5	very low	very low	0	Good
CAYAMBE 73	2,800-3,200	4.0	0	0	very low	Good
ATACAZO	2,800-3,200	3.9	very low	very low	0	Good

(1) Meters above sea level.

(2) The yield and rust-resistance data have been taken at the median of the recommended altitude range.

Source: INIAP publication.

Exhibit 7

NATIONAL WHEAT RESEARCH IN ECUADOR

INIAP Fertilizer Recommendations for Wheat, 1975

I. Perform a soil analysis to determine the recommended quantities of fertilizer needed:

Interpretation of Soil Analysis	kilograms/hectare		
	N	P2OS	K20
Low	100	120	80
Medium	80	80	40
High	60	60	20

II. Apply all the recommended fertilizer with machine or broadcast planting. Incorporate the fertilizer into the soil with a disc harrow.

III. Additional nitrogen may be needed after application of the compound fertilizer to reach the recommended nitrogen level. If so, broadcast over the area 30 to 40 days after planting.

Exhibit 8

NATIONAL WHEAT RESEARCH IN ECUADOR

Technical Assistance for Wheat Production in Ecuador by Province
(1960 - 1976)

Year	Province	Wheat Plantings (hectares)	Sponsor	Number of Production Agronomists	Cost of Technical Assistance (Sucres/Wheat ha)
1960(1)	Bolivar		MAG(2)/BNF(3)	2	
	Pichincha		MAG/BNF	2	
	Imbabura		MAG/BNF	2	
	Chimborazo		MAG/BNF	2	
	Cañar		MAG/BNF	2	
	Loja		MAG/BNF	2	
			MAG/BNF	12	
1970	Bolivar	21,000	MAG	1	4
	Pichincha	9,000	MAG	3	30
	Imbabura	6,200	MAG	1	14
	Chimborazo	13,000	MAG	2	14
	Cañar	2,000	MAG	1	45
	Loja	5,000	MAG	2	36
		56,000	MAG	10	
1976	Bolivar	10,381	MAG	3	36
	Pichincha	6,716	MAG	7	131
	Imbabura	4,111	MAG	4	122
	Chimborazo	9,778	MAG	5	64
	Cañar	2,447	MAG	3	154
	Loja	8,944	MAG	5	78
		42,377	MAG	27	

(1) Regional data do not exist for 1960.

(2) MAG: Ministry of Agriculture.

(3) BNF: National Development Bank.

Exhibit 9

NATIONAL WHEAT RESEARCH IN ECUADOR

Wheat: Area Planted, Production and Yields in Ecuador
1960-1961 to 1975-1976 *

Year	Area Planted (hectares)	Production (tons)	Yield (kg/ha)
1960-61	60,824	57,683	949
1961-62	78,770	77,242	981
1962-63	70,863	66,520	939
1963-64	63,548	51,984	819
1964-65	62,555	48,667	780
1965-66	63,844	60,520	948
1966-67	65,064	62,727	965
1967-68	79,585	78,543	987
1968-69	79,389	82,340	1,044
1969-70	98,741	85,264	864
1970-71	75,722	81,033	1,070
1971-72	67,482	63,089	935
1972-73	56,047	50,633	904
1973-74	45,332	43,582	962
1974-75	56,354	45,647	810
1975-76	70,073	64,531	920

Source: Ministerio de Agricultura y Ganadería, Ecuador, 1977.

* Figures for area planted, production, and yield may vary somewhat in documents from different sources.

Exhibit 10

NATIONAL WHEAT RESEARCH IN ECUADOR

Harvested Area, Production and Yields of Wheat, Barley, Maize and Potato in the Highlands (by year)

	WHEAT			BARLEY			MAIZE[1]			POTATO		
	Area (ha)	Prod (ton)	Yield (t/ha)	Area (ha)	Prod (ton)	Yield (t/ha)	Area (ha)	Prod (ton)	Yield (t/ha)	Area (ha)	Prod (ton)	Yield (t/ha)
1965-66	63,844	66,583	1.04	157,035	79,524	0.50						
1966-67	65,004	69,000	1.06	143,215	91,770	0.64	225,565	120,536	0.57	44,360	390,371	8
1967-68	79,585	86,398	1.08	144,036	76,793	0.53	308,700	180,738	0.59	44,439	346,624	7
1968-69	79,399	91,201	1.14	135,031	81,322	0.60	225,200	102,700	0.46	47,965	398,609	8
1969-70	98,741	93,791	0.94	125,650	75,917	0.60	236,610	160,507	0.68	49,063	510,259	10
1970-71	75,722	89,722	1.17	133,920	109,990	0.82	236,980	196,410	0.83	41,517	456,686	11
1971-72	67,482	69,399	1.02	119,981	68,691	0.57	276,520	168,717	0.61	47,460	545,794	11
1972-73	56,047	55,697	0.99	113,957	73,387	0.61	173,185	100,695	0.69	53,601	630,740	12
1973-74	45,332	47,940	1.05	93,178	79,383	0.85	159,178	135,360	0.85	37,867	473,348	12
1974-75	56,087	60,363	1.07	60,844	56,148	0.92	150,630	122,337	0.81	43,484	539,198	12

Source: Estimation of harvested area and agricultural production in Ecuador, MAG., 1975.

(1) In the highlands, white maize is the most widely cultivated type.

Exhibit 11

NATIONAL WHEAT RESEARCH IN ECUADOR

Estimated Costs of Mechanized Production of Wheat, Barley, Soft Maize, and Potato, 1960, 1970, and 1975

Crop	Sucres per Hectare 1960	1970	1975
Wheat	1,637	3,019	7,836
Barley	1,538	2,734	7,041
Maize (soft)	3,394	5,029	8,695
Potato	10,740	14,652	25,567

Source: Diagnóstico para el Proyecto "Fomento de la Producción de Trigo en el Ecuador." INIAP, 1978.

Exhibit 12

NATIONAL WHEAT RESEARCH IN ECUADOR

Average Farm-gate Price for
Wheat, Barley, Maize (Soft), and Potato
1959-69, 1969-70, and 1974-75

Crop	Sucres per kilogram 1959-60	1969-70	1974-75
Wheat	2.00	2.20	3.83
Barley	0.93	1.10	3.30
Maize (Soft)	1.50	2.60	4.18
Potato	1.20	1.30	3.88

Source: Diagnóstico para el Proyecto "Fomento de la Producción de Trigo en el Ecuador." INIAP, 1978.

Exhibit 13

NATIONAL WHEAT RESEARCH IN ECUADOR

Changes in the Size Distribution of Wheat Plots in Ecuador
1970-1971 to 1974-1975

Plot Size ha	1970 - 1971		1971 - 1972		1973 - 1974		1974 - 1975	
	Number of Plots	Total Wheat Area	Number of Plots	Total Wheat Area	Number of Plots	Total Wheat Area	Number of Plots	Total Wheat Area
<10	24,550	30,490	22,160	26,800	23,160	22,429	26,730	25,914
10 - 20	3,240	11,948	3,830	11,534	1,900	4,505	2,724	7,050
20 - 50	1,534	8,567	1,750	9,594	860	4,192	1,526	7,479
50 - 100	297	4,219	287	4,420	270	3,069	271	3,584
100 - 500	396	11,277	321	8,529	288	6,306	271	6,657
500 - 1,000	70	3,709	61	3,100	38	1,719	53	2,428
>1,000	44	5,511	31	3,504	30	3,111	31	2,972
T o t a l	30,131	75,721	28,440	67,481	26,546	45,331	31,606	56,084

Source: National Wheat Commission: National Survey of Wheat Production.

Exhibit 14

NATIONAL WHEAT RESEARCH IN ECUADOR

Structure of Average Costs for Three Production Systems
(US $ per hectare)

Input	Non-Mechanized	System Semi-Mechanized	Mechanized
Labor	94.50	65.70	8.50
Machinery	13.80	43.80	72.40
Seed	16.50	22.00	22.00
Fertilizer	-	68.70	68.70
Herbicide	-	4.70	4.70
Total variable costs	124.80	204.90	176.30
Yield	800.00	1,800.00	2,200.00
Gross income	176.40	397.00	485.00
Net income	51.60	192.00	368.70
Net income/ variable costs	0.41	0.94	1.75

Exhibit 15

NATIONAL WHEAT RESEARCH IN ECUADOR

Fertilization of Wheat Production, 1970-71 to 1974-75

Year	Wheat Area Fertilized (hectares)	% of Total Wheat Area	Average Application(1) (kg/ha)
1970-71	35,618	47%	125
1971-72	26,340	40%	146
1973-74	15,143	33%	155
1974-75	19,809	35%	176

(1) Average taken of the fertilized areas only.

Source: National Wheat Production Survey; National Grains Program. INIAP, 1976.

Exhibit 16

NATIONAL WHEAT RESEARCH IN ECUADOR

Fertilizer Use by Plot Size 1973-1974 and 1974-1975 Production Cycles

Plot Size Hectares	1973 - 1974			1974 - 1975		
	Number of Plots	Amount of Fert.(MT)	Area (ha)	Number of Plots	Amount of Fert.(MT)	Area (ha)
T O T A L	2,952	2,348	15,143	8,489	3,490	19,809
< 10	2,150	304	3,034	6,780	319	2,811
10 to 20	260	120	1,235	832	172	1,825
20 to 50	200	159	1,223	421	170	2,058
50 to 100	111	201	1,639	189	432	2,654
100 to 500	185	904	4,431	197	1,163	5,578
500 to 1,000	23	236	1,114	42	514	1,986
>1,000	23	425	2,467	28	718	2,898

Source: National Survey of Wheat Production, National Grains Program, INIAP.

Exhibit 17

NATIONAL WHEAT RESEARCH IN ECUADOR

Utilization of Certified Seed, Total Wheat Area and Average Yield

Agricultural Year	1970-1971	1971-1972	1973-1974	1974-1975
Total Wheat Area	75,721	67,482	45,332	56,085
Certified Seed Area	10,135	5,989	3,522	4,209
Percentage	13.4	8.9	7.8	7.5
Yield (tons/ha)	1.07	0.94	0.96	0.98

Source: National Wheat Production Research, National Grains Program, INIAP.

Exhibit 18

NATIONAL WHEAT RESEARCH IN ECUADOR

Type of Crop and Use of Insecticides and Herbicides by Plot Size, Production Cycles 1973-74 and 1974-75

Plot Size hectares	Agricultural Cycle 1973-1974						
	Wheat (ha)	Mech. Land Prep.	Drilling	Mech. Harvest	Mech. Threshing	Insecticide	Herbicide
< 10	23,160	930	270	320	13,510	340	934
10 to 20	1,900	30	0	0	960	4	64
20 to 50	860	50	20	30	510	4	45
50 to 100	270	106	41	25	211	38	107
100 to 500	288	197	66	88	257	29	166
500 to 1,000	38	29	10	11	30	4	26
> 1,000	30	26	10	12	30	2	22
TOTAL	26,546	1,368	417	486	15,508	427	1,364

Plot Size Hectares	Agricultural Cycle 1974-1975						
	Wheat (ha)	Mech. Land	Drilling	Mech. Harvest	Mech. Threshing	Insecticide	Herbicide
< 10	26,730	0	0	0	2,430	392	1,030
10 to 20	2,724	3	1	0	203	10	220
20 to 50	1,526	12	1	1	64	10	31
50 to 100	271	112	24	24	226	69	167
100 to 500	271	178	64	88	208	59	169
500 to 1,000	53	44	16	26	51	5	42
> 1,000	31	27	9	21	30	11	26
TOTAL	31,606	376	115	160	3,212	556	1,735

Source: National Wheat Production Research, National Grains Program, INIAP.

Exhibit 19

NATIONAL WHEAT RESEARCH IN ECUADOR

Wheat Consumption in Ecuador, 1963-1977

Agricultural Year	Available National Production (metric tons)	%	Imports (metric tons)	%	Total Apparent Consumption (metric tons)	Per Capita Consumption (kilograms)
1963-64	42,611	44.3	53,533	55.7	96,144	20.82
1964-65	40,317	39.0	62,984	61.0	103,301	21.68
1965-66	49,845	45.9	58,635	54.1	108,480	22.02
1966-67	49,994	42.6	67,152	57.4	117,146	23.10
1967-68	65,361	51.6	61,069	48.4	126,430	24.15
1968-69	66,959	50.4	65,722	49.6	132,681	24.56
1969-70	72,381	50.8	70,026	49.2	142,407	25.54
1970-71	69,401	45.7	82,272	54.9	151,673	26.37
1971-72	53,554	36.6	92,519	63.4	146,073	24.07
1972-73	42,864	24.7	130,153	75.3	173,015	28.25
1973-74	34,628	20.8	131,324	79.2	165,952	26.26
1974-75	39,510	14.9	225,183	85.1	264,693	39.33

Source: Ministry of Agriculture, Ecuador, 1976.

Exhibit 20

NATIONAL WHEAT RESEARCH IN ECUADOR

Production of Wheat Flour in Ecuador, 1963-64 to 1975-76
(in metric tons)

Year	Mill Purchases of National Wheat	Wheat Imports	Wheat Processed	Flour Production
1963-64	37,042	53,533	89,571	66,593
1964-65	39,086	62,984	96,190	71,817
1965-66	41,360	58,635	103,419	75,701
1966-67	46,731	67,152	106,888	78,317
1967-68	53,684	61,069	116,515	85,802
1968-69	59,171	65,722	125,941	92,503
1969-70	61,158	70,026	128,113	93,610
1970-71	52,010	82,272	127,157	93,759
1971-72	39,182	92,519	134,713	99,999
1972-73	30,924	130,153	153,920	115,490
1973-74	28,705	131,324	153,450	115,903
1974-75	29,613	156,921	194,038	144,875
1975-76	26,689	225,183	224,514	171,034

Source: Ministry of Agriculture, Dirección de Comercialización y Empresas, 1976.

Exhibit 21

NATIONAL WHEAT RESEARCH IN ECUADOR

Value of Imported Wheat to Ecuador 1960-1976
(in US dollars)(1)

Year	Value CIF(2)
1960	3,300,900
1961	4,173,400
1962	2,893,100
1963	2,786,600
1964	4,916,000
1965	5,422,800
1966	5,413,300
1967	7,180,800
1968	6,509,600
1969	4,924,800
1970	6,662,800
1971	3,917,800
1972	9,901,400
1973	16,494,000
1974	6,317,500
1975	33,817,900
1976	37,057,800

(1) Original values in sucres. Exchange rates used to convert to US$: 1960 - 15.0 sucres/US$; 1961 - 16.5 sucres/US$; 1964 to 1967 - 18 sucres/US$. 1967-1976 - 22.00/US$; 1967 to 1976 - 22.0 sucres/US$.

(2) CIF = cost, insurance, freight.

Source: Anuario de Comercio Exterior: 1960 to 1975 - Import Permits Granted from 1976 to October 1977.

Exhibit 22

NATIONAL WHEAT RESEARCH IN ECUADOR

Price Average of Imported and National Wheat, 1965-1975

Year	Imported Price[1] (US$ per metric ton)	National Price[2] (US$ per metric ton)	Ratio of National Price over Imported Price
1965	81.90	94.40	1.15
1966	83.20	101.30	1.22
1967	84.50	103.00	1.22
1968	87.10	100.00	1.15
1969	82.00	104.00	1.27
1970	85.80	90.00	1.05
1971	113.10	93.40	0.83
1972	110.50	104.40	0.94
1973	180.70	163.70	0.91
1974	208.00	198.50	0.95
1975	210.60	220.00	1.04

(1) Price is CIF (cost, insurance and freight) Guayaquil, Ecuador plus 30% for handling and transport within Ecuador from Guayaquil to Mill.

(2) Price to Producer.

Source: International Trade Year Book, Ecuador, 1976.

Chapter 11

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

CIAT: THE CASSAVA PROGRAM (COLOMBIA):

A Management Commentary

"CIAT: The Cassava Program (Colombia)" reflects the strongest international perspective of any situation described in this volume. It underscores that the effective management of research often requires not only a national understanding but also regional and international perspectives.

The world cassava industry is complex. In Asia, cassava is generally converted into animal feed for export; in Africa, it is principally a human food; and in Latin America, cassava is both a human food and raw material for industrial processing. This diversity brings difficulties and opportunities, which need to be understood by an agricultural research manager if his decisions are to have the desired impact on the cassava production system.

Furthermore, goals differ among some of CIAT's major clients, the various national governments. For some, the primary goal of a national cassava program is to increase food supplies; for others, it is to increase farm incomes, especially among small- and medium-sized producers. For still others, it is to increase foreign exchange earnings. Client goals need to be monitored constantly, for they change. These changes have an impact on the structure of the commodity system and the functions of its various participants.

The vital benefits of a systems approach to agricultural research management emerge clearly from this chapter. A systems approach is a means for a manager of agricultural research activities to understand the changing goals of the participants in the system and the ways in which the participants are interrelated. This understanding is a prerequisite if research output is to have a significant influence on a system. Continuing surveillance of the system provides data needed for relevant decision making. In a well-functioning system, information is constantly flowing to and from each segment of the system.

The researchers at CIAT have limited direct contact with the ultimate targets of their research, the farmers. The more removed a research decision maker is from the ultimate targets, the more vital a systems perspective and the more important the linkages within a system, if the impact of research activity is to be maximized.

CIAT faces the challenge of being responsive both to the desires of donors, its principal sources of funds, and to national research programs, its principal clients. The goals of these groups are sometimes in conflict. CIAT keenly feels the pressures that exist within the world cassava commodity system to bring small farmers, some of whom are subsistence farmers, into the commercial system and, hence, to improve their standard of living. This goal reflects the dual commitments of many research programs to achieve both social and economic advances.

However, social impacts cannot be achieved without economic achievement. The opportunity for economic impact and, hence, social impact, is enhanced when there is a systems perspective and understanding of an industry.

In addition to underscoring the role and value of a systems approach to understanding a commodity system, this chapter presents a description of the Consultative Group on International Agricultural Research (CGIAR). This organization is a major coordinator of agricultural research around the world. It influences and is influenced by the world cassava industry and by other commodity systems of which it is a part.

The challenge of a particular commodity changes over time, and CIAT has evolved to meet this challenge. "CIAT: The Cassava Program (Colombia)" has become a classic case. It is the only case included in this volume not written by someone associated with ISNAR or the CGIAR. The case has proved its worth in numerous management training seminars, and the management issues presented in this case are as relevant today as they were in 1979. While many of the budgets and tables in the case study could be updated, the information that is presented is the data that were available to the decision makers presented in the case.

CIAT: THE CASSAVA PROGRAM (COLOMBIA):

A Case Study*

by Jo Froman
Ray A. Goldberg

It was an impressive sight: row upon row of slender branches and feathery foliage swaying gently in the tropical breeze, all cassava plants in an astonishing array of sizes, shapes, and verdant shades. As his gaze traveled down the rows of plants, some 20,000 in all, Dr. James Cock, Coordinator of the Cassava Program at CIAT (The International Center for Tropical Agriculture),(1) reflected on the progress of the past six years. There before his eyes was the world's largest cassava germplasm bank, over 2,500 varieties painstakingly collected from the cassava-growing areas of Latin America where cassava originated.

The collection of varieties, an ongoing process, was really just the beginning for Dr. Cock and his colleagues. It provided the raw material from which an interdisciplinary team of scientists had begun their efforts to improve cassava yields. For the past six years, this work had moved simultaneously in two directions: the improvement of germplasm through the development of high-yielding hybrid cassava varieties, and the improvement of yields of existing varieties by research into production techniques, commonly referred to as neutral practices.

Now, in August 1979, the program appeared to be on schedule. The first hybrid lines, after trials in Colombia, had been planted in regional field trials in other countries and would be harvested within the year. In the meantime, on-farm tests with nonimproved varieties selected from the germplasm bank have shown that farmers could double or triple their yields in many cases simply by following a series of cultural practices identified by CIAT, such as better seed selection and the use of disease-free material.

To those within CIAT, the results so far had been encouraging although it was clear that there were still serious problems to resolve. But to those on the outside who were critics of the international crop research centers, the process of transfer of new cassava technology appeared to be proceeding too slowly. They questioned why, after six years of research, small farmers were not yet benefiting from the breakthrough which had allowed cassava yielding as much as 80 tons per hectare to be grown under the optimal conditions at CIAT, when farmers in the rest of Colombia were getting yields of less than 10 tons per hectare.

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(1) The acronym is derived from Spanish: Centro Internacional de Agricultura Tropical.

Such questions were raised in the context of an atmosphere of public skepticism about the nature and purpose of the international crop research centers. The period from 1968 through 1974 had been something of a "golden age" for the centers, a time when journalists coined the phrase "Green Revolution" to describe the miracles which it appeared the centers had produced. But in a post-OPEC world, many of the parameters had changed, and it soon became clear that much of the benefit of the new varieties of rice and wheat had accrued to the urban consumer through lower prices and to the larger-scale, more efficient producer who could afford to purchase high-cost inputs. Often, the small farmer was left further behind by these advances because the technology was mainly used in large-scale production.

Much of CIAT's research had gone toward filling this gap. Two principal areas of crop research, beans and cassava, were small-farmer crops. The technology developed was purposely designed to be scale-neutral: if not biased toward the small farmer, then at least not biased away from him. But, except as part of its research process, CIAT did not work directly with farmers. That was the role of the national agricultural agencies in the countries which CIAT served, and lay beyond the mandate of the center itself.

It would be another three or four years before there was sufficient improved genetic material in the pipeline to begin wide-scale distribution through the countries' national agricultural extension agencies. In the meantime, each country had to adapt CIAT's technology package to its own ecosystem through testing on local experimental stations and on farms. It was in the transfer of technology at the national, not at the farm, level that CIAT had a major role to play. CIAT could influence the national programs through the training of their personnel and through assistance in their own research efforts, but it could not provide the critical direct link between research and farmer which would ultimately determine the outcome of the Cassava Program.

Yet attention was focused on the Cassava Program, initially because it symbolized within the international centers a new emphasis on small-farmer crops and low-input technology and, subsequently, because of concern that the new technology reach, and be used by, farmers as soon as possible. The Cassava Program came of age within CIAT just at a time when the whole international system of research centers was going through a period of intense soul-searching and when donors where beginning to reexamine their funding priorities. Significant changes had been made in the Cassava Program since its inception, and the process of refinement was still going on.

Now, just as the first fruits of six years' development were ready to be transferred into national research programs, Dr. Cock faced a dilemma. Four staff positions, which he saw as critical in the process of transferring technology to the national programs, had been cut out of the 1980-81 budget submission. This meant that the link between CIAT and the end-users of its technology would be even more difficult to forge. As his gaze drifted back to the field before him, Dr. Cock wondered what other options he might have to accomplish this task.

It was hard to believe that these innocuous-looking plants, stretching for hectare after green hectare, could be the source of so much controversy and interest outside the research centers. For Dr. Cock and CIAT, they represented both a substantial accomplishment and the focus for many issues about the goals, purpose, and organization of the network of international crop research centers of which he and CIAT were a part.

The International Network

There were 11 international agricultural research centers which concentrated on the development of tropical subsistence crops (Exhibits 1 and 2). Perhaps the most famous among the centers were the International Rice Research Institute (IRRI) and the International Maize and Wheat Improvement Center (Spanish acronym: CIMMYT), whose names were linked with the "miracle" wheat and rice discoveries of the 1960s. They were the pioneering institutions, set up originally under the auspices of the Ford and Rockefeller Foundations with a heavy emphasis on purely biological research. Subsequently, the centers had moved away from developing technology for irrigated farming with high purchased input levels toward research on plant types and technology packages appropriate to the production constraints typical of tropical subsistence farming. Social scientists, concerned with consumer behavior, social customs, demand constraints, and input costs, for example, had been added to the research teams in the centers.

Each center was an autonomous institution, governed by its own international board of trustees whose members were drawn from both the developed and developing countries. Besides research, the centers were concerned with training other research scientists and production specialists, primarily at the graduate level and above. They maintained close links with the national research programs of their host governments, as well as with universities and private research efforts in their regions. For crops for which they had global responsibility, the centers undertook outreach activities on a world-wide scale, sponsoring conferences, seminars, and short-term training programs, often in conjunction with their sister institutions in other regions. CIAT's activities, described below, were typical of those of other international crop research centers.

The funding for this international network was provided by the Consultative Group on International Agricultural Research (CGIAR), which was founded in 1971. Its sponsors were the Food and Agriculture Organization of the United Nations (FAO), the World Bank, and the United Nations Development Programme (UNDP). The CGIAR was an informal international consortium of donors which included governments, bilateral assistance agencies, private foundations, and regional development banks (Exhibit 3).

The CGIAR began operating in 1972 with 15 member-donors and $12 million to support the work of five international centers. In 1974, there were more than 30 donors and it was estimated that $100 million would be provided to the 11 centers currently in the CGIAR network.(2)

The CGIAR met once a year at the World Bank's headquarters in Washington, D.C., and held a second meeting each year at another site to review the work of the centers and their priorities for future research. Members allocated their own funds among centers, deciding which programs they wished to support and how much support to commit. The CGIAR's members were under no obligation to support all of the centers and there was no center which received support from all donors.

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(2) The 1986/87 Annual Report indicates that in 1986 more than 40 donors provided US$ 235.5 million to support 13 international centers.

Although each center was required to submit budgets for two years at a time, with projections for an additional two-year period (e.g., in 1979 centers submitted budgets for 1980-81, projections through 1983), appropriations were made on a yearly basis. This meant that there was always an element of uncertainty for plans projected more than a year into the future. In 1979, for the first time, there was a shortfall of funds for the system as a whole, which meant that some of the centers would be less certain of their funding in the future or would need to take a hard look at their current range of activities whenever new opportunities arose.

Advising the CGIAR was a group of 13 eminent scientists known as the Technical Advisory Committee (TAC). The TAC reviewed the work of each of the centers and considered matters, such as research priorities, the effectiveness of present research and training activities, and the merit of individual proposals which came to the CGIAR. Their recommendations influenced the allocation of funding among the centers.

The priorities for the international centers had shifted during the past eight years primarily because of two factors: in part as their funding had come under the United Nations umbrella and the compostion of donors had changed, and also the social and economic implications for small farmers of some of the early genetic breakthroughs of the "Green Revolution" had become more apparent. For many of the donor agencies, the measure of success of the centers was the degree to which their work was of benefit, potential or actual, to small farmers in the tropics. At the same time, there had been concern that the centers not usurp the role of national research and extension agencies in the countries and regions in which they operated. The mandate of the international centers had been clearly defined as one of working through these agencies and not directly with local farmers. This meant that while the centers were under pressure from their donors to get the fruits of their labor out to small farmers, they were not in control of the national programs which were the operational mechanisms for getting this task accomplished. Both the speed and effectiveness with which small farmers were reached depended entirely on the will and capabilities of the centers' client countries.

While considerable progress had been made in crop research over the past two decades, the gap between theoretical and actual national average yields for the major subsistence crops remained high (Exhibit 4). The challenge of the 1980s for the centers would be finding ways to help the countries they served to close this gap.

CIAT

In light of the priorities of donors and the new budgetary situation for the research center network, Dr. John Nickel, Director General of CIAT, had reason for concern about the tenor of recent internal commentary on the Cassava Program. It was the perception of some critics that the Cassava Program had failed to reach small farmers when, in fact, the program was not yet at the stage of being able to release genetic material to farmers except as part of the research/feedback process.

Dr. Nickel's job was complicated by the need to respond to criticism which directed his attention from the main task of keeping the center's programs on track. He also had to balance the priorities of donors with the needs of CIAT's clients which were the national research agencies, although at times these seemed to pull in opposite directions.

Arriving in CIAT in 1974, Dr. Nickel's tenure had corresponded to the period of soul-searching and redefinition of priorities which was going on throughout the network of international research centers. The organizational chart at CIAT had changed significantly over the past four years. Still, Dr Nickel wondered whether CIAT was organized properly to face the tasks ahead as each of its programs reached the stage at which dissemination of technology was critical. What, if anything, could CIAT do to influence national programs for the transfer of technology to small farmers? CIAT's options were limited by its mandate; it was still searching for an appropriate response within the context of its goals and structure.

Goals

CIAT's objectives were clearly defined in its 1979 budget publication. This Statement of Objectives addressed many of the issues which the international centers were facing in 1979.

Statement of Objectives

To generate and deliver, in collaboration with national institutions, improved technology which will contribute to increased production, productivity and quality of specific basic food commodities in the tropics -- principally countries of Latin America and the Caribbean -- thereby enabling producers and consumers, especially those with limited resources, to increase their purchasing power and improve their nutrition.

Major Features of the Statement

1) The product of CIAT's work is improved technology.

- While there are many other factors limiting production and productivity (for example, credit, markets, transportation, availability of purchased inputs, etc.), CIAT will concentrate its efforts on the generation and transfer of technology.

- The nature of this improved technology is characterized by the identification of the beneficiaries as the producers and consumers, expecially those with limited resources, i.e., the rural and urban poor.

  Consumers with limited resources must be able to increase their purchasing power; therefore, the new technology must not be such as will increase production at any cost, but at lower unit costs. In addition, the commodities chosen for CIAT's activities must be those which are important parts of the diets of lower-income consumers.

  Identification of the low-resource producer (the small farmer) as a special target means that the technology must be biologically feasible, economically viable, and socially acceptable under the real conditions of this group of producers. CIAT's minimum-input philosophy is meant to insure that resource-poor farmers will have access to the benefits of such technology.

- An intermediate product is implied, i.e., manpower trained in specific skills which will enable local institutions to adapt the product to specific local conditions and transfer it to the ultimate users.

2) The client for the product is identified as the national institution.

- This definition is made to dispel any misconceptions that CIAT has the responsibility or right to transfer technology directly to farmers. That function is a sovereign, national prerogative which cannot be usurped by an international institution. Moreover, the resources of an international center would not be adequate to work properly with individual farmers in its broad geographical area of responsibility.

- The fact that the national institution is the client also implies that CIAT should play an active role in the delivery of the product to national agencies. This means that CIAT's responsibilities do not end at its gate but in the local institution. The technology cannot really be considered appropriate until it has been validated at the farm level. CIAT must be involved in such trials but through its collaboration with national institutions.

3) The geographic scope of CIAT's activities is defined as the tropics, and specifically the tropics of Latin America.

- In general terms the tropics refers to the area between the Tropic of Capricorn and the Tropic of Cancer. This has different climates and altitudes, but shares the common advantage and related problems of a year-round growing season (where water is available) due to the absence of frosts.

- Specifications of the Latin American tropics as a working area recognizes that CIAT is basically a Latin American organization and has primary responsibility in the Western Hemisphere. The commodities it has selected to concentrate on were chosen because of their importance as basic foods in this region. Having decided to make a major effort on these commodities, global responsibilities have been assigned to CIAT within the framework of the international center network for two commodities: beans and cassava. Thus, CIAT has responsibilities and hopes to make an impact on production for these products outside of the Latin American region; nevertheless, its principal commitment is to the American tropics.

4) The functional scope of CIAT's work is shown to be related to increases in production, productivity, and quality of selected basic foods.

- Increased production is to be through improved technology both to bring new land into production and to increase productivity per unit of land area, manpower, and investment in existing production areas.

- Quality factors are not to be ignored. Consumer acceptance must be insured and improved nutritional objectives must be met.

- Post-harvest factors, such as processing, storage, utilization, and marketing, are included in the functional scope only as required when they clearly impinge on the successful adoption of improved production technology.

5) Human welfare concerns, as well as production goals, are emphasized.

- Increased productivity is only a means to achieve the basic purpose of human well-being as measured by increased purchasing power and improved nutrition.

6) CIAT's product is not viewed as a panacea.

- Improved technology developed at CIAT is envisioned as only contributing to increased production while recognizing the importance of other institutions and factors.

Programs

1) CIAT's work is centered at its 522-hectare farm and headquarters in the fertile tropical lowlands near Cali, Colombia. CIAT concentrates on the improvement of technology for four products: beef (through work in tropical pastures and forage crops), beans, cassava, and rice.

2) CIAT's activities can be divided into research and international cooperation. Research includes both crop improvement and outreach. In its outreach activities CIAT cooperates with national research programs in running regional field trials of varieties and production methods under development and in transferring genetic material to these agencies for later release. Outreach also includes running commodity-specific training courses and workshops for members of national research and extension services. As part of CIAT's outreach activities, postgraduate training in specific commodities is offered to a limited number of scientists.

3) International cooperation activities include the collection and dissemination of current scientific information concerning the crops within the center's purview; assistance to the training activities through the development and publication of manuals and audio-tutorial aids; and maintenance of contact with other international research centers, as well as with national research centers collaborating with CIAT in special programs.

4) CIAT's work is carried out by a staff of about 90 scientists, 150 other professionals, and over 800 administrative and support personnel.

Organization

1) CIAT is governed by a 17-member international Board of Trustees and is managed by a director general (Exhibit 5).

2) Formerly, the CIAT was organized more along functional lines, with economists working separately from the crop research programs in a special unit called the Economics Unit.

3) After 1975, this unit was disbanded and the economists were integrated into each crop's interdisciplinary research team.

4) As a result of this change, the inputs of the economists had increasingly become reflected in the setting of research parameters for the crop-improvement programs.

Funding

1) CIAT's funding is provided through the CGIAR system. A budget is prepared annually, looking ahead two years and projecting estimated financial needs for an additional two years. CIAT's sources and applications of funds for 1978 through 1983 and balance sheets for 1977 through 1981 are presented in Exhibits 6 and 7.

2) Expecting a shortfall in funds in the CGIAR system for the first time in 1980-81, CIAT's Board of Trustees decided to postpone the addition of seven new staff positions requested by the commodity programs. These were the regional services staff, three for the Bean Program and four for the Cassava Program, whose role was seen as critical to the next stage of CIAT's work. The rationale for these positions was outlined in the budget proposal:

> During the first years of its existence, CIAT had to concentrate on generating new technology and training national program personnel in research methodology. As new technology has become available, the responsibility has increased for coordinating international testing of new materials and management practices. With this responsibility has come the need for creating closer relationships with and between testing and transfer at the regional level.
>
> The outposting of regional services staff constitutes a principal means to achieve the objectives of technology testing and transfer to regional levels. Regional services staff are posted to strategic locations in order to serve regions in which a particular CIAT commodity is important. Their major role is to assist in the inter institutional transfer of CIAT-generated technology and to provide feedback into the research process, making them essential links in the technology-generation/technology-transfer continuum. Their activities relate chiefly to international commodity-testing networks and collaboration with national programs in the technology-generation, validation, and transfer process. In close collaboration with national programs in their respective regions, they conduct or encourage research on problems of special importance to that area. They expedite and help organize international nurseries and other collaborative trials in the region. They also assist in the selection of participants for training at CIAT and in the development of in-country training programs. While representing a key component in CIAT's outreach services strategies, they also fulfill an important inreach function by acting as a channel for essential feedback to their respective commodity programs.

3) The board accepted these positions as being in principle part of the core budget but, due to the current financial stringencies in the system, designated them as the "conditional core." This meant they could be filled during 1980-81 if special project funding above the core budget could be obtained.

4) This problem reflected a new reality for the international centers. They had grown up during a time of freely flowing funds, characterized both by flexibility and availability. Now, the centers would be forced to take a harder look at their priorities.

5) But clearly one of CIAT's top priorities for the next several years would be getting its technology into national programs as expeditiously as possible. Without the regional services personnel to oversee this process, Dr. Nickel needed an alternative strategy. How could CIAT organize itself for the task ahead? What other resources could it call upon? The evolution of the Cassava Program made these questions urgent.

THE CASSAVA PROGRAM

Cassava in the World Food System

Cassava was an energy staple in the diet of an estimated 300 to 500 million people living in tropical regions. A root crop, cassava ranked third after rice and maize as the most important food crop in the tropics in terms of dry matter produced. It was often the main source of income for small farmers and a staple in the diet of low-income consumers, providing 37% of the calorie requirement of Africa and 12% and 7% of Latin America and Asia, respectively (Exhibit 8).

Fourty percent of world cassava production came from Africa, 30% from Asia, and 30% from Latin America. World production was estimated at approximately 110 million tons of fresh roots in 1977 (or 35 million tons on a dry-matter basis). World production increased about 2.5% per year between 1961-65 and 1977 from a base of 76 million tons of fresh roots. During this same period, the area under cultivation rose from 9.9 million hectares to 12.6 million, with average yields rising only from 7.7 to 8.8 tons per hectare (Exhibit 9).

In Asia, production had been increasing at the rate of more than 4% per year, due primarily to increases in the area under cultivation. Thailand had shown a sixfold increase in area planted during the last 20 years and had become the world's largest exporter of dry cassava for use in animal feeds. Its major customer had been the European Economic Community. (Exhibit 10).

Nutritional Value

Cassava was 35% to 40% dry matter by weight, and 60% to 65% water. It was a rich source of carbohydrates with very little protein content. Though cassava was deficient in certain properties, its value as a carbohydrate source was of great importance. One of the causes of malnutrition in developing countries was insufficient calories for the body to utilize other nutrients, and cassava was an efficient producer of energy to supply that base. Furthermore, cassava lent itself well to double-cropping with protein-rich legumes (though double-cropping lowered yields somewhat for both crops).

One problem with cassava was its toxicity from cyanide compounds found in the fresh root. Where fresh cassava formed a major part of the diet and iodine deficiency also existed, as in some areas of Africa, chronic cyanide poisoning occurred. With proper handling and processing, however, cyanide could be reduced to safe levels. One of the criteria of cassava "quality" sought in CIAT's breeding program was low cyanide content.

Cassava was an efficient producer of energy on marginal land. Because it grew on infertile, acid soil without irrigation and needed only very minimal purchased inputs, cassava could be profitably produced on soil which would otherwise be unproductive, leaving better land to higher-value crops. Cassave yielded, on the average, three to four tons of dry material per hectare, per year. Were rice and maize to be grown under the same tropical unirrigated conditions with only one harvest per year, they would yield only one to two tons of dry material per hectare.

One use of cassava, which was under study, could hold great promise for the future. Cassava and other root crops could be converted into protein sources through a process of fermentation using microorganisms as fermentation agents. A biomass was produced which could be fed fresh or dried to be incorporated into animal feeds. It was not yet clear whether such a product would have a role in human nutrition in the future.

Cassava in Latin America

Each of the three regions where cassava was grown, Africa, Asia, and Latin America, presented different problems both for production and utilization. Generalizations about cassava production and/or marketing were difficult to make because techniques, customs, and consumer tastes varied widely. A look at the role of cassava in Latin America, however, would illustrate the way cassava production and utilization was organized in other areas of the world.(3)

While cassava was consumed throughout Latin America, it was a staple in only two countries, Brazil and Paraguay (Exhibit 11). Of all Latin American production, 92% came from three countries: Brazil, Colombia, and Paraguay (Exhibit 12). Because cassava was a highly adaptive crop and was capable of producing a high-calorie yield under a wide range of environmental conditions, economic considerations were the primary determinant of where the crop was grown. With the value of cassava in general very low relative to other crops (Exhibit 13), it had traditionally been grown on the most marginal land.

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(3) Dr. John Lynam, economist for the Cassava Program at CIAT, has done considerable analysis of cassava systems in Latin America. His article, "Options for Latin American Countries in the Development of Integrated Cassava Production Programs", Ch. 14, Development Studies Center Monograph No. 11, The Australian University, 1978, (pp. 213-256), forms the basis for this section of the case.

Almost half of the area planted to cassava in these three countries was on farms of under 10 hectares (Exhibit 14). Cassava production lent itself to small-scale farming due to the high labor content and low purchased inputs required (Exhibit 15). The largest component of labor was weeding (63%), a task hard to mechanize. The rest of the labor component was in preparation of land (29%) and harvesting (8%).

Because of its adaptability and resistance to adverse factors and other stress factors, cassava was a low-risk crop to grow. While average yields varied greatly from country to country, the year-to-year variation in any one area was around 25%; for beans, this variation in yields could be as high as 50% to 100% from one year to the next.

Despite its image as a subsistence crop, a farm survey in Colombia showed that 99% of cassava grown went to market. In an area where small farms predominated, 6% was retained for home consumption. In the largest production area of Brazil, a similar study showed that 11% of production was consumed on the farm.

While the production of cassava involved low risk, its post-harvest handling was very risky. Because cassava was highly perishable, most varieties began deteriorating within 48 hours of harvesting. At the same time, however, cassava could be "stored" in the ground for long periods. It could be harvested at any time between five and 18 months after planting. Because of its perishability and transportation difficulties due to its weight, cassava was marketed under a variety of arrangements.

The system which involved least risk to the farmer was to sell his crop to a middleman while it was still in the ground. The middleman arranged a marketing outlet and harvested the crop once that outlet was assured. In the Colombia farm sample, 30% of the farmers used this arrangement for marketing their crop. Another one-third harvested their own crop and then sold it to middlemen directly from their field. The final one-third harvested and transported their crop directly to market, but in general they did not carry it for long distances (Exhibit 16).

There were four distinct markets for cassava output: as human food, as animal feed, as an industrial starch, and for production of ethyl alcohol. Each market had different quality requirements, and in each, cassava competed against a different set of substitute products. The price at which cassava remained competitive with other crops depended on the price relationship in each of four separate markets; in other words, the demand for cassava was an aggregate of the individual markets for four separate end products. While no reliable data for overall consumption of cassava in Latin America was available, the data seemed to indicate that less than half of the cassava harvest was for human consumption. In 1971, FAO made the following estimates on the distribution of cassava consumption in Latin America:

Human consumption	38%
Animal feed	26%
Waste	20%
Industrial uses	16%

These data showed less cassava consumed as human food than was previously thought.

It was believed that the growth potential of cassava for human consumption was not large. Per capita consumption in the urban areas had always been lower than in the rural areas; as Latin American countries moved toward urbanization, per capita consumption of roots and tubers tended to decline. The best available estimates suggested that both income and price elasticities for cassava for human consumption were low, suggesting that population increases, not falling prices, would account for growth in future demand (Exhibit 17).

Brazil was the only Latin American country which exported cassava products and was the only country whose internal prices for cassava were even close to being competitive on the international market. The greatest export potential currently was for dry cassava as a component in animal feed. In 1973, it was estimated that to be competitive, prices for dried cassava c.i.f. European ports would have to be in the range of US $90 per ton, implying a fresh cassava price of roughly US $16 to US $22 per ton before processing and transportation costs. In order for Latin American cassava products to compete effectively in international markets, price levels would have to drop sharply. However, there was still a great potential for the use of cassava in domestic animal feed, releasing more cereals for human consumption.

There was little information on the utilization of cassava starch in Latin America except that virtually all was for domestic consumption, except in Brazil. Demand for cassava starch was derived from demand for the end products for which it was an ingredient, including soaps, clothing starch, and paper sizing. Entry into starch export markets would require more competitive prices.

In Brazil, cassava was considered to be the most promising source of biomass for conversion into alcohol. Alternative sources, sugar and sorghum, required better land than cassava and were somewhat less efficient. Brazil intended to replace 20% of domestic gasoline consumption with gasohol by 1980. This plan required an increase of between 50% and 100% in the area under cassava production.

The nature of the market for fresh cassava in Latin America offered potential for reducing costs to low-income urban consumers without reducing prices to producers. In Colombia, for example, margins of middlemen accounted for 50% to 80% of the price to consumers of fresh cassava (Exhibit 18). Such margins were justified by the risks middlemen took in handling an extremely perishable product and by the high unit cost of transporting a bulky product. Technologies for increasing the shelf life of fresh cassava or reducing its bulk would offer the opportunity to lower its price to urban markets without lowering the farm-gate price.

The importance of this point can best be appreciated by reference to Exhibit 28 which shows that 81% of Colombia's farmers had landholdings of less than 10 hectares and that these farmers devoted more of their land to cassava than to annual crops (Exhibit 19). If the improvement of cassava technology resulted in larger supplies than the market could absorb, prices would decline and production would shift to the more efficient farmers. If, on the other hand, the improved technology resulted in increased yields which could be utilized without a decline in price, a significant proportion of Colombia's farmers would be better off.

CIAT's Work in Cassava

Cassava yields in Latin America varied between national averages of 2 to 15 tons per hectare (Exhibit 20). CIAT estimates that with new cassava varieties and improved cultural practices, farmers, by 1982, would be able to achieve average yields of 20 tons per hectare under the worst soil conditions and of 40 tons per hectare under excellent conditions. It was also expected that by 1982 enough genetic material would have been transferred both to Latin America and Asia so that improved results would begin to show up in regional cassava production. This would mark the end of nine years of work by CIAT.

Several characteristics of cassava complicated the process of developing new varieties. Unlike beans, which had a growing cycle of three months under CIAT conditions, cassava generations took a year to produce. This meant that in six years, only six generations of cassava could be produced, in comparison with 24 generations of beans during the same time period. This made breeding a slow process.

Another complicating fact was that cassava was reproduced by vegetative propagation rather than from seed. Cassava "seed" is a stake, roughly one inch in diameter and six inches long, cut from a mature plant. The transfer of genetic material became difficult when it took 150 kilograms of stakes to produce the same number of plants which 10 kilograms of cereal seeds produce. Transporting such materials from one country to another was complicated not only by their weight and bulk, but also by quarantine restrictions imposed by many countries on the importation of vegetative plant materials (e.g., cuttings, as in the case of cassava); seeds moved freely.

It was in the context of these difficult problems that CIAT began its Cassava Program in 1971. The program became fully operational in 1973. Its objectives were:

1) To develop technology that did not require high levels of inputs for production of high yields of cassava. Particular emphasis was placed on developing technology for regions that had traditionally been considered unsuitable for crop production due to the low fertility of the soil and poor rainfall distribution.

2) To develop systems that could be used to reduce the perishability and facilitate transportation of cassava and to explore better methods of utilization.

3) To make the technology and new genetic material available to the local and national agencies and assist them in its transference to the producers.

Functionally, the Cassava Program was divided into three sections: (1) cassava improvement, concerned with developing and validating production technology; (2) utilization, concerned with processing and post-harvest technology; (3) outreach, concerned with the adaptation and transfer of technology to regional and national programs. Their work is described below.

1) Cassava Improvement

The development of improved germplasm was a slow process, requiring four to six years between the identification of suitable parents and field testing of their progeny (see Exhibit 21). Breeding, however, was critical. For a crop which was grown under a low-input technology, most of the improvement in yield would have to come from improved germplasm. The emphasis in breeding was on varieties which were disease and pest resistant, grew well on low-fertility soils, and produced high yields.

While the slow process of breeding was going on, scientists had been working on a technology package of improved cultural practices to enable farmers to increase yields by 50% to 150% with minimal purchased inputs, and using local or selected, and not hybrid, plant varieties. These practices included careful selection of planting material, treatment of stakes with an inexpensive fungicide (US$4 per hectare), planting an optimum population of plants per hectare (10,000 plants), planting in straight lines, control of weeds, biological control of pests by release of predators, and only for the most infertile soils, a minimum application of fertilizers. The technology packages developed were to some degree location specific and variety specific. As with new genetic material, production technology had to be tested and modified under actual farmer conditions at some stage in the development process.

There were three stages in the research process: (1) scientific research and technology development, (2) regional adaptation, or site-specific research, (3) farm-level adaptation. Stages two and three provided vital feedback to stage one (see Exhibit 22).

The development of cassava began with investigation into the existing production and marketing constraints. During the first three years of the program, genetic material (the germplasm bank) was collected, the goals of the research were defined, promising varieties were selected from among those collected, and work was begun simultaneously on the development of hybrids and cultural practices. It took four years from the time work was begun on a hybrid variety until it could be evaluated in replicated yield trials. Each step in the process required one year because of the long growing cycle of cassava: hybrid seed production, seedling selection, an observational yield trial at CIAT, and replicated yield trials under experimental conditions outside of CIAT. Thus, replicated yield trials conducted in 1978 were of hybridizations made during 1973. The replicated yield trials of 1977-78 were conducted at CIAT, Caribia, and Carimagua (a high-yield environment, a more representative cassava growing area, and a high-stress environment which lacked water and had acid soils, respectively).

Stage two in the research process was the testing of hybrids and selected varieties in regional trials. It was recognized that cassava varieties which performed well under the growing conditions of CIAT would not necessarily perform equally well under field conditions. Furthermore, there were regional and local preferences for different types of cassava which had to be met in order to market the end product profitably. At the same time, production methods would have to be varied to produce results under different climate and soil conditions. Therefore, CIAT tried to test the genetic material and production technology under a wide variety of environments as soon as possible in the research process. It took three growing cycles to produce results which might be taken as valid for local conditions. Each country had to go through this process before it could launch a major cassava improvement program of its own. Fortunately, regional trials could be carried out simultaneously with the latter stages of cassava research at CIAT. The primary constraint for beginning regional trials had been CIAT's ability to provide sufficient genetic material to interested countries. The development of a method for rapidly propagating cassava through tissue culture had greatly facilitated both the production and the transfer of genetic material to the national programs, but required a level of sophisticated handling at the other end which many countries did not yet possess. Regional trials were begun in Colombia in 1975 in association with the national agricultural service (see Exhibit 23 for results of these trials). By 1979, the first hybrid varieties were ready for international trials. These were hybrids from crosses made in 1973.

The third stage of the research process was on-farm validation, the testing of CIAT's technology under actual farmer conditions. There were three objectives for the on-farm trials: (1) to measure the productivity of improved cassava-production technology under actual farm conditions, (2) to define factors limiting cassava yields that might have been overlooked in designing technology at the research station, (3) to provide a preliminary assessment of potential constraints to adoption of the new technology.

A significant discovery was made during the first on-farm trials conducted at Media Luna in 1977-78. These trials did not involve the introduction of hybrid varieties, but rather five varieties selected from CIAT's germplasm bank for their wide adaptation and high-yield characteristics (Exhibit 24).

In defining the parameters of its genetic-improvement program, CIAT's scientists had chosen high yield as the characteristic for development. Yield was defined as dry material (starch) per hectare. After the Media Luna trials, it became apparent that it was not starch yield (tons per hectare) which was important, but starch content (percent starch per root). Local preferences as to cassava quality were related to its starch content, and the cassava produced by the varieties new to the region had to be sold at a large discount on the local market due to their unacceptability to consumers. After the Media Luna experience, more emphasis was placed on quality as part of the breeding program.

Because of CIAT's mandate to work only with national agencies, its work with small farmers was confined to this stage of the research process. On-farm validation in other countries had to be part of the national agencies' own research and adaptation process.

The experience of Media Luna illustrated one of the dilemmas facing CIAT's crop scientists. One question which had not yet been answered to their satisfaction, nor to the satisfaction of the economists, was at what stage should feedback from testing technology with farmers be incorporated into the research process. After Media Luna, CIAT was criticized as having failed to develop a product acceptable to farmers, criticism which could have been avoided had the quality consideration been understood earlier in the research process. But testing on the farm required the release of technology which was still in the process of being developed. As soon as technology was released for testing outside the research center, public interest was aroused and the technology was available for public scrutiny. If it failed, as it sometimes must in the early stages of development, the center was subject to criticism; worse, it might lose the confidence of its clients for later when the final research product was ready for dissemination. On the other hand, it was only through testing technology on farms that the center could learn how it was going to be received by its ultimate consumers and could incorporate necessary improvements in the research model.

While a research center could simulate the climatic and soil conditions of farmer plots, it could not simulate farmers' behavior, attitudes, and receptivity to change. Views on the role of farmers in the research process varied from involving them in the setting of research parameters in the earliest stages of the process to excluding them until the technology was fully developed, using on-farm validation as the final step.

2) Utilization

The utilization unit was added to the Cassava Program in 1979. It was an innovative step by CIAT to define its responsibility for crop research as extending beyond the development and transfer of germplasm. The rationale for this step is best summarized by John Lynam, the cassava economist:

> "The one conclusion that can be drawn from this brief analysis of demand for cassava is that any large expansion in the utilization of cassava in Latin America is heavily dependent upon a fall in the current price level, which is in turn dependent upon the availability of an improved cassava-production technology. The development of a lower-cost production technology is therefore a two-edged sword. On the one hand, new technology is necessary in order to provide the proper price incentives for development of growth markets for cassava products and, on the other hand, the extension of improved technologies without proper market development and market integration could produce a severe price depression with negative effects on producers and on the distribution of farm income, especially if increased supplies are absorbed only into the fresh food market. A post-harvest technology is necessary to insure that new cassava technology is not constrained by a limited market. It is at this point that technology design in cassava becomes even more crucial to the achievement of agricultural development goals in Latin America."[4]

Lynam cited two objectives for post-harvest technologies:

1) to provide an inexpensive but acceptable food source for urban consumption;
2) to insure that industrial processing of cassava was adaptable to small-farmer systems.

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(4) John Lynam, "Options for Latin American Countries in the Development of Integrated Cassava Production Programs," Ch. 14, Development Studies Center Monograph No. 11, The Australian University, 1978, pp. 213-256.

There were six uses of cassava in which various governments had expressed interest:

1) Starch production;
2) Dried or fresh cassava for animal feed;
3) Replacement of wheat flour with cassava for bread making;
4) Alcohol production;
5) Use of leaves as a forage or protein supplement;
6) Fermentation of cassava roots as a protein source.

Of these, 1, 3, and 4 were being adequately developed by the governments themselves or by commercial concerns. CIAT was working on simple technologies related to the rest.

The objectives of the utilization program are:

1) To develop simple technology for preserving fresh roots;

2) To develop simple sun-drying systems;

3) To evaluate cassava forage as an animal feed and develop integrated production/feeding systems;

4) To develop novel methods of cassava feeding, such as feeding fresh or ensiled cassava and high-protein products produced by fermentation.

Progress had been made in all of these areas. As with the rest of the program, the emphasis had been on low-cost methods which could be used economically at the farm or village level. Similar systems had been developed and used successfully in Africa and Asia. While there were still technical problems to be solved, the development of simple drying technology would allow farmers to dry their excess production for animal feed. This would essentially fix for cassava a minimum price, that is, the price at which it would be substituted for grains in balanced feeds.

Work was continuing on the investigation of the causes for rapid deterioration of cassava and several methods of preservation had been tested, such as treating roots with a fungicide and storing them in plastic bags. It was expected that simple storage methods would be developed and ready for commercial use. The goal was to find a way of preserving fresh cassava for up to two months after harvesting.

3) Outreach

The outreach unit was directly concerned with the transfer of CIAT's technology to the Cassava Program's counterparts in national agencies. CIAT identified three conditions which had to be met in order for its technology to have an impact:

1) National or local agencies become actively interested in CIAT commodities;

2) The national agencies develop technology to suit their conditions;

3) The national or local agencies transfer the technology to the producers.

It was up to the governments themselves to determine the priorities of their national programs. CIAT's role vis-a-vis the national programs, in the words of one scientist, was to "inform, wait, and assist." To date, the outreach unit had provided training in cassava technology to personnel from the national programs, and had assisted in the regional and international field trials (Exhibit 25).

There were fundamental questions related to the issue of technology transfer:

1) Where should CIAT transfer technology? Should CIAT concentrate its efforts only on those countries which already had advanced cassava systems and a high level of interest, or should it try to bring other countries up to this stage?

2) What technology should CIAT transfer? Should CIAT continue to concentrate its efforts on simple, low-cost technologies even as governments expressed interest in large-scale commercialization of cassava?

3) How should CIAT transfer its technology? CIAT had already trained 248 technicians, most at the level of graduate agronomists, in new cassava-production techniques. Was this the most appropriate level at which to train people? Were CIAT's resources being stretched too thin by trying to train people at this level? Was it better to train technicians at CIAT's center in Colombia or in their own countries where training could be adpated to local conditions?

While CIAT had no direct role beyond the transfer of technology to the national agencies, it could influence the character of national programs through the people it trained. Given that the impetus and leadership for such programs came from senior decision makers, would it be better for CIAT to work with PhDs and visiting scientists in its training efforts than with extensionists? If there were more CIAT-trained senior scientists in the national programs, would the need for regional services staff be reduced?

CIAT had been very successful in working with the National Coffee Federation of Colombia, a private industry group which was actively promoting commercial cassava production as part of its crop-diversification program. Should CIAT be more involved in transferring its technology to private groups?

CIAT needed to move quickly in helping countries to develop their cassava programs. Once a national program began testing new varieties, it would be at least three years before the genetic material could be delivered to farmers on a wide scale. Now in its sixth year and poised to move into outreach in a major way, the Cassava Program needed a new strategy for the task ahead.

CIAT's Dilemma

Dr. Lynam identified three objectives for the implementation of cassava programs in Latin America:

1) An increase in the productivity of cassava producers and therefore, farm incomes, particularly at the level of the small- to medium-size producer;

2) Increasing food supplies, thereby either maintaining or reducing the price to the consumer;

3) Generating foreign exchange, either by reducing food (or petroleum) imports or by increasing exports.

To date, four Latin American countries had expressed a strong interest in cassava production and were ready to undertake major programs: Brazil, Colombia, Cuba, and Mexico. None of them explicitly addressed the issue of small-farmer income. Brazil was concerned primarily with the third objective in its intention to cut down oil imports. In Colombia, where fresh cassava was consumed as a high-prestige food in urban areas, the immediate concern was with objective (2) and, for the long term, with commercial use of cassava in alcohol production, industrial utilization and animal-feed compounding. In Cuba, the government had just imported 60,000 seedlings as part of a major program to encourage large-scale production of cassava on state farms for both human and animal consumption. In Mexico, the concern was with both (2) and (3); cereal imports were currently at five million tons per year and rising. Substitution of cassava for cereals in animal feeds would either reduce the level of these imports or would allow more grains to be channeled into human consumption without further negative impact on the balance of payments. The question was what impact these programs would have on the small producer.

CIAT began the Cassava Program with the intention of developing a technology which would be of benefit to small- and medium-scale producers. Cassava seemed ideally suited to this purpose because of its low risk and prevalence among small landholders. Now, because CIAT's work had been successful, commercial and industrial exploitation of cassava on a large scale was beginning to appear attractive for the first time. This potential had drawn the interest of several governments and had led to the initiation of major programs.

Without the commercial development of cassava for industrial uses, it was unlikely that a sufficient level of demand could be sustained in Latin American countries to provide long-term price incentives and stability to producers. On the other hand, such development would not work to the advantage of small producers unless governments adopted strategies which specifically addressed their needs.

A cassava strategy which sought to benefit small landholders would require significant expenditures both of financial and manpower resources on extension work, marketing and logistic infrastructure, credit schemes, and small-scale regional processing facilities. It was easier for governments to work with a few large producers who had access to private credit sources and did not require intensive management input from public agencies.

The private sector also would have a major role in determining the agro-industrial structure of a cassava system in these countries.

If processing facilities were large scale, the need for throughput would encourage the establishment of large, mechanized plantations, rather than dependence on a dispersed, smallholder source of supply.

These two decisions -- scale of technology and source of supply -- would have a major impact on small cassava producers in Latin America. Whether that impact was positive or negative was largely within the power of the national programs to determine.

Yet in some sense, CIAT would be held accountable both by its donors and the public at large for the outcome of the national programs. Did this mean that CIAT should try to influence the governments to bias their strategies toward protecting the welfare of small farmers? If so, what influence could the center bring to bear? Where did the responsibility for new technology end? Was it the obligation, or even the right, of the international centers to choose the beneficiaries of their technology?

As Dr. Nickel and his colleague worked to define their strategy for the task ahead, these were the difficult issues which they faced.

Exhibit 1

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

The Thirteen CGIAR Research Centers

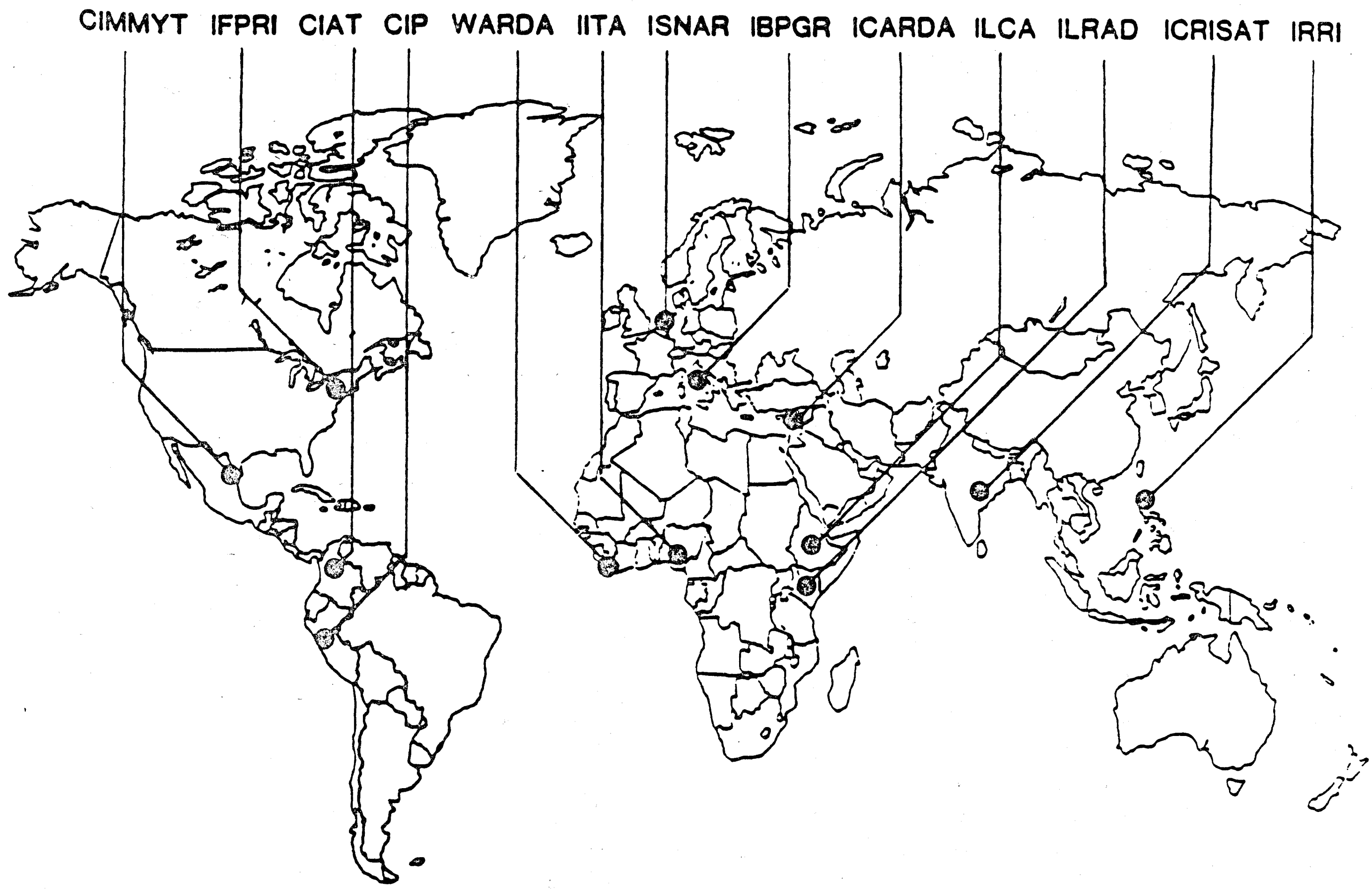


Exhibit 2

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Program of the Thirteen CGIAR Centers

Center	Acronym	Joined CGIAR	Program
International Rice Research Institute, Los Baños, Philippines.	IRRI	1960	Rice, multiple cropping.
Centro Internacional de Mejoramiento de Maiz y Trigo (International Maize and Wheat Improvement Center) Mexico, D.F., Mexico.	CIMMYT	1966	Wheat, maize, barley, triticale.
Centro Internacional de Agricultura Tropical (International Center for Tropical Agriculture) Cali, Colombia.	CIAT	1967	Beans, cassava, beef and forages, maize, rice, and swine.
International Institute of Tropical Agriculture, Ibadan, Nigeria.	IITA	1968	Maize, rice, cowpeas, soybeans, lima beans, cassava, yams, sweet potatoes, and farming systems.
Centro Internacional de la Papa (International Potato Center) Lima, Peru.	CIP	1971	Potatoes.
International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, India.	ICRISAT	1972	Sorghum, millet, peanuts, chickpeas, pigeon peas.
International Laboratory for Research on Animal Diseases, Nairobi, Kenya.	ILRAD	1973	Blood diseases of cattle.
International Livestock Center for Africa, Addis Ababa, Ethiopia.	ILCA	1974	Cattle production.
West Africa Rice Development Association, Monrovia, Liberia.	WARDA	1974	Rice.
International Board for Plant Genetic Resources, Rome, Italy.	IBPGR	1974	Coordinate collection and exchange of plant genetic materials.
International Food Policy Research Institute, Washington, DC, USA.	IFPRI	1975	Economic & political issues surrounding food production, distribution and the international food trade.
International Center for Agricultural Research in the Dry Areas, Beirut, Lebanon.	ICARDA	1976	Wheat, barley, lentils, broad beans, oilseeds, cotton, and sheep farming.
International Service for National Agricultural Research, The Hague, The Netherlands.	ISNAR	1980	Responds to requests from developing countries for assistance in strengthening their national agricultural research programs.

Exhibit 3

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Members of the Consultative Group on International Agricultural Research in 1979

SPONSORS

The Food and Agriculture Organization of the United Nations (FAO).
The World Bank (IBRD).
The United Nations Development Programme (UNDP).

DONORS

Governments

Australia
Belgium
Canada (CIDA)
Denmark
France
The Federal Republic of Germany
Iran
Italy
Japan
The Netherlands
New Zealand
Nigeria
Norway
Saudi Arabia
Sweden
Switzerland
The United Kingdom
The United States (AID)

Private Foundations

The Ford Foundation
The Kellogg Foundation
The Rockefeller Foundation

Regional Development Banks

African Development Bank
Asian Development Bank
Inter-American Development Bank (BID)

Others

The Commission of the European Communities
The International Development Research Center (IDRC), Canada

Exhibit 4

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Crop Yields:
World Record vs. Highest National Average

Crop	Yield (tons per hectare) World record(*)	Highest national average(**)
Wheat	14.5	5.4
Rice	14.4	6.1
Maize	21.2	8.0
Sorghum	21.5	4.3
Barley	11.4	4.6
Soybeans	7.4	2.0
Potatoes	94.1	39.8
Cassava	60.0	17.9

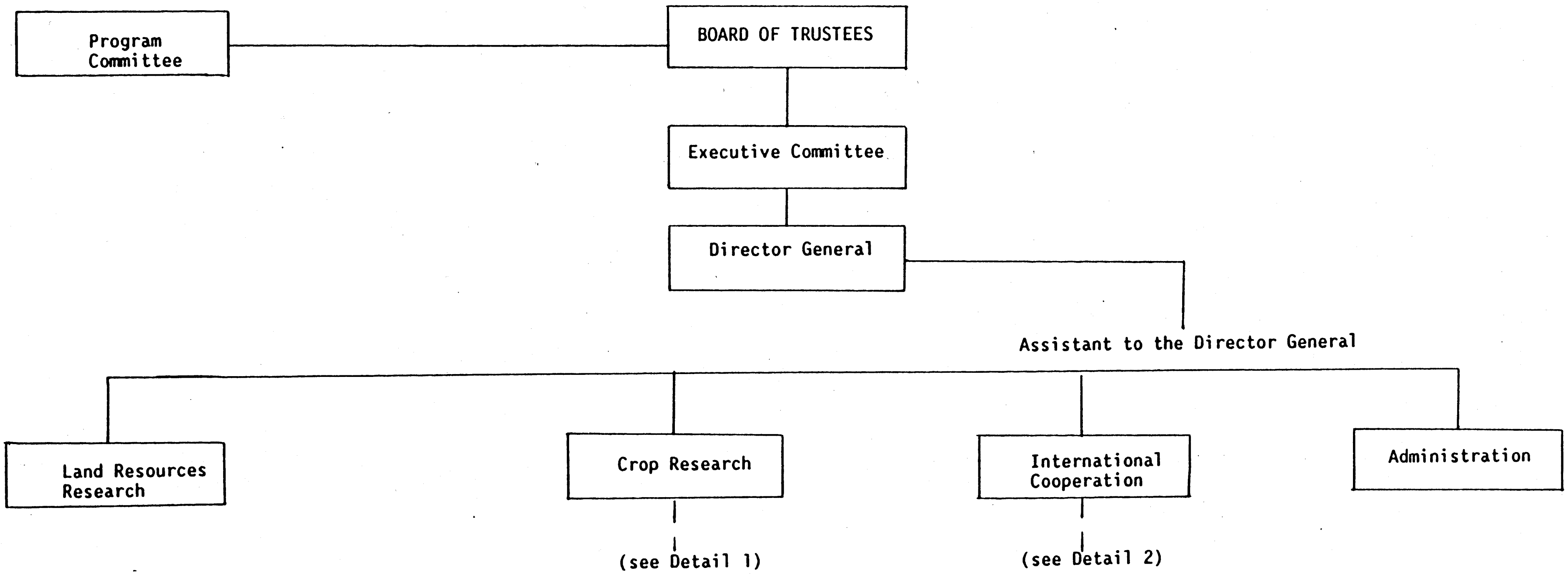
Sources: (*) Marylin Chou et al., World Food Prospects and Agricultural Potential (New York: Praeger, 1977).

(**) 1974-1977 average, FAO.

Exhibit 5

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Organizational Structure of CIAT - 1979



Source: CIAT.

(continued)

Exhibit 5 (continued) CIAT: The Cassava Program (Colombia) Detail 1: Crops Research

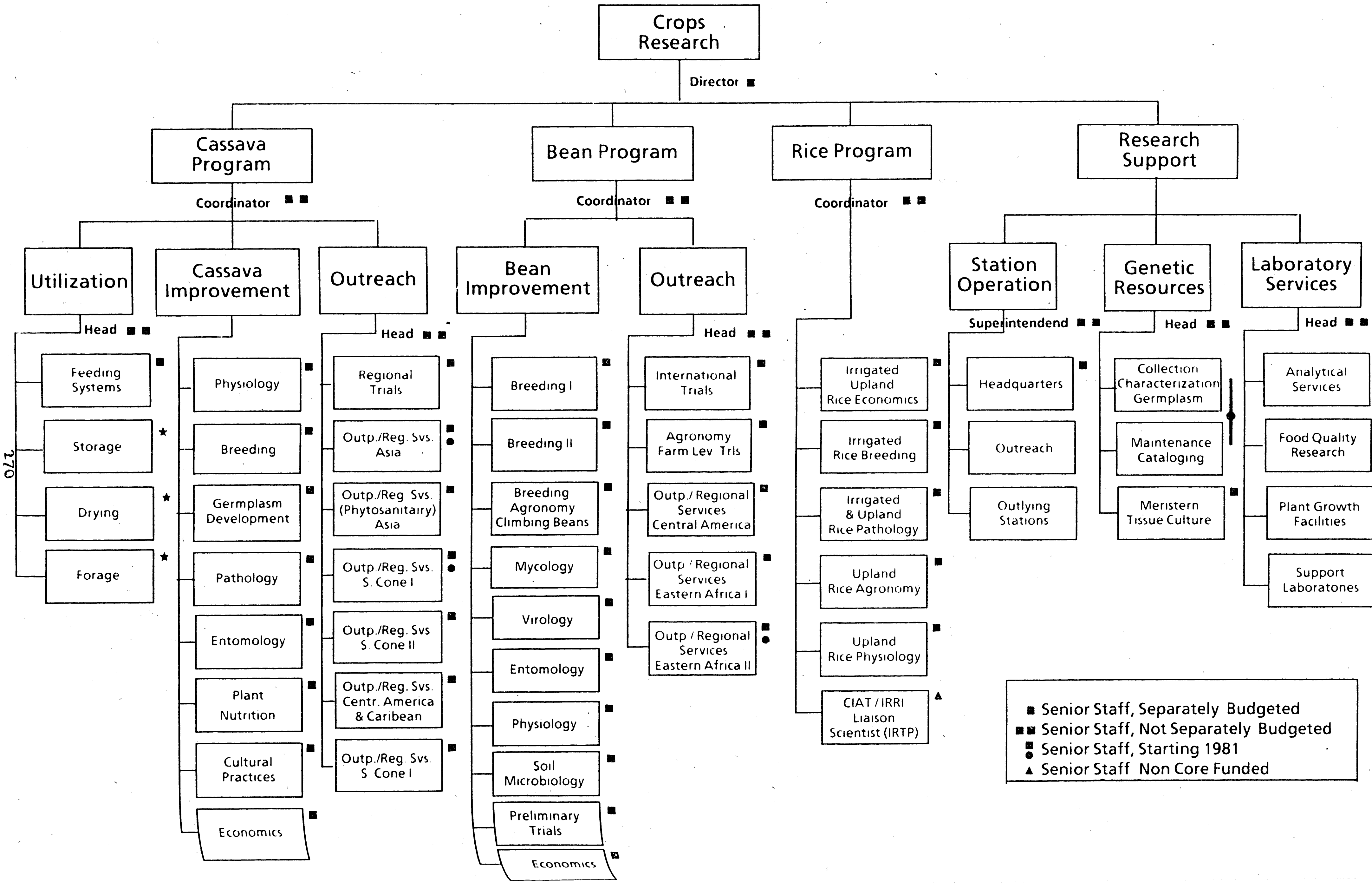


Exhibit 5 (continued)
CIAT - THE CASSAVA PROGRAM (COLOMBIA)
Detail 2: International Cooperation

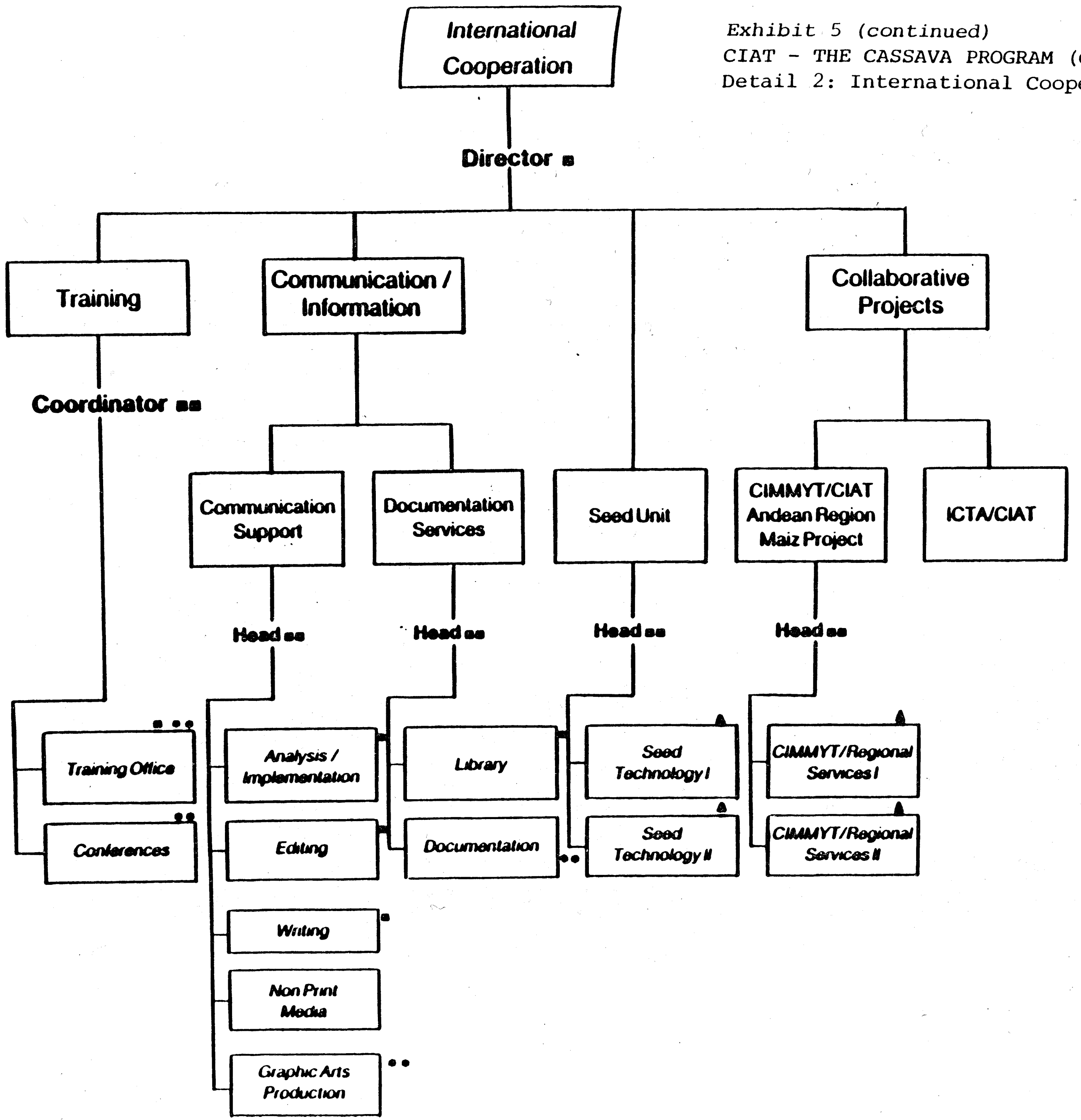


Exhibit 6

CIAT: THE CASSAVA PROGRAM

Centro Internacional de Agricultura Tropical
Summary of Sources and Applications of Funds
(in thousands US$)

	BUDGET		
SOURCES OF FUNDS	1978[a]	1979	Total
Core Operations			
Unrestricted			
Australia	182	185	367
Belgium	157	185	342
Canada (CIDA)	982	980	1962
European Economic Community		1070	1070
Ford Foundation	200	150	350
Germany (Federal Republic)	1096	1060	2156
Interamerican Dev. Bank	2400	2650	5050
Int. Devel. Assoc. (World Bank)	202	250	452
Japan	200	400	600
Netherlands	200	250	450
Norway	207	210	417
Rockefeller Foundation	300	300	600
Switzerland	228	300	528
United Kingdom	353	415	768
United States (AID)	2600	3300	5900
Unidentified Sources		432	432
Balance from previous payment		82	
Income applied in year	432	400	832
SUBTOTAL	9739	12619	22276
Restricted			
Kellog Foundation	320		320
TOTAL CORE OPERATING FUNDS	10059	12619	22596
Capital			
Inter-American Development Bank	235		235
Int. Dev. Assoc. (World Bank)	620	917	1537
Unidentified Sources		21	21
Balance from Previous Period	1689	763	1689
Balance of Working Funds	700	800	700
Other	31		31
TOTAL CAPITAL FUNDS	3275	2501	4213
Special Projects			
Belgium	52	28	80
CIMMYT (CIDA)	126	85	211
Ford Foundation		5	5
Germany (CTZ)	72	30	101
Inter-American Development Bank	34	41	75
IBPGR	25		25
Int. Dev. Research Centre	229	236	465
Int. Fertilizer Dev. Centre	41	100	141
Int. Rice Research Institute	99	100	199
Rockefeller Foundation	(13)	32	19
Switzerland	637	593	1230
United Kingdom	(18)		(18)
U.N. Dev. Program	721	600	1321
United States (AID)	104	130	234
Other	(1)		(1)
Unidentified Sources			
Balance from Previous Period	351	1152	351
TOTAL SPECIAL PROJECTS	2458	3132	4438
TOTAL FUNDS	15792	18252	31247

(continued)

Exhibit 6 (continued)

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Centro Internacional de Agricultura Tropical
Summary of Sources and Applications of Funds

	BUDGET		
APPLICATIONS OF FUNDS	1978[a]	1979	Total
Core Operations	9977	12619[b]	22596
Capital	1712	1551	3263
Special Projects	1306	2332	3638
Unexpended Balances			
Unrestricted Core	82		
Capital	763		
Working Funds	800	950	950
Special Projects	1152	800	800
SUBTOTAL	2797	1750	1750
TOTAL APPLICATIONS	15792	18252	31247
Memo:			
1. Total Core Operating Funds Required	10059	12619	22678
Less Unexpended Balance Previous Period		(82)	(82)
Less Earned Income Applied Current Year	(432)	(400)	(832)
Net Core Operating Funds Required	9627	12137	21764
2. Total Capital Funds Required	3244	2501	4182
Less Unexpected Balance Previous Period	(1689)	(763)	(1689)
Less Balance of Working Funds	(700)	(800)	(700)
Net Capital Funds Required	855	938	1793
3. Total Funds Required from Donors	10482	13075	23557
4. Total Earned Income	432	400	832
Applied to Core Operations	(350)	(482)	(832)
Applied to Capital	-	-	-
Balance carried forward	82	(82)	-

(a) Figures are actual for 1978.

(b) The 1979 Core Operations Budget has been increased by the 182,000 underspent in 1978.

Note: While more recent budgets are available, these are the sums that were available to the decision makers presented in this case.

Exhibit 7

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Centro Internacional de Agricultura Tropical
Summary Financial Data 1977 - 1981
(US$ Thousands)

	Actual 1977	Actual 1978	Original 1979	Revised 1979	Budget 1980	Budget 1981
Current Assets						
Cash	2481	3540	600	1500	1900	2300
Receivable from Donors	288	93	700	500	500	500
Receivable from Employees	91	92	70	100	120	130
Receivable from Others	1091	992	500	1000	1100	1200
Inventories	549	678	350	650	700	750
Prepaid Expenses	10	9	30	10	10	10
TOTAL CURRENT ASSETS	4510	5404	2250	3760	4330	4890
Fixed Assets						
Research Equipment	2104	2450				
Aircraft		664				
Vehicles	1110	1649				
Furnishings & Office Equipment	1103	1177				
Buildings	4954	5616				
Other	69	160				
TOTAL FIXED ASSETS	9340	11716	12626	13267	13894	14369
TOTAL ASSETS	13850	17120	14876	17027	18224	19259
Liabilities						
Bank Loan		650		450	200	
Bank Overdrafts		182		500	500	500
Accounts Payable	1542	1702	700	1374	2000	2200
Grants Received in Advance	228	667	300	350	324	614
TOTAL LIABILITIES	1770	3201	1000	2674	3024	3314
Fund Balances						
Invested in Fixed Assets	9340	11716	12626	13267	13894	14369
Unexpended Funds:						
Core Unrestricted		82				
Working Fund Grants	700	206	950	286	606	876
Capital Grants	1689	763				
Special Projects	351	1152	300	800	700	700
TOTAL FUND BALANCES	2080	13919	13876	14353	15200	15945
TOTAL LIABILITIES AND FUND BALANCES	13850	17120	14876	17027	18224	19259

Note: While more recent budgets are available, these are the sums that were available to the decision makers presented in this case.

Exhibit 8

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Human Intake of Cassava in 14 Countries
Sample Year

	Human population (millions)	Cassava as total caloric intake	Cal/day from cassava	Cassava intake per year (kg)
Congo (Brazzaville)	0.84	54.8	1184	470
Zaïre	15.63	58.5	1193	437
Central African Rep.	1.33	48.7	1057	354
Gabon	0.46	47.0	1027	342
Mozambique	6.96	42.6	908	304
Angola	5.15	34.5	659	220
Liberia	1.08	26.2	600	201
Togo	1.64	26.5	590	197
Benin	2.36	20.1	438	148
Paraguay	2.03	19.7	540	181
Ghana	8.14	18.2	380	130
Brazil	80.77	10.8	274	107
Nigeria	58.48	14.1	306	103
Indonesia	105.74	15.3	269	92
Total	304.15	-	-	-
Weighted avg.	-	19.4	374	124

Source: FAO Food Balance Sheets, 1964-66.

Exhibit 9

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

World Production of Cassava, 1973 and 1975
(million tons)

	1973	1975 Total	1975 Percent world product
Africa	41.2	44.0	42
Angola	1.6 [a]	1.6 [a]	2
Burundi*	3.3	4.1 [a]	4
Central African Empire*	1.1 [a]	1.1 [a]	1
Ghana	1.7 [a]	1.8 [a]	2
Madagascar	1.2	1.4 [a]	1
Mozambique	2.5 [a]	2.3 [a]	2
Nigeria	9.6 [a]	10.0 [a]	10
Sudan*	1.1	1.1 [a]	1
Tanzania*	3.4 [a]	3.6 [a]	3
Uganda*	1.2 [a]	1.0 [a]	1
Zaire	8.6	9.1	9
Others	5.9	6.9	6
North & Central America	0.7	0.8	1
South America	30.6	31.4	30
Brazil	26.6	27.2	26
Colombia	1.3 [b]	1.3 [b]	1
Paraguay	1.1	1.1 [a]	1
Others	1.6	1.8	2
Asia	27.0	28.8	27
India	6.4	6.3	6
Indonesia	11.2	13.0	12
Thailand	0.4	6.4	6
Others	9.0	3.1	3
Oceania	0.2	0.2	-
World Total	99.7	105.2	100
Least developed countries	12.2	13.3	13

Source: FAO, Production Yearbook, vol. 29, 1975, and estimates.
* Least developed countries.
(a) FAO estimate.
(b) Unofficial figure.

Exhibit 10

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Summary of World Trade in Cassava Products, 1962 - 1976

REGION		NET EXPORTS 1962-64	NET EXPORTS 1972-74	NET EXPORTS 1976		NET IMPORTS 1962-64	NET IMPORTS 1972-74	NET IMPORTS 1976
		THOUSAND TONS - FRESH ROOT EQUIVALENT						
LATIN AMERICA		210	157	166		-	-	-
	BRAZIL	200	151	160		-	-	-
AFRICA		140	206	115		-	1	-
ASIA		2,170	5,870	11,047		150	517	505
	INDONESIA	280	818	830		-	-	-
	MALAYASIA	80	94	100		-	2	-
	THAILAND	1,710	4,958	10,117		-	-	-
	JAPAN	-	-	-		110	305	305
NORTH AMERICA		-	-	-		824	820	850
	U.S.A.	-	-	-		812	800	830
EUROPE		-	-	-		1,520	4,935	8,180
	E.E.C.	-	-	-		1,504	4,928	8,160
WORLD TOTAL		2,520	6,261	11,328 (1)		2,496	6,273	9,535

(1) Divergence between exports and imports due to end of year shipments from Thailand.

Source: FAO, "Cassava: Supply, Demand and Trade Projections, 1985," Rome, June 1978.

Exhibit 11

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Consumption of Cassava, on a per capita, fresh-weight basis, in Latin America, 1964-66

Country	Production per capita (kg/year)	Consumption * per capita (kg/year)	Calories per day	Cassava as % of Minimum Calorie Requirement ***
Paraguay	722.2	180.8	540	23.4
Brazil	298.3	104.9	274	11.5
Ecuador	22.5	14.6	41	1.8
Colombia	43.2	25.9	74	3.2
Bolivia	39.9	25.9	74	3.1
Dominican Republic	43.2	28.0	82	3.6
Peru	41.0	29.6	88	3.7
Haïti	26.6	23.2	69	3.1
Cuba	26.3	21.8	65	2.8
Panama	16.0	11.1	35	1.5
Venezuela	33.9	25.4	68	2.8
Guyana	15.8	14.2	41	1.8
Honduras	11.2	10.6	31	1.4
Argentina	11.0	4.6	12	0.5
Jamaica	5.0	3.3	11	0.5
Nicaragua	8.5	8.1	21	0.9
Costa Rica	6.9	6.2	17	0.9
El Salvador	3.3	3.0	8	0.3
Puerto Rico	2.2	1.9	6	0.3
Guatemala	1.2	1.1	3	0.1
Latin America **	139.4	53.2	158	6.6

* Direct human consumption. The discrepancy between per capita production and consumption is due to differences in wastage and utilization as animal feed, and in industrial uses.

** Also includes Mexico, Uraguay, Chile, and Trinidad and Tobago.

*** Calculated on the basis of minimum calorie requirement given in "Monthly Bulletin of Agricultural Economics and Statistics," no. 4, vol. 26, August 1977, FAO, Rome.

<u>Source</u>: FAO (1971).

Exhibit 12

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Per Capita and Total Production of Cassava for Latin American Countries, 1963-65 and 1973-75

Country	1973-75	1963-65		1973-75	
	Per Capita Production (kg)	Total production (1000 MT)	% of Total	Total production (1000 MT)	% of Total
Paraguay	446.3	1,230	4.8	1,117	3.6
Brazil	245.4	23,866	85.6	25,986	84.2
French Guiana	69.0	6	0	4	0
Ecuador	56.8	215	0.8	396	1.3
Colombia	54.3	733	2.6	1,353	4.4
Bolivia	45.2	143	0.5	233	0.8
Dominican Republic	35.0	153	0.5	169	0.5
Peru	31.6	461	1.7	479	1.6
Haïti	28.7	111	0.4	144	0.5
Cuba	25.2	180	0.6	234	0.8
Panama	24.7	19	0.1	40	0.1
Venezuela	24.5	318	1.1	301	1.0
Guyana	17.7	10	0	14	0
Honduras	14.2	24	0.1	44	0.1
Argentina	10.2	244	0.9	261	0.8
Jamaica	9.4	9	0	19	0.1
Guadalupe	8.6	5	0	3	0
Martinique	8.4	3	0	3	0
Nicaragua	8.2	13	0	18	0
Costa Rica	5.2	10	0	10	0
Trinidad and Tobago	5.2	4	0	5	0
Surinam	4.9	2	0	2	0
Barbados	4.1	1	0	1	0
El Salvador	3.7	9	0	15	0
Puerto Rico	1.7	6	0	5	0
Guatemala	1.2	5	0	7	0
Total	126.4	27,870	100.0	30,863	100.0

Source: FAO (1973 and 1976).

MT = metric ton.

Exhibit 13

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Prices Received by South American Producers of Cassava and Price Indices for Selected Crops

Country	Price of Cassava (US$/MT)	Price Indices *			
		Potatoes	Paddy Rice	Wheat	Maize
Argentina	24.3	95	270	177	166
Bolivia	36.6	175	198	230	320
Brazil	9.5	555	698	1147	350
Colombia	49.7	141	209	231	148
Ecuador	36.0	172	217	267	244
Paraguay	21.4	445	334	371	265
Peru	31.8	194	401	365	275
Venezuela	55.3	210	224	181	123
South America**	12.7	380	581	478	324

* Price indices based on cassava price in each country equal to 100.

** Prices weighted by production.

MT = Metric ton.

Source: FAO (1972:11-94).

Exhibit 14

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Distribution of Area Planted to Cassava by Farm Size

Country	Less than 10 ha (percentage)	10-49 ha (percentage)	50 ha and larger (percentage)
Brazil	45.7%	33.3	21.0
Paraguay	52.3%	32.6	15.1
Colombia	41.2%	44.2	14.6

<u>Sources:</u> Fundaçao Instituto Brasileiro de Geografía e Estatística (1973); International Bank for Reconstruction and Development (1976); DANE (1970).

Exhibit 15

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Characteristics of Cassava Production Systems in Colombia, 1973-75

		ZONES					
	Unit	I	II	III	IV	V	Average
Farm size	hectare	6.1	39.1	11.1	59.4	18.3	26.9
Utilizable land	hectare	4.1	38.1	5.4	45.9	15.2	21.9
Area in crops	hectare	3.4	24.7	3.4	11.6	7.0	10.4
Area in cassava	hectare	2.8	6.9	2.0	9.5	4.0	5.1
Area in pasture	hectare	0.7	13.4	2.0	34.3	8.2	11.5
Total labor utilization per farm	man-days	105.4	81.2	82.1	65.4	90.8	85.2
Per cent of farmers using mechanized land preparation		0.0%	76.6%	3.4%	76.4%	54.5%	41.3%
Variable cost per farm	Colombian Pesos	3068	5019	3954	4096	3543	3968
	US Dollars*	98.33	160.86	126.72	131.27	113.55	127.17
Purchased inputs as per cent of variable cost		10%	12%	4%	8%	5%	8%

* Colombian Pesos converted to US$ by case writer using 1975 average market rate (31.202/US$).

Source: Calculated from R.O. Diaz and Pinstrup-Andersen (1977), as presented in John K. Lynam, "Options for Latin American Countries in the Development of Integrated Cassava Production Programs," Development Studies Center Monograph, 11 (1978), The Australian National University.

Case writer note: Key to zones

	Agro-climatic characteristics	Farm size
Zone I	mountainous region	small
Zone II	rolling, commercial farming area	medium to large
Zone III	mountainous region	small
Zone IV	"new land" expansion, acid-soil savanna region	medium to large
Zone V	lowland coastal area	small

Exhibit 16

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Marketing Patterns for Cassava in Colombia: Percentage of Farmers, by Zones According to Type of Selling Place and End Utilization of Cassava

	Agricultural Zones				
	I	II	III	IV	V
Selling place					
In the field before harvest	41	76	0	27	0
In the field after harvest	28	9	53	2	89
Local market	20	2	39	7	9
Major urban market	8	13	3	60	0
End utilization					
Sales for:					
Human consumption	46	100	95	96	75
Processing	51	0	0	0	23
No sales	3	0	5	4	2

Source: Diaz and Pinstrup-Andersen (1977), as presented in John K. Lynam, "Options for Latin American Countries in the Development of Integrated Cassava Production Programs," Development Studies Center Monograph, 11 (1978), The Australian National University.

Zone 1 - mountainous region
Zone II - rolling commercial farming area
Zone III - mountainous region
Zone IV - "new land" expansion, acid-soil savanna region
Zone V - lowland coastal area

Exhibit 17

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Domestic Demand (total and per capita) for Cassava for Human Consumption
in South America, 1970 and Projections to 1980*
(in 1,000 metric tons and kilograms per capita)

Country	1970		1980 Projections of Demand for Cassava**					
	Actual Demand for Cassava		Low		Medium		High	
	Total	Per Capita	Total	Per Capita	Total	Per Capita	Total	Per Capita
Argentina	133	(5.5)	142	(5.1)	138	(5.0)	138	(5.0)
Bolivia	150	(30.4)	197	(31.0)	201	(31.7)	203	(32.1)
Brazil	10,980	(117.3)	13,637	(109.5)	12,460	(100.0)	12,106	(97.2)
Colombia	720	(34.1)	982	(34.1)	982	(34.1)	982	(34.1)
Ecuador	226	(43.7)	371	(43.7)	371	(43.7)	371	(43.7)
Paraguay	476	(200.3)	662	(200.3)	662	(200.3)	662	(200.3)
Peru	403	(29.8)	536	(29.1)	584	(31.7)	611	(33.1)
Venezuela	229	(20.8)	322	(21.1)	383	(25.1)	414	(27.1)
Total South America	13,317	(70.4)	16,849	(67.8)	15,781	(63.5)	15,487	(62.3)

* In 1,000 metric tons with kilograms per capita in brackets.
** The 1980 projections are based on the following assumptions:

Alternative projections	Economic growth	Income redistribution	Export trend
Low	Low	No change	Pessimistic
Medium	High	Moderate change	Optimistic
High	High	Drastic change	Optimistic

While more recent data are available, these were the data available to the decision makers presented in the case.

Source: FAO (1972).

Exhibit 18

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Price in Colombian Pesos* of Fresh Cassava at Different Levels in the Marketing System

	Bogotá			Barranquilla		
Market Level	1969	1970	1971	1969	1970	1971
Farmer	803	865	1240	347	429	931
Wholesale	1600	2100	2470	1420	960	1030
Retail	2040	2450	2550	1630	1570	1980
Marketing margin as percentage of price to consumer	61%	65%	51%	79%	73%	53%

* Colombian pesos/US$ = 1969 17.930 (Market rate at year end)
1970 19.170
1971 21.000

Exhibit 19

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Land Distribution in Colombia and Distribution of Cassava Cultivation, 1970
(in percentage)

Farm Size (hectares)	Percentage of Farmers in Farm Size Group	Farm Area in Farm Size Group Percent	Area Planted to Annual Crops Percent	Area Planted to Cassava Hectares	Percentage
Less than 10	81.0	10.5	37	89,517	41
10 - 99	16.0	30.0	39	96,120	44
100 - 499	2.5	30.5	16	24,305	11
500 - 999	0.3	10.0	4	3,918	2
1,000 or more	0.2	20.0	4	3,485	2
Total	100.0%	100.0	100	217,315	100

Source: DANE (1970), presented in John K. Lynam, "Options for Latin American Countries in the Development of Integrated Cassava Production Programs," Development Studies Center Monograph, 11 (1978), The Australian National University.

Exhibit 20

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Average Yield of Cassava in Latin American Countries
1963-65 and 1973-75

Country	Average Yield 1963-65 (tons per hectare)	Average Yield 1973-75 (tons per hectare)
Paraguay	14.0	13.9
Brazil	14 1	12.5
French Guiana	6.0	4.0
Ecuador	8.6	9.0
Colombia	6.4	8.2
Bolivia	11.0	11.6
Dominican Republic	10.2	8.9
Peru	10.2	12.6
Haiti	3.7	4.2
Cuba	6.9	6.7
Panama	9.5	8.0
Venezuela	12.7	7.7
Guyana	10.0	14.0
Honduras	6.0	7.3
Argentina	11.6	11.9
Jamaica	3.0	9.5
Nicaragua	4.3	4.5
Costa Rica	3.3	5.0
El Salvador	9.0	15.0
Puerto Rico	3.0	5.0
Guatemala	2.5	2.3
Total Average	13.1	11.9

Source: FAO (1973 and 1976).

Exhibit 21

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Number of Lines in the CIAT Cassava Breeding Activity
and the Possible Pathway to Arrive at the First Recommended Cultivar*

	Before 1973	1973	1974	1975	1976	1977	1978	1979	1980
Collection and maintenance of germplasm	2,200	2,200	2,200	2,500	2,500	2,600	2,700	2,800	2,800
Evaluation of germplasm.		2,100			200	200	100	100	
Hybridization		10,000	25,000	40,000	50,000	50,000	50,000	50,000	50,000
Seedling selection		3,000	10,000	25,000	25,000	25,000	25,000	25,000	25,000
Observational yield trial in CIAT			3,000	2,000	3,000	3,000	3,000	3,000	3,000
Advanced yield trial in CIAT			300	300	500	500	500	500	500
Observational yield trial in Carimagua			300	500	500	500	500	500	500
Advanced yield trial in Carimagua				30	30	30	30	30	30
Observational yield trial in Caribia			300	500	500	500	500	500	500
Advanced yield trial in Caribia				30	30	30	30	30	30
Observational yield trial in Popayan				400	500	500	500	500	500
Advanced yield trial in Popayan					30	30	30	30	30
Multiplication of breeder's seed in CIAT						30	30	30	30
Agronomy regional trials		12	12	12	12	12	12	12	12
Recommended breeder's seed to national agencies							1		1

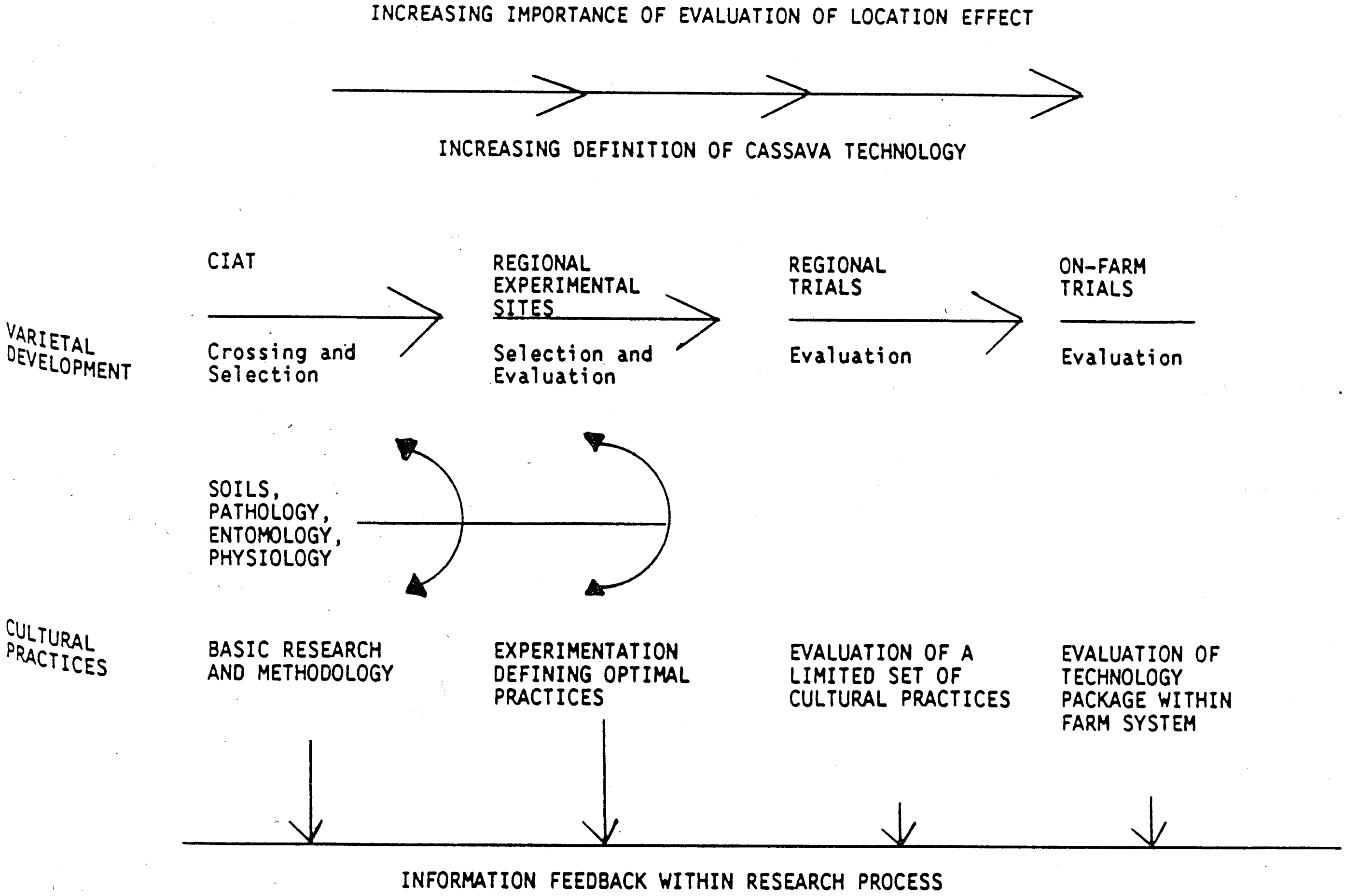
* Broken lines: first generation products; solid lines: further improved material.

Source: Barry Nestel and James Cock, Cassava: The Development of an International Research Network, (International Development Research Center, 1976).

Exhibit 22

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Cassava Technology Development Process



Source: CIAT publication.

Exhibit 23

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Yield Comparison of Selected Varieties, Regional Varieties, and Hybrids in CIAT Regional Trials
(in tons/ha)

Regional Trial Sites	1975-78 Four-year average				Selected Variety Average	Regional Variety Average	Hybrid Average (1)
	CMC 40	Mex 59	CMC 84	M Col 22			
	Tons/ha						
Zone 1							
Popayan (2)	3.8	0.9	1.0	0.3	1.5	22.9	-
Tambo	22.2	18.7	25.2	11.1	19.3	24.3	-
Quilichao	22.8	27.5	22.9	-	24.4	27.7	20.6
Zone 2							
Pereira	36.6	17.9	18.1	8.8	20.4	35.7	-
Caicedonia	27.8	33.6	26.5	25.2	28.3	25.4	36.9
CIAT	38.4	24.8	35.0	27.9	31.5	23.9	30.3
Zone 3							
Rio Negro	24.7	34.4	30.4	19.8	27.3	13.9	18.4
Nataima	34.1	31.0	24.0	26.0	26.3	17.2	28.9
Zone 4							
Florencia	20.6	21.2	12.2	8.8	15.7	18.5	-
Carimagua	23.9	22.6	24.1	15.5	21.5	13.5	27.5
Zone 5							
Media Luna	21.9	21.9	13.5	14.5	18.0	8.3	12.5
Colombian average (3)	26.1	26.6	21.3	17.8	23.0	14.6	21.1

(1) Represents only one year of testing. Yields are average of the five highest yielding, most widely adapted varieties.

(2) Location above 1500 meters in altitude.

(3) Average for Colombia weighted by total cassava production in individual zones.

Source: CIAT publication.

Exhibit 24

CIAT: THE CASSAVA PROGRAM (COLOMBIA)

Profitability of the Cassava Technology Tested on the North Coast of Colombia in Farm Trials, 1977-78

Location	Technological practice	Income Pesos	Increase %	Increased costs of Inputs %	Comments
Media Luna, Atlantic Coast	Agronomic practices: Stake selection Stake treatment Plant population Timely weeding	11,750	65	155[1]	This practice is dependent upon an intensive extension input to substitute management for high input use.

All New Technologies Tested in Media Luna

Technology	Yield (t/ha)	Profitable	Comments
Traditional technology	7.4	Yes	Low plant population due to intercropping with maize; germination problem due to inadequate stake storage.
Agronomy practices: Seed selection Seed treatment Plant population Timely weeding	12.1	Yes	Higher plant populations and greatly improved initial germination raise yields. Discarding maize may introduce cash flow problems.
Improved varieties	14.6	No	Though giving a slight yield advantage, starch content was lower resulting in a price differential, which the yield advantage does not overcome.
Fertilizer: Local variety	13.0	No	Not profitable and starch content was reduced by fertilization.
Improved varieties	16.6	No	Not profitable due to sharp price discount.

(1) Few or no cash inputs are utilized by these small farmers.

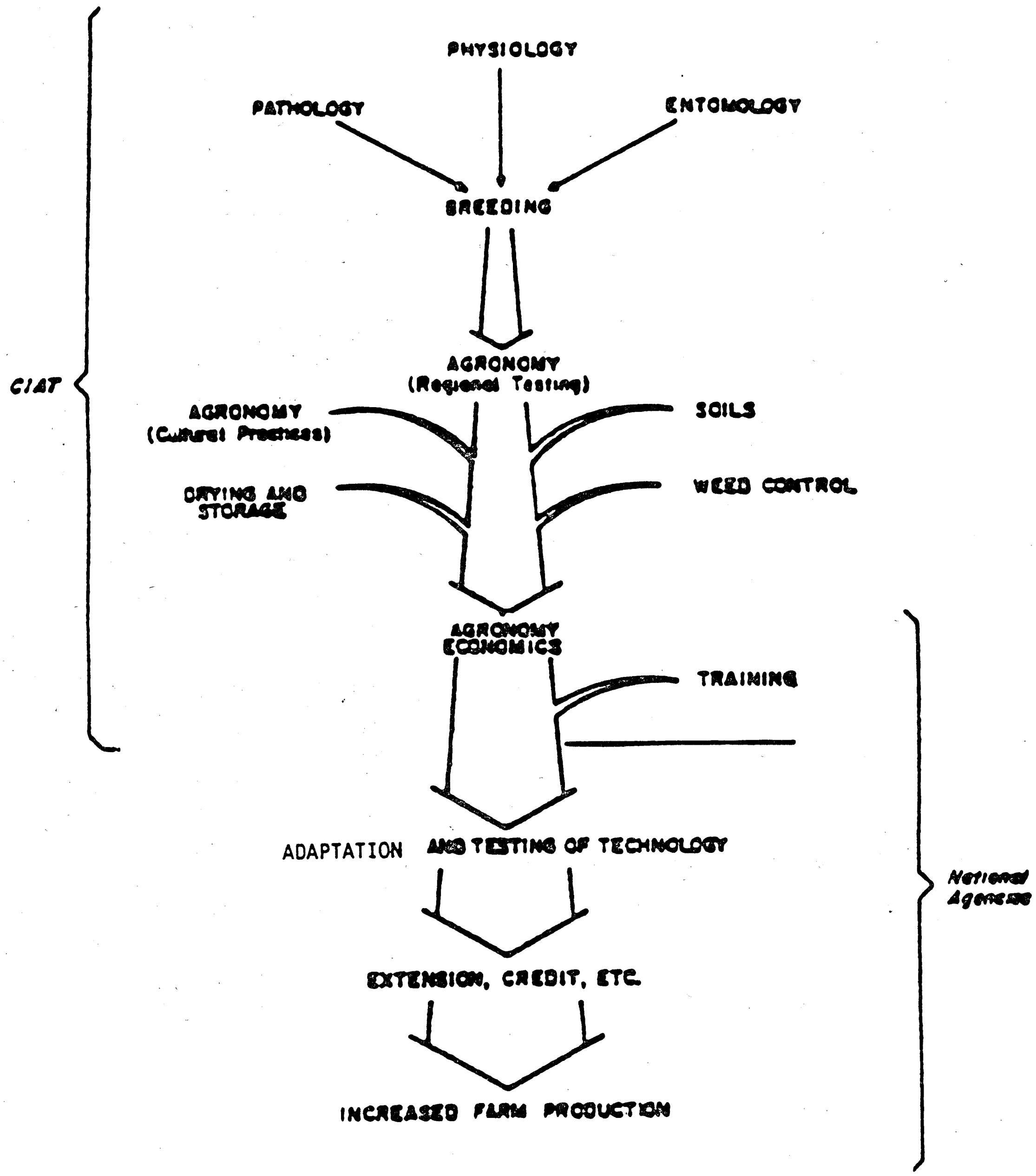
Source: CIAT publication.

Exhibit 25

CIAT: THE CASSAVA PROGRAM (COLOMBIA

Schematic Representation of CIAT/National Agency

Program Relations



Source: Barry Nestel and James Cock, Cassava: The Development of an International Research Network (International Development Research Center, 1976).

SECTION FOUR

INTEGRATING NEW PERSPECTIVES:

THE CHALLENGE OF IMPLEMENTATION

AN INTRODUCTION TO INTEGRATING NEW PERSPECTIVES: THE CHALLENGE OF IMPLEMENTATION

Targeting the clients of agricultural research, maximizing public- and private-sector linkages, and responding to the challenges of changing environments are prerequisites for effective and dynamic agricultural research management. But these perspectives alone do not create good management. The perspectives need to become an integral part of one's managerial thinking and be reflected in the formulation and implementation of decisions.

The marketing perspective, the partnership perspective, and the systems perspective that are reflected in effective management decision making share several common characteristics. First, the perspectives underscore that the effective decision maker focuses on the forces outside the organization as well as the forces within the organization in making decisions. The perspectives demand that the decision maker be sensitive to changes, activities, and trends taking place outside the research environment and recognize the impact of these factors on his tasks.

Second, the perspectives cannot be effectively utilized in decision making unless the manager has a view that is both broad and focused. The breadth enables the manager constantly to scan both the external and internal environments, to monitor changes, and to identify relevant factors that should be taken into account in the formulation and implementation of a decision. Being focused demands that the manager center on resolving specific problems and pursuing management actions.

Third, the perspectives recognize that the inputs into management decision making are dynamic. The environment is constantly changing; organizations are frequently shifting priorities and focus; persons within organizations are often altering their objectives and goals; and resource availability fluctuates. An effective decision maker reaches out to encounter the environment. He is influenced by, but not shaped by, the environment. The effective manager deals with environmental influences before he is forced to by change.

Fourth, the perspectives on their own have no influence on management decision making. The perspectives have impact only when they are integrated into the manager's thinking and are reflected in his decisions. The perspectives, therefore, are no substitute for hard analysis but are a vital part of any analysis that leads to relevant management action.

Fifth, the impact of these perspectives on the thinking of managers vary from manager to manager. Each manager differs in terms of background, professional experiences, aspirations, and skills. Thus, two people sharing the same perspectives might make different responses to the same problem situation. The perspectives are preconditions to quality management thinking but are not the sole determinants of management decisions. They are catalysts that lead to relevant (and at times, creative) responses to management challenges.

In the management case studies described in this section, three distinctive management settings and management problems are described. In the first management case study, the focus is on organizational structure. The situation underscores that organizational structure is dynamic, that it needs to be responsive to environmental and organizational changes, and that it influences and is influenced by actions taken to implement management decisions.

The second management case study focuses on an agricultural research project that involves two national research organizations and an international research center. It deals with the role and impact of external linkages and coordination on the implementation of management decisions in a research setting.

The third management case study targets a problem of increasing relevance in effective agricultural research management: how to conceive, develop, and implement programs designed to broaden and increase financial support for agricultural research activities.

Perspectives have no influence on a management situation until they are a part of a manager's thinking. A manager's decision, regardless of how excellent, has no impact until it is implemented.

Implementation is a complex endeavor, especially in a changing environment. Budget projections regarding income or expenditures may prove inaccurate; expected staff performance may not be achieved; unanticipated events may occur; and unforeseen forces may emerge that influence the organization. These all make the manager's task of translating decisions into actions more difficult and, at times, force him to modify his decision.

In implementing decisions, managers rely primarily upon people. In agricultural research organizations, salaries routinely account for over 50% of the budget. People are the greatest single resource within these organizations, and implementation is achieved by working through and with people.

An effective manager knows the people in his organizations. Knowledge regarding the aspirations, skills, and values of the people within his organization are all important components to a manager's thinking as he plans, communicates, and implements a management decision. The effective manager is aware that effective communication is a two-way process. He also carefully monitors performance within his organization.

Perhaps the formal instrument most frequently used within agricultural research organizations that affects performance and influences implementation is the budget. The way that funds are allocated in a budget is a more persuasive communicator of the organization's real goals and the manager's top priorities than are speeches and memoranda. The budget can be a measuring stick for assessing progress, a device for measuring performance, an instrument for allocating resources, and a document for communicating organizational goals.

Effective budgeting is a dynamic process, and a useful budget is a flexible instrument. A budget is continuously monitored. It is adjusted to take into account unexpected occurrences, such as an unanticipated cut in government funds, a sudden change in government, or a surprise grant from an international donor.

Managerial perspectives are conceptual tools for decision making. Implementation is about turning decisions into action. People implement decisions and these people must be led and motivated. Budgets give support to decisions. Implementation is the task of securing funding, building linkages, developing staff, defining organizational structure, and engaging in other activities required for effective managerial action. The effective implementation of management decisions is the orchestration of resources within the context of an organization's goals and a manager's purposes. It is an integral part of any effective response to a management challenge.

Chapter 12

ORGANIZATIONAL CHANGE AT SAMARU, NIGERIA

ORGANIZATIONAL CHANGE AT SAMARU, NIGERIA:

A Management Commentary

The Director of the Institute for Agricultural Research (IAR) at Samaru, in Nigeria, is confronted with the decision of whether to change the organizational structure of the institute. He is faced with the challenge of how to organize researchers with different disciplinary backgrounds and interests into productive working units which concentrate on specific commodities or special research projects.

The organization of an agricultural research center is a dynamic and continuing challenge. It is influenced by changes occurring in the institute's internal and external environments. It is affected by the changes in the needs and priorities of not just the institute and its personnel, but of all those who are interested in and influenced by the research findings and activities of the organization.

Every organization, including IAR, has a formal structure and an informal structure. The formal structure, often printed on a sheet of paper with appropriately drawn boxes, is the one that generally gets shown and is talked about in public. The informal structure seldom appears on paper but is familiar to knowledgeable people in the organization. The informal structure is the more powerful. It represents how the organization really works. It is the organizational structure of reality, the one that in fact produces the achievements. The effective manager is knowledgeable about both the formal and informal structures of his organization.

No single right or wrong way exists to organize a research institute. Many factors, some of which are out of management's control, influence how an institute functions or is organized. The issue is how to make the organization efficient, how to make it responsive, how to make it work.

Generally, effective changes in organizational structure are those that bring the formal organizational design more in line with the informal decision-making process. The search for the right organizational structure is usually futile, and it will not guarantee reaching the desired organizational goals. However, a "wrong" organizational structure, one that is imposed on an organization and is not sensitive to the needs of its people, inhibits and at times prevents research productivity.

An organization's structure does not stand by itself. It can strongly influence every activity in the organization. It should facilitate the integration of related functions. For example, in an environment like IAR's, the research process is tied closely to the organization's planning, financial, and budgeting procedures. The structure of the organization should reflect and facilitate these interrelationships.

Regardless of the organizational structure chosen by the Director of IAR, the staff must accept or buy into the structure if its impact on the organization is to be positive. The acceptance of a new organizational structure is facilitated if people in the organization have been involved in the process that led to the restructuring. Of course, the closer the new structure conforms to the informal way the organization functions, the more readily the new structure is accepted.

Several characteristics of an effective organizational structure can be outlined. First, the structure is sensitive to the needs of the people of the organization and is perceived by them as being responsive to their needs. Organizational structure serves people; people do not serve organizational structure. Second, the organizational structure is flexible and permits people to establish new relationships and new partnerships both within and outside the organization. Third, the organizational structure reinforces and strengthens the key personnel and functional linkages within the organization. Fourth, the organizational structure has a systems orientation in that it reflects an awareness of the interrelationships among the various parts of the organization and the management functions required for the organization's success.

A good organizational structure will never ensure the effective implementation of management decisions at the IAR. However, the organizational structure can facilitate the effective implementation of decisions, and for that reason it is of great concern to the director of the institute.

ORGANIZATIONAL CHANGE AT SAMARU, NIGERIA:

A Case Study

by John McKenzie

It was a day in mid-October, 1983. The sun was beginning to invade the cool of early morning when the Nigerian president's appointees to the Board of Governors of the Institute for Agricultural Research arrived at Samaru in northern Nigeria. The three men, resplendent in fila caps and vivid agbada gowns, were escorted to the office of the Director, Mr. John Davies, who bid them welcome. Mr. Davies hoped he did not look as tired as he felt. He had worked late into the previous night, putting the final details on his presentation to the board.

As Mr. Davies and his guests began talking, he knew that they would be particularly interested to know how his institute was pushing forward the President's agricultural policy. The government was committed to bringing the Green Revolution to the farmers of Nigeria. For many months, the senior staff at the institute had been considering means by which their research efforts could be more directly aimed at furthering the priorities of the government. They had formulated a proposal to change the way in which their research work was organized.

The institute's research work had a high reputation for excellence and Mr. Davies and his colleagues had applied their usual thoroughness in developing a new plan. The proposal was to be presented to the Board of Governors for approval in a meeting that afternoon.

The Institute for Agricultural Research

The Institute for Agricultural Research (IAR) at Samaru was northern Nigeria's most eminent agricultural research establishment and was Nigeria's main center for savanna crop research (Exhibit 1). By 1982, the institute had a highly qualified and enthusiastic scientific staff including 67 PhDs, 37 MScs, and 25 BScs, with 110 skilled and qualified support staff. IAR was funded through Nigeria's Federal Ministry of Science and Technology and had a recurrent budget in 1982 of over 7 million Naira.(1)

The institute had its origin in 1922 when the Department of Agriculture for the Northern Provinces established its headquarters at Samaru with research and training facilities. In 1962, the Nigerian government inaugurated its new Ahmadu Bello University at Samaru. At that time, the Department of Agriculture headquarters became the Institute for Agricultural Research, attached to the university, though the institute maintained its semi autonomy. IAR had its own director, its own statutes, and its own board of governors to advise the director on budget and policy issues. The Director, however, was appointed by the university vice-chancellor, who also sat on the board of governors.

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(1) In 1982, the official exchange rate was N 1.00 = US$ 1.50.

In physical terms, the institute was very much a part of the university campus and was closely linked with the Faculty of Agriculture. The Institute's scientific staff, which was five times as large as the faculty, was organized into research sections attached to the academic departments of the faculty.

There was a strong interchange between the institute and the faculty. For example, research scientists could devote up to 10% of their time to teaching. Similarly, academic staff of the faculty could spend up to 30% of their time on research projects in the institute's program. Both the faculty and the institute benefited from the cross-pollination of ideas.

The institute used the faculty as a source of manpower. It was able to recruit staff from the academic world through the university. It also sought to recruit the best of the Faculty's graduate students. Up to 20 graduates were employed each year as research assistants. Also, MSc and PhD students were encouraged to link their thesis research with the institute's program.

Dr. Joe Yayock, who was the assistant director of the institute, was enthusiastic about this link. He commented, "We like to work people into our system. We succeed by commitment and team spirit. We can really develop this in our scientists if we catch them young."

Although close ties existed, the institute and faculty were separate entities. This was strongly underlined by the fact that the institute was funded by the Federal Ministry of Science and Technology, whereas the university was funded by the Federal Ministry of Education. This meant that the institute was held accountable for its results both to the University and to the government which funded the institute for the purpose of increasing national agricultural production.

Since its creation in 1962, the institute had experienced some turbulence in its relationship with government agencies. Many changes had taken place in the organization of government in Nigeria. This had meant that the government bodies responsible for administering agricultural research institutes had changed as well. The most recent change had been when Nigeria returned to civilian rule in 1979. At this time, the institute had come under the control of the new Federal Ministry of Science and Technology.

Being placed under the control of the new ministry involved the institute in redrafting its statutes and reconstituting its board of governors. The board of governors was an important body that advised the Director and held the ultimate power of approval over the budget and policy of the Institute. When a new board of governors was appointed in 1980, its size was reduced to 10 members and the proportional representation of scientific officers was diminished. For the first time, the President of Nigeria selected personal appointees to sit as members (Exhibit 2).

In 1980, the government embarked on a campaign named "The Green Revolution" to provide national self-sufficiency in food crops within five years and in cash crops within seven years. It looked to the national research institutes to provide the means to carry out this task. At this time, the country's income from oil exports was eight billion Naira, and this income provided the funds to carry out extensive development plans. At the same time, the Nigerian economy was characterized by a population growth rate of 3.5% per year. Compared to the population growth, agricultural production was increasing at an average of only 1% a year.

The government considered the role of Samaru essential to the agricultural development of northern Nigeria. In 1982, over half the country's 90 million population lived in the northern region. The region was largely an area of flat grassy savanna and had a single rainy season of seven months a year in the south, diminishing to four months a year in the north. The main traditional crops of the region were sorghum, millet, and cowpeas. Cereals usually were intercropped with other cereals or legumes, and most cultivation was by hand. The northern region provided a major contribution to national food production. The three crops sorghum, millet, and cowpeas alone provided on average 38% of the calories and 56% of the protein consumed daily in Nigeria.

Between 1980 and 1982, the world demand for oil declined sharply. Nigeria's daily oil output fell from two million barrels in 1980, to 800,000 in 1982. The government was obliged to begin cutting back on its development plans. Despite the fact that agricultural research was a priority, the government began to examine the activity of its agricultural research institutes by comparison with its investment. In August 1982, Mr. Davies was called before a special committee of the House of Representatives. He was required to inform the committee on the size and nature of the contributions that his institute had been making towards national agricultural self-sufficiency. He was also required to justify his proposed recurrent budget of 7.5 million Naira for the forthcoming year of 1983 (Exhibit 3). This was the first occasion that any director of a national research institute had been called before members of the government in Nigeria.

The Structure of the IAR

The focus of the institute was its administration building, where Mr. Davies and Dr. Yayock had offices. The administration building also contained the institute's meeting hall and a library. The research scientists themselves occupied buildings scattered over a wide area of the Ahmadu Bello University campus (Exhibit 4).

There were six agricultural departments of the university to which were attached 13 research sections from the institute (Exhibit 5). Each research section comprised six to 12 research officers plus intermediate and junior staff and was led by a section head. The section head was responsible for the overall management of the program and reported to the director.

The heads of section were nominally subordinate to their heads of department. The heads of department held joint faculty/institute appointments and reported both to the Dean of the Faculty and to the Director of the Institute. They were in charge of both the faculty and institute staff within their departments over matters of commendation or discipline but consulted very closely with section heads. The section heads submitted annual appraisals of their intermediate and junior staff to their heads of department. Heads of department were paid a responsibility allowance of 8% of their salary.

Putting the Research Program Together

In 1972, the IAR adopted a new procedure for the organization of experiments by program. Ten programs were identified that were in line with government agricultural priorities for northern Nigeria. To administer each program, a committee was chosen under a chairman. The members of committees were chosen from senior members of the different sections to give an appropriate spread of scientific knowledge. For example, the committee on cereals improvement included an agronomist, an entomologist, a plant breeder, a climatologist, a soil scientist, an agricultural engineer, and an agricultural economist. Committee meetings were open to all interested parties and could proceed only if representatives of at least five sections were present, plus a representative of the Agricultural Extension-Research Liaison Service.

Dr. Joe Yayock explained: "Because our resources were limited, we had to look at the balance of our energies in any one program. When the disciplines worked without cross-communication we might, as an example, have had extensive experimentation in crop protection for a given crop, yet quite neglected work in crop nutrition."

The research program committees held meetings during the year to consider ways of improving their programs. This gave the scientists of different sections an opportunity to swap ideas. There was general awareness that scientists of different disciplines had different approaches to problems.

The program committees had two major meetings at the end of each year. One of these was to examine newly proposed projects for the forthcoming year; the other was to examine on-going projects.

Researchers, having first carried out a preliminary investigation, would draft a project proposal describing their intended experiment and giving a statement of its justificaion (Exhibit 7). This proposal would be checked by the researchers' head of department and head of section for technical feasibility. The proposal then would be submitted to the committee.

The meetings were lively affairs, and the number of people at the meetings sometimes filled the hall so that latecomers had to stand. Mr. Davies and Dr. Yayock always made a point of attending. At the meetings, a researcher would present his project proposal, and the committee would consider how the proposal would fill a gap or otherwise strengthen the overall program. The committee also would make a decision on how much priority the project should be given in relation to the availability of resources. A proposal would only be accepted when a consensus had been reached that it was worthy of support. Proposed projects that were not accepted generally underwent comprehensive criticism.

On a separate occasion, the program committees met to review ongoing projects. Each research scientist submitted an annual progress report on his work (Exhibit 8). At these reviews, the committee had the opportunity of discontinuing unsuccessful projects or advancing successful ones.

When both the new and ongoing projects had been considered by the committee, a program for the forthcoming year was compiled. This was then submitted for final approval to an advisory board to the director called the Professional and Academic Board.

The Professional and Academic Board advised on internal issues, such as the details of the overall research program or the publication program. It was the function of the Professional and Academic Board to see that the research programs drawn up by the crop committees were translated into the programs of the research sections. A scientist proposing a particular project to the crop committee would do so with the approval of his section head. In this way the scientists would know within which section the project work would be carried out even before the experiment was approved. Also, the section head would know the projects for which his section would need to budget.

Each year, the crop or program committees met in October or November. Their completed programs were submitted to the Professional and Academic Board for approval before January of the following year. Before the meeting of the Professional and Academic Board, the heads of the sections, in communication with Mr. Davies and the finance officer, would have to estimate the budget allocations that their sections would receive the forthcoming July. If the section heads felt that their anticipated funding would not be adequate to carry out all the projects from various crop programs, the matter would be discussed at the Professional and Academic Board meetings. Heads of section could meet with chairmen of program committees to rank projects in terms of priority. In the event of inadequate funding, the projects with the lowest priority would be held back.

Budget funds were granted to the institute in July, and Mr. Davies would then apportion funds to the various sections, according to the government priorities attached to particular programs. The section heads would then know how many projects it was possible to undertake. Since 1972, when the multidisciplinary program committees were initiated, the benefits of the committee had become obvious.

"By taking a systems approach we no longer see experiments as independent endeavors. Also, joint experiments from scientists of different disciplines are giving us entirely new perspectives," said Dr. Joe Yayock. It was widely felt that the program committees also gave scientists from the various sections an invaluable opportunity to come together and talk to each other.

In 1974, the institute began to prepare its budget proposal by programs. Although within the institute the research projects were carried out by sections, Mr. Davies found the government was more enthusiastic in giving money to develop crops rather than to carry out scientific activities.

The program approach also made Mr. Davies' job much easier in presenting his results to government agencies. A nonscientific official, for example, could appreciate a breakthrough in maize more readily than a breakthrough in plant pathology.

For the purpose of carrying out research, the program budget was then translated into the requirements of the research sections. Mr. Davies calculated this by estimating the resources allocated to particular projects within programs and then reallocating these projects to sections.

The institute had achieved a consistently high standard of research output by accommodating to change. As the government became more interested in the progress of agriculture, it had begun to identify priority crops and wished to see research related directly to these priorities. Mr. Davies and his senior staff were therefore aware of a pressure for change, and saw a need for action.

Proposal for Change in the Organizational Structure of IAR Research

In July 1981, Mr. Davies and Dr. Yayock made a proposal that research sections should be disbanded and that the institute's research function should be reorganized along program lines. The proposal was circulated for open discussion among department heads, section heads, and chairmen of program committees. The reaction from individuals and entire sections was intense. "If the university recognizes disciplines and the institute recognizes programs, are we going our separate ways?" asked a strongly worded memo from the entire plant pathology section to the director.

Mr. Davies set up an eight-person working group of senior staff to look at the reaction of individuals and sections to the proposed change. The working group, having considered the implications, was then to suggest a suitable organizational structure. The Department of Crop Protection was militantly against the proposal; Mr. Davies chose its head, Dr. S.T. Erinle, as chairman of the working group.

Maintaining a close link to the Faculty of Agriculture was seen as important. The working group resolved that institute staff should remain attached to their existing departments. The department heads would continue to be responsible for all appointments, promotions, staff discipline, and the upkeep and maintenance of the department buildings. The research sections, however, would be abolished, and research projects would be carried out under programs. The personnel management tasks of section heads, such as the administration of intermediate and junior staff, would be transferred to the department heads. The budgetary and supervisory function of section heads would be passed on to newly appointed program leaders.

Each research program would be headed by a program leader who would assume the function of chairman of the research program committee. He would assume all administrative responsibilities for research projects in the program, including budgeting and the disbursement of funds. He also would be responsible for the acquisition and deployment of casual labor and the administration of transport allocated to the program. Office space was to be vacated in the administration building of the director.

Each program leader would occupy a newly furnished office from which he would direct research operations. This meant that the scientific staff would remain in their existing offices but would be administered centrally.

The program leaders would answer directly to Mr. Davies. They would be senior members of staff with status eligible for appointment as heads of academic departments. They also would be compensated for their administrative responsibilities by being paid a supplement equal to 8% of their annual salaries. Whereas some of the research committees were chaired by faculty staff, the new program leaders would all be institute appointees. (For the current organizational structure, see Exhibit 9. For the proposed organizational structure, see Exhibit 10.)

Upon submission of the working group's report, the members of the Department of Crop Protection remained unhappy. "Some of our equipment is expensive," said an entomologist, "and our section makes economic use of it. If each program has to have its own equipment for entomological research, and I suppose each one will, are we able to afford it? Will we get full use out of it?"

The entomologist went on to express further concern over the possible loss of section heads. "At the moment, if I need my boss, he's just next door. He is available. But what will happen when he is way off in the administration office and a problem arises. Thinking about that, who will be my boss anyway?"

One problem with the proposed change that the working group found difficult to resolve was the linkage between heads of departments and the heads of programs. The scientist would look to his department head for promotion, but to one or more program leaders for the supervision of his work.

Some scientists were concerned that the abolition of research sections would lead to their loss of disciplinary identity. A researcher in the Department of Soil Science explained that if soil scientists were merely attached to programs, there might be a lack of communication between them. Furthermore, there was a risk that research goals would become short term, and longer-term perspectives on such issues as soil degradation would be neglected.

Another concern among some researchers was whether they would retain their freedom to select projects. As one agronomist put it, "At the moment, we each formulate our own projects and then take them before a research program committee for approval, rather in an academic tradition. I suppose that with the new system the committees will be telling us what to do."

On the other hand, some researchers saw opportunities with the new program structure. One plant pathologist who had been specializing in pest control in cotton said, "If we want our work to be recognized internationally, we have to go with programs. I am becoming recognized for my work on cotton because the world is interested in crops."

Mr. Davies was anticipating that certain costs would be involved in a changeover to a research system organized by programs. Besides the cost of locating the program leaders in their new offices, certain support functions would require upgrading. For example, the internal telephone network worked very poorly and required an investment of 200,000 Naira to operate properly.

The working group under Dr. Erinle realized that its task in proposing a new organization structure for the institute was a delicate one. This was particularly so because of the relationship between the institute, the government and the university. When the working group submitted its proposal to Mr. Davies in June 1982, Dr. Erinle mentioned in a covering letter, "Perhaps it will not be far from the truth to say that IAR is like a woman living with two husbands. Such liaison often requires some balancing acts."

Before any part of the proposed reorganization could take place, the approval of the Board of Governors had to be sought. As the members of the working group had reached consensus on each of their recommendations, Mr. Davies felt confident that on paper the new scheme was workable. What made Mr. Davies a little less comfortable was the uncertainty as to how the institute itself would react to a changeover and exactly how this would affect the quality of its work. Twenty-six years of experience in Nigeria told Mr. Davies that the future is impossible to predict.

Conclusion

Mr. Davies had held a small reception for his honored colleagues on the Institute's Board of Governors, following their meeting. His last guest had just left. He sat down in his old leather armchair exhausted and gazed up at the fan turning in the ceiling. His presentation had gone well. He also had expressed to the board his concern with the risks involved in putting an organizational change into practice. The board had congratulated the workmanship of the proposal but also had appreciated his concern regarding implementation.

"Proceed if you think that is best" had been their conclusion. Mr. Davies felt tired and very far from knowing what was best. He did not know if he should proceed or not. There might be a better way of reorganization that he and the board had not even considered. If he did proceed with the reorganization, he was uncertain how long it would take for people to get used to the new system.

The lights flickered for a second, then died. The power failed, leaving Mr. Davies in the darkness with his thoughts.

INSERT

Exhibit 1

ORGANIZATIONAL CHANGE AT SAMARU, NIGERIA

I.A.R. and Its Outstations
Map of Nigeria

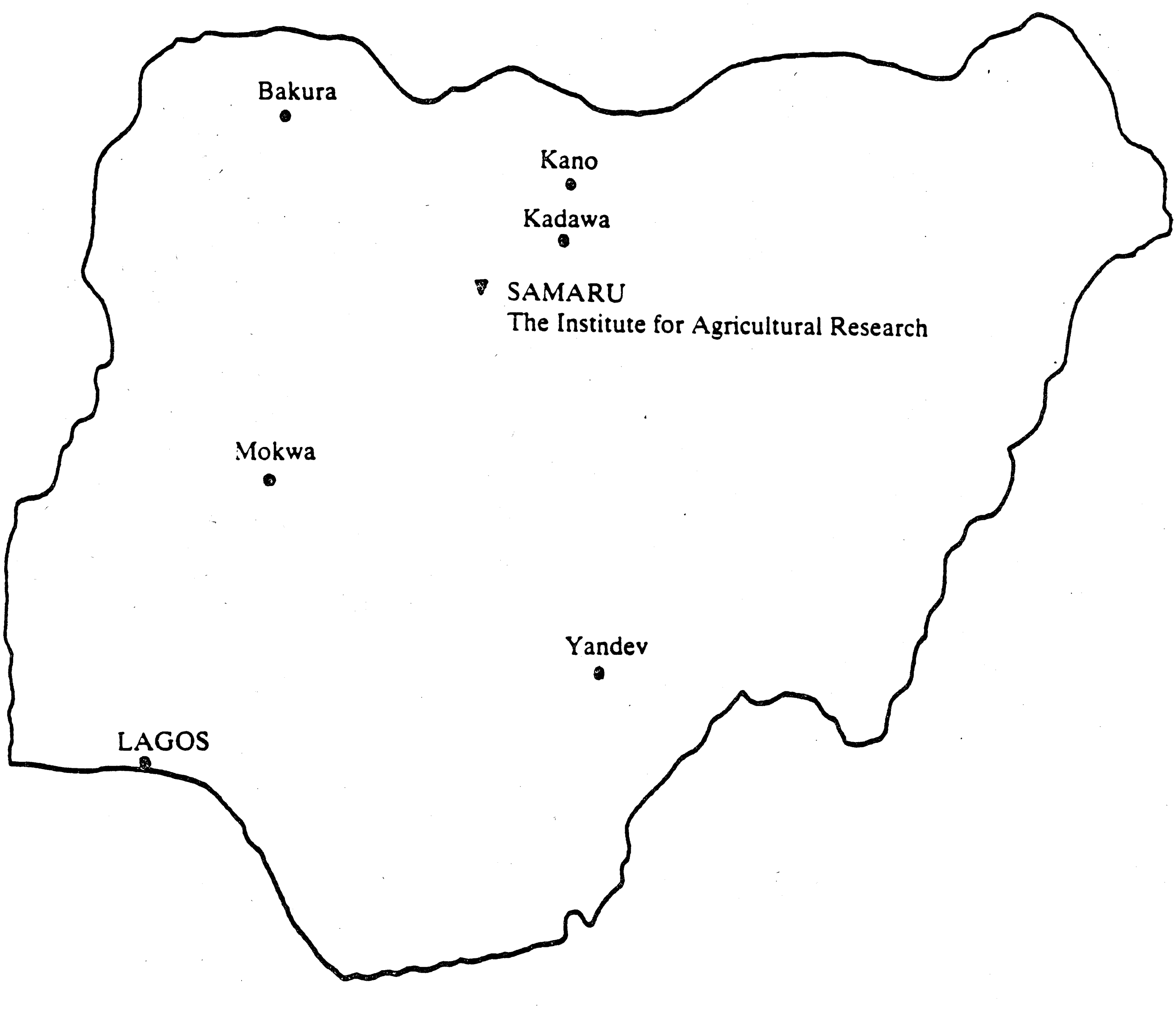


Exhibit 2

ORGANIZATIONAL CHANGE AT SAMARU, NIGERIA

The Board of Governors of the Institute of Agricultural Research
Samaru, Nigeria
1983

Prof. Ango Abdullahi *
The Vice-Chancellor (Chairman)

Mr. J.H. Davies *
The Director, Institute of Agricultural Research

Alhaji Imrana Yazidu *
The Director, Agricultural Research-Extension Liaison Service

Dr. J.A. Gana *
University Senate Representative

Prof. L.B. Olugbemi *
Institute of Agricultural Research Professional & Academic Board Representative

Dr. P.A.E. Onuorah
Federal Ministry of Science & Technology Representative

Alhaji Zakariya Dogara
Appointed by the President of the Federal Republic of Nigeria

Alhaji Bawa Nuhu
Appointed by the President of the Federal Republic of Nigeria

Alhaji M.K. Sani
Appointed by the President of the Federal Republic of Nigeria

* Nominated by the university.

Exhibit 3

ORGANIZATIONAL CHANGE AT SAMARU, NIGERIA

1983 Summary Program Budgets and Special Expenditures
in Nairas

Program	Senior Management Staff	Other Staff	Total Personnel Expenditures	Allowances	Emergency & D/Rated Labour	Supplies & Expenses	Equipment & Materials	Travel	Total Other Charges	Total Cost
1. Cereals Program	42,412	174,444	216,856	19,447	38,203	15,898	12,380	11,760	97,688	314,544
2. Oilseeds Program	29,924	106,861	136,785	6,300	23,000	7,880	7,700	9,900	54,780	191,565
3. Fibres	8,090	83,920	92,010	8,820	14,900	20,000	1,000	6,000	50,720	142,730
4. Grain Legumes Program	24,692	68,359	93,051	6,900	13,210	9,975	–	4,635	34,720	127,771
5. Vegetable & Fruit Trees	10,956	71,414	82,370	8,716	20,315	3,885	6,010	11,422	50,348	132,718
6. Crop Nutrition, Soil, etc.	66,550	258,103	324,653	61,333	12,500	41,920	44,700	12,000	172,453	497,106
7. Irrigation Program	49,168	163,360	212,528	17,000	19,000	25,000	60,000	18,000	139,000	351,528
8. Socioeconomic & Extension	71,300	334,725	406,025	76,384	9,100	18,900	20,400	32,700	157,934	563,959
9. Farming Systems Program	16,959	95,486	112,445	10,260	10,318	9,975	11,720	5,193	47,466	159,911
10. Ag. Mech. Program	42,962	129,792	172,754	12,000	6,000	25,000	20,000	5,500	68,500	241,254
11. Central H.Q. Administration	157,658	371,807	529,464	320,300	–	397,400	21,500	20,000	759,200	1,288,665
12. Operation of Res. Stations	31,514	841,751	873,265	86,000	206,000	354,500	148,000	83,000	877,500	1,750,765
13. Supporting Services	30,532	174,150	204,682	16,340	6,250	221,700	77,400	15,600	337,290	541,972
			3,456,889						2,847,599	6,304,488
									788,190	788,190
Staff Gratuities (1% Personnel Expenditures)									345,688	345,686
TOTAL BUDGET			3,456,889						3,981,477	7,438,366

Exhibit 4

ORGANIZATIONAL CHANGE AT SAMARU, NIGERIA

Plan of the Institute and faculty Buildings
Ahmadu Bello University Campus

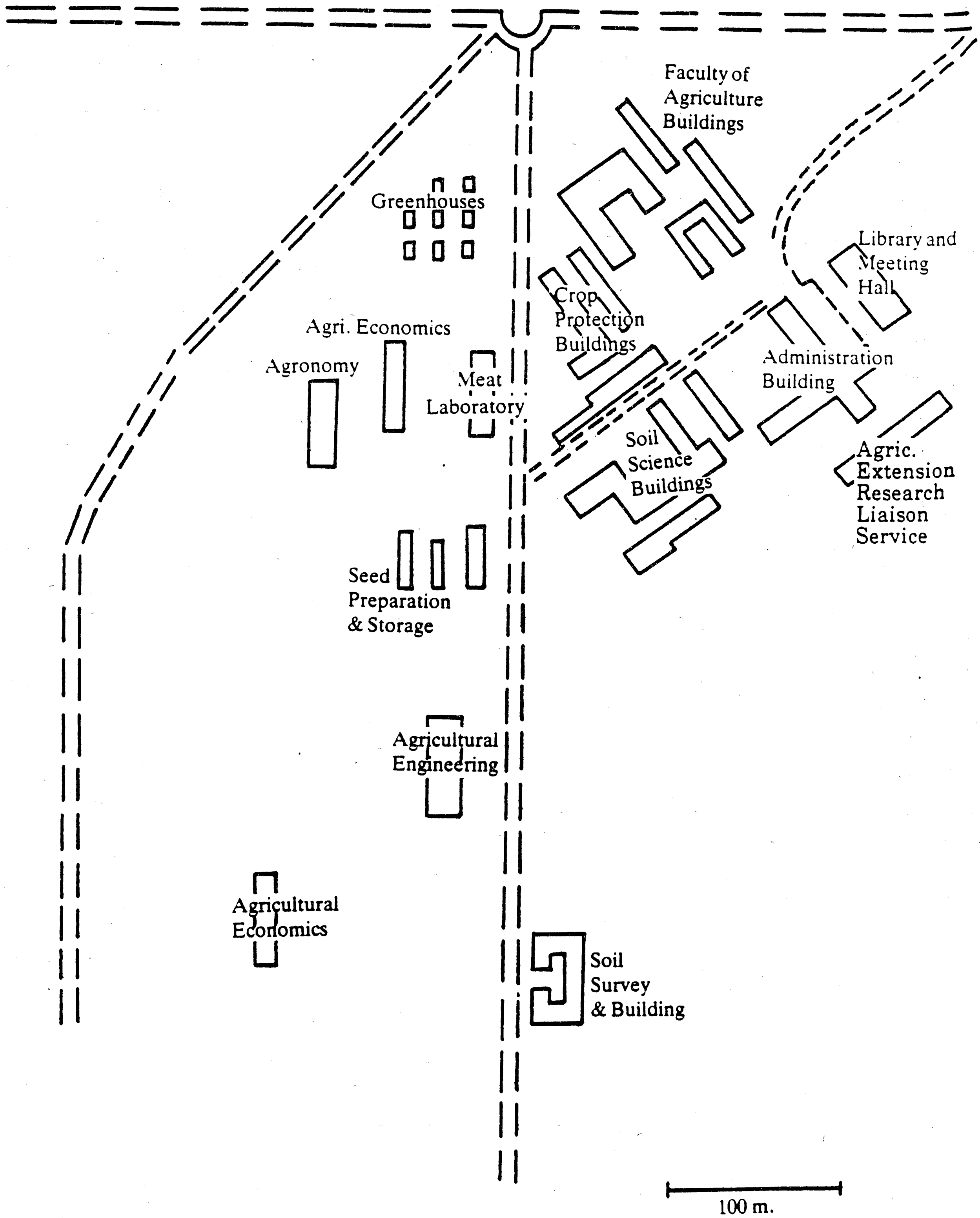


Exhibit 5

ORGANIZATIONAL CHANGE AT SAMARU, NIGERIA

Departments of the Faculty of Agriculture
and Research Sections of the Institute

Departments	Sections
Agricultural Economics & Rural Sociology	- Agricultural Economics
	- Rural Sociology
Plant Science	- Plant Breeding
	- Fibre Breeding
	- Horticulture
Soil Science	- Soil Science
	- Soil Survey
	- Soil and Water Management
Agronomy	- Agronomy
	- Weed Science
Crop Protection	- Plant Pathology
	- Entomology
Agricultural Engineering	- Agricultural Engineering

Exhibit 6

ORGANIZATIONAL CHANGE AT SAMARU, NIGERIA

Research Programs with Component Subprograms

Research Programs	Subprograms
Cereals Improvement	Sorghum
	Millet
	Wheat
	Maize
	Barley
Oilseed Improvement	Groundnut
	Beniseed
Grain Legumes Improvement	Soyabean
	Cowpea
Fibre Crop Improvement	Cotton
	Roselle
	Jute
Horticulture Crop Improvement	Tomato
	Pepper
	Onion
	Okra
	Mango
Cropping Systems	Intercropping
	Rotations

Exhibit 7

ORGANIZATIONAL CHANGE AT SAMARU, NIGERIA

New Research Project Proposal

PROGRAM:	Cereal Crop Improvement
SUBPROGRAM:	Sorghum
PROJECT:	Socioeconomics of production
SUBPROJECT:	Technology adoption
TITLE:	Socioeconomic study of production of improved sole-crop sorghum under different technologies.

OBJECTIVES:

i. To ascertain the extent to which improved sole-crop sorghum practices have been adopted in the study area.

ii. To estimate costs and returns from growing sole crop sorghum under different technologies.

iii. To determine the level of adoption of an improved sorghum production package and consider the problems faced by adopters.

iv. To observe how the adoption of an improved sorghum package affects resource utilization on other farm enterprises.

JUSTIFICATION:

Researchers are coming up with new recommendations on sorghum production as regards variety, plant population, method of weed control, pest control, etc. These changes will no doubt affect a farmer's cost-return structure, utilization of resources and therefore his decision whether to adopt or not to adopt a new package. A study of this kind will reveal the shortcomings and strong points of the package.

OUTLINE OF EXPERIMENTAL APPROACH:

Participating farmers will be classified into those using hand tools only, those using animal-drawn equipment, and those using tractors. All farmers will be encouraged to adhere to recommendations with regard to variety, plant population, fertilizer application, pest and disease control. Land preparation can be carried out as the farmer chooses, but good seedbed preparation will be encouraged. Farmers also can choose to control weeds by herbicides, manually, or by any mechanical means they prefer. Any available ox-drawn weeding equipment for testing can be utilized. Reasonable weed control will however be ensured on all plots. Individual farm size will depend on the farmer's past experience and the number of hectares of maize he plans to grow during the year. Credit may be required to a limited extent to encourage farmers to use improved inputs.

STARTING DATE: 1982-83 cropping season.

DURATION: 1-2 years.

RESEARCHERS: Ogungbile, Abalu, Ogunlela, Obilana, Shebayan, Santa, Awolola, Atala, and Kalkat.

PROPOSAL SUBMITTED BY: Dr. Ogungbile.

COMMENT BY SECTION HEAD: An important experiment, given the government's high priority for sorghum. The major researchers represent a wide cross-section of disciplines, including agricultural economics, agronomy, plant breeding, agricultural engineering, weed science, and sociology. The methodology is perhaps a little open-ended, but results could be interesting.

APPROVAL BY SECTION HEAD SIGN & DATE ____________________

APPROVAL BY RESEARCH COMMITTEE SIGN & DATE ____________________

Exhibit 8

ORGANIZATIONAL CHANGE AT SAMARU, NIGERIA

Annual Review of Research Projects 1982 Season

INSTITUTE FOR AGRICULTURAL RESEARCH
Ahmadu Bello University, Zaria

PROGRAM: Horticultural Crops

SUBPROGRAM: Mango

PROJECT: Propagation

SUBPROJECT: Vegetative Propagation

TITLE: Propagation Technique in Mango

OBJECTIVE: To compare different methods of vegetative propagation of mango in different ecological zones

STARTING DATE: 1982

RESEARCHER(S): Dr. Olarewaju, Dr. Karikari, and Dr. Adejoh

LIST OF EXPERIMENTS CONDUCTED DURING THE YEAR ONE IN SUPPORT OF SUBPROJECT

PROJECT LOCATION: Samaru

PROGRESS REPORT: The trial is still at the initial stage, having just been established in July 1982. However, the number of shoots that developed from the date of transplanting to September 26, 1982, were counted. Bench-grafted seedlings had four shoots, unbudded local mango had nine shoots, side-grafted seedlings had 10 shoots, and patch budded seedlings had 16 shoots per plant. Tomatoes, peppers, and eggplants were planted between rows to avoid wastage of usable land.

COMMENT BY MAJOR RESEARCHER: The trial has made encouraging progress. Plans are under way to spread the trial in different ecological zones in 1983.

Sign & Date: ______________________________

COMMENT BY SECTION HEAD: The progress made is impressive. The trial should be established in outstations during the 1983 wet season.

APPROVAL OF SECTION HEAD: Sign & Date: ______________________________

APPROVAL OF RESEARCH COMMITTEE: Sign & Date: ______________________________

Exhibit 9
ORGANIZATIONAL CHANGE AT SAMARU, NIGERIA
Structure of Organization of Institute for Agricultural Research and Faculty of Agriculture

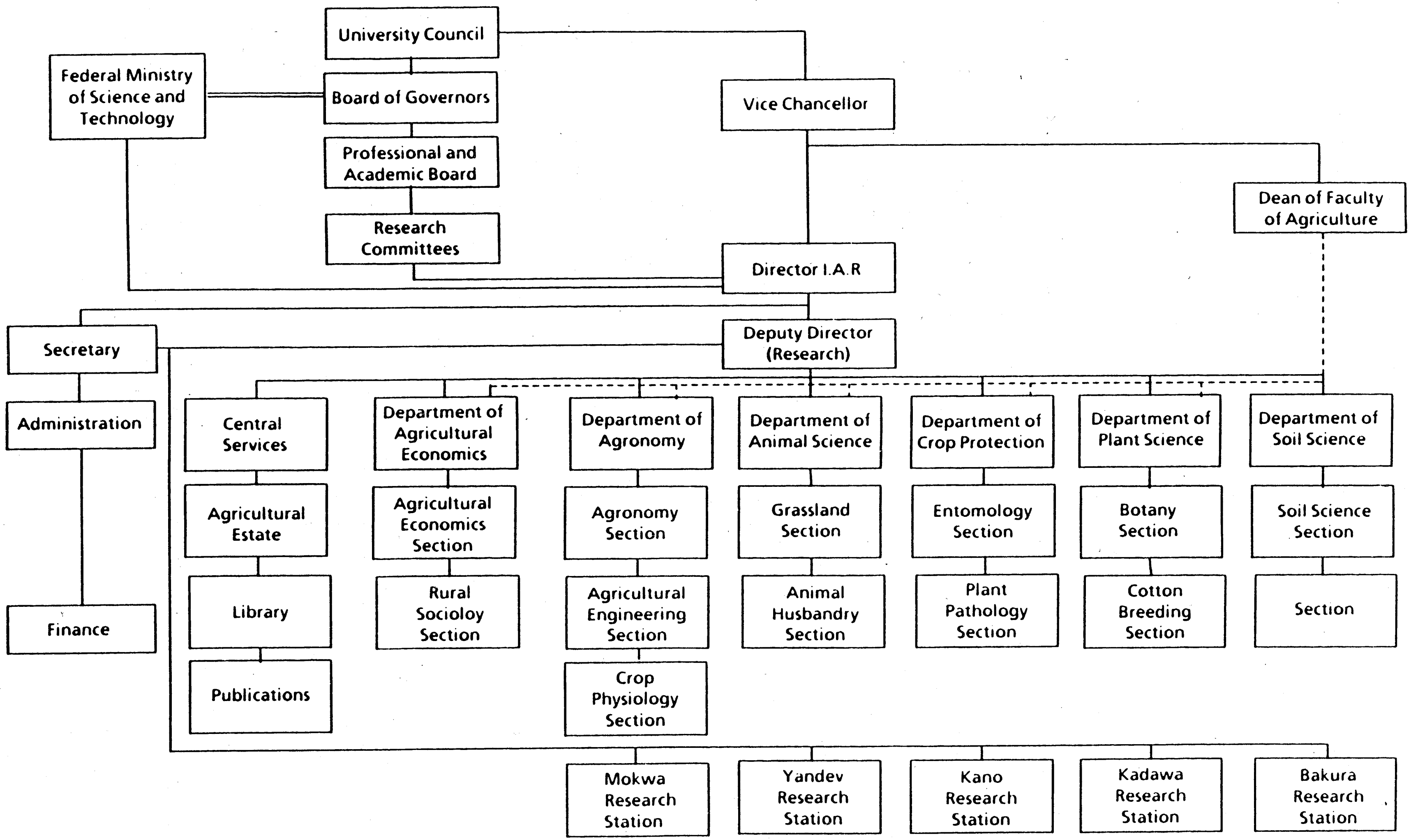
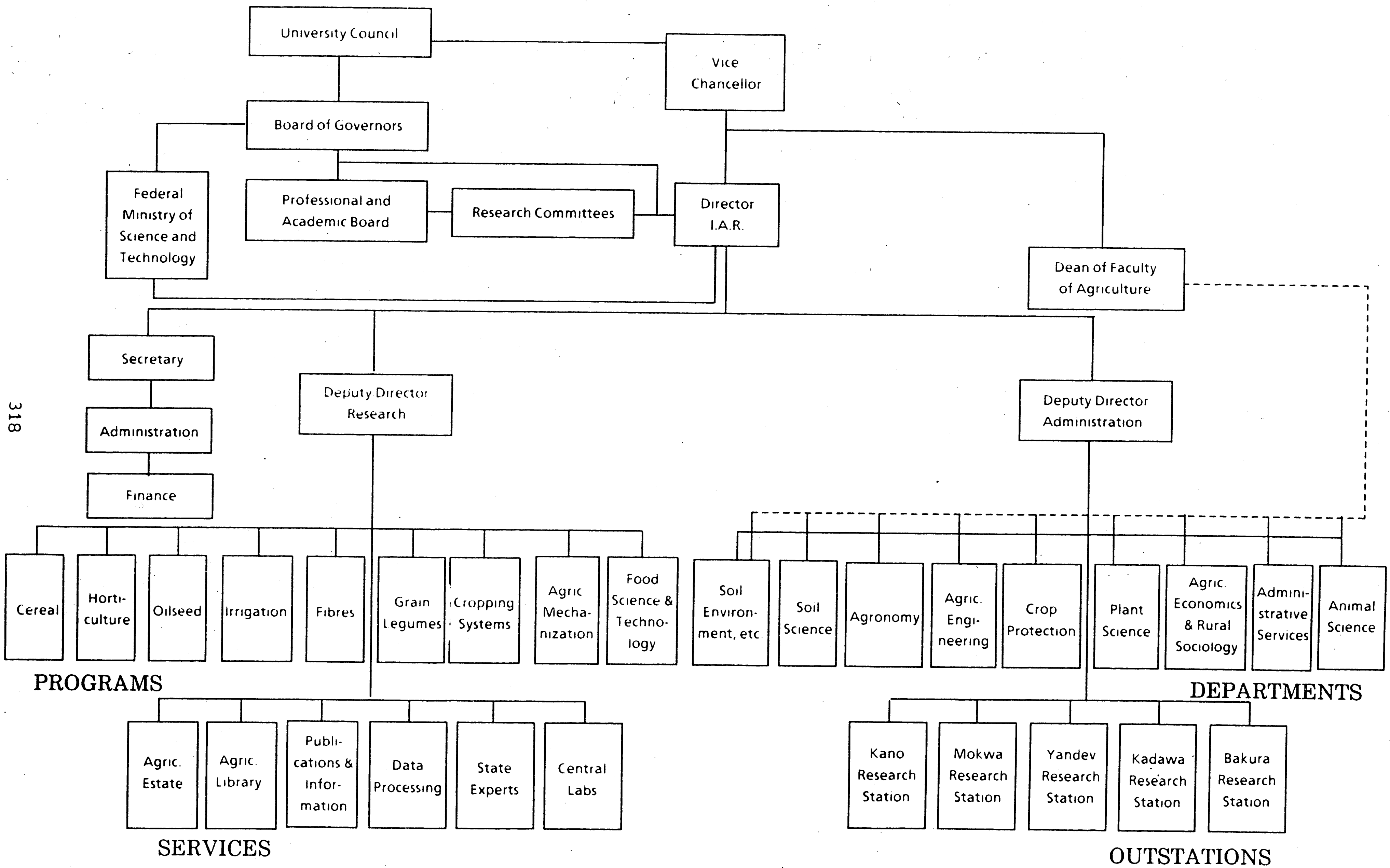


Exhibit 10

Exhibit 10

ORGANIZATIONAL CHANGE AT SAMARU, NIGERIA

The proposed Organizational Change
Separating Programs from Departments



Chapter 13

THE NILE VALLEY PROJECT

THE NILE VALLEY FABA BEAN PROJECT:

A Management Commentary

"The Nile Valley Faba Bean Project" focuses on an endeavor that involved the national agricultural research organizations of Egypt and Sudan, as well as the International Center for Agricultural Research in Dry Areas (ICARDA) located at Tel Hadya, Syria. The prime purpose of the project was to improve faba bean yields in Egypt and Sudan and thereby to increase the food security of the two countries.

The case situation deals with the linking of national agricultural research systems to the international agricultural research system represented by the Consultative Group on International Agricultural Research. It shows the different roles that national and international agricultural research institutions can play. The case identifies the benefits that can accrue from cooperation among institutions and illustrates the forms that the cooperation can take. The case also raises the issue of what kinds of linkages should exist among the institutions, given their objectives and resource bases.

Collaboration is a dynamic process. Environments change, priorities shift, and the forms of collaboration adjust. Generally, national research endeavors become more self-sufficient over time, the inputs of international bodies are modified and, in some instances, cease. As the roles of research organizations change, so does the nature of the linkages that relate them to each other.

The Nile Valley Faba Bean Project underscores the fact that access to policymakers by managers of agricultural research centers is not sufficient. Established linkages that are not used are no better than linkages that do not exist. The management challenge is what to do with the linkages -- how to articulate the needs, interests, and accomplishments of the institute; how to achieve the flow of relevant information; and how to translate the efforts into establishing solid and continuous support for the research institution, its needs, and its endeavors.

The case situation raises the question of the role of objectives in the management of research activities. The institutional objectives of research bodies are often stated in broad terms. Having broad objectives may facilitate reaching an agreement on objectives by the interested parties. However, broad objectives generally have limited operational value, for their breadth prevents their being used to measure an organization's progress. Objectives that have operational value are carefully focused and precisely stated so they can be used both to guide the activities and to measure the achievements of the organization. The objectives of a research organization strongly influence its institutional linkages and the roles it plays in any collaborative endeavor.

a major purpose in establishing linkages among institutions is to facilitate the transfer of resources. The transfer of resources can take many forms, such as the transfer of germplasm to the institution or the assignment of a visiting scientist to a national agricultural research center.

An area frequently neglected in the transfer of resources is the transfer of management practices and procedures. International organizations that are invited to cooperate at the national level often bring to their work a set of planning and review procedures and other relevant management practices. The transfer of these practices can strengthen the management of a national agricultural research center. Like other useful research resources, management practices and procedures can seldom be simply adopted by a particular institution; they need to be adapted. The adaptation of improved management practices in research management can contribute to a more efficient use of available national agricultural research resources. The case focuses on the planning procedures of an international agricultural research center, to which Sudanese scientists have been exposed during the development of the Nile Valley Faba Bean Project. The case presents the questions: Are the planning procedures useful to the Sudanese scientists, and how must these procedures be adjusted to meet Sudanese needs?

In seeking the collaboration of an international research center, national agricultural research organizations often focus on the resources that the international center can bring to the collaboration. This is a vital part of the collaboration, but another dimension is also important. This dimension is the role of collaboration in bringing a national research center more into the international agricultural research system and in enhancing the national center's contributions toward strengthening this system. And perhaps most important, collaboration and the resulting transfer of improved management practices can enhance the efficiency and effectiveness with which the agricultural research manager implements his decisions.

THE NILE VALLEY FABA BEAN PROJECT:

A Management Case Study*

by Paul Bennell

It was 8:55 a.m. on Saturday, September 10, 1983. Over 60 Egyptian and Sudanese agricultural research scientists and representatives from a wide range of national and international organizations were taking their seats in the conference room of the Khartoum Hilton. They were there as participants and observers at the Fourth Annual Coordination Meeting of the Nile Valley Project (NVP) on faba bean research, which was a cooperative venture between the national agricultural research organizations in Egypt and Sudan and the International Center for Agricultural Research in Dry Areas (ICARDA).

His Excellency Lewa Omar Mohamed El Tayeb, First Vice-President of the Republic of Sudan, had agreed to present the inaugural address at the 1983 coordination meeting. At 9.00 a.m. precisely, he entered the conference room accompanied by Dr. Mohammed Nour, Director General of ICARDA. They were greeted by other Sudanese dignitaries who were already seated at the platform at the front of the room. These included His Excellency Sayed Sagheyroun El Zein, Minister of State for Agriculture and Irrigation; His Excellency Sayed Gaafar El Hassan, Minister of Agriculture and Natural Resources, Northern Region; Dr. Omar El Amin, Presidential Advisor on Agriculture; and Dr. Bakheit Said, Director General of the Agricultural Research Corporation in Sudan.

The vice-president began his address, "Scientists, guests, it gives me great pleasure to inaugurate this important fourth coordination meeting of the Nile Valley Project on faba bean research. The project has achieved many scientific results which are on their way to the farmer. The application of these results will lead to the availability of this important food crop to the peoples of Egypt and Sudan and, over time, to the achievement of food security. The project would not have seen the light and achieved success if it had not been for the sincere efforts of scientists of the International Center for Agricultural Research in the Dry Areas. Nile Valley Project represents a live model of fruitful international and regional cooperation."

Dr. Hubert Zandstra joined in the applause for the vice-president's speech. He worked for the International Development and Research Centre (IDRC) of Canada and had been invited to the meeting as an observer and to chair some of the working sessions. He was well known for his pioneering work on farming systems research.

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* This case is a revised edition of an earlier version distributed by ISNAR.

Dr. Zandstra had heard a great deal about NVP and was at the meeting to learn more about the project. He had a number of questions: What had this project achieved? What factors had been particularly important in the project's development? How sustainable was this research effort in the long run, especially after external assistance had finished? In what ways did the project differ from other externally supported initiatives? Could the project be replicated for other research programs in Sudan or Egypt or elsewhere in Africa and the Middle East?

The Sudanese Environment

Sudan, the largest country in Africa, has a total land area of nearly 2.5 million square kilometers. It had an estimated population of 18.9 million in 1981. The topography of the country consists of vast plains with a few scattered hills and mountain ranges. Rainfall varies from traces in the far north to over 1,500 millimeters in the southern province.

Sudan is economically poor. (Its Gross National Product {GNP} per capita was US$410 in 1981.) The average growth in per capita income measured in constant prices between 1960 to 1980 was -0.2%.

Agriculture is the mainstay of the economy. About 98% of the country's foreign exchange earnings were accounted for by agricultural exports in 1981. 19.3% of the earnings came from cotton; 18.4%, from groundnuts; 9.8%, from sesame; 12.0%, from sorghum; and 12.0%, from gum arabic. The other important commodities grown in Sudan were fruits, vegetables, wheat, sugar cane, beans, and millet (Exhibit 1).

Faba Bean Production in the Sudan

The faba bean (*Vicia faba*) is cultivated throughout the Middle East and North Africa. The production of faba beans in the 22 countries served by ICARDA accounted for 15% of the world production of the crop in the early 1980s (Exhibit 2) and exceeded the combined total production of all other pulses in the region.

Faba beans were an important staple food item for a large proportion of the population in Egypt and Sudan. While pulses accounted for only 10% of per capita protein intake in these two countries, they were of special importance for the poorer sections of the populations who rarely could afford to eat animal protein.

Whereas the area planted to faba beans in Egypt had declined by 25% since the mid-1960s, it had expanded rapidly in the Sudan during the same period (Exhibit 3). Over 60% of the faba beans raised in Sudan in 1979 was grown in the northern province, which had a population of approximately 2.5 million. The faba beans were grown as an irrigated winter crop with land preparation and sowing taking place from mid-October to early November and harvesting in late February to early March. Most producers of faba beans in the northern province were small-scale farmers whose farms averaged 2.9 hectares.

The Nile Province was the other major area of faba bean production in the Sudan. However, growing conditions in this region were less favorable than in the northern province because of higher winter temperatures.

The Agricultural Research Corporation of Sudan

The Agricultural Research Corporation (ARC) was a semi-autonomous national research body based at Wad Medani and was responsible directly to the Minister of Agriculture, Food and Natural Resources (MAFNR). Almost all agricultural research in Sudan was the responsibility of ARC, which was created by the Agricultural Research Corporation Act of 1967 to undertake crop research. In 1975, research activities in food processing, fisheries and marine biology, forestry, range and pastures, and game and wildlife were transferred to ARC.

The Board of Management of ARC met twice a year to plan general agricultural research policy and approve the annual budget and the appointment of scientists and officials. The Director General reported to the board. A technical committee and an administrative and finance committee assisted the Director General in carrying out the functions of ARC.

The technical committee was formally responsible for developing ARC's annual research program. While national commodity coordinators and station and center heads were expected to play important roles in the program formulation process, task forces with ARC and non-ARC members had also been established for a number of commodities and research areas. Scientists were supposed to present their research results and proposals at an annual agricultural meeting. These proposals were combined into an overall research program by the technical committee.

In 1983, the ARC comprised five regional research stations and 14 other research stations and centers. Research on a wide range of crops was undertaken with the largest concentrations of personnel working on cotton, groundnuts, and vegetables (Exhibit 4). In total, there were 175 scientists employed by ARC, approximately 115 of whom were directly involved in crop research. Their average age was 39 years. In addition, another 68 scientists were undertaking postgraduate courses, mostly at overseas institutions. The corresponding staff figures in October 1979 were 161 on post and 115 in training overseas. Over 65% of Sudanese scientists actively engaged in research activities had PhD qualifications in 1982.

The average salary of a research scientist at ARC in 1983 was S 3,940 to S 6,985.(1) Research scientists had received no significant salary increases for over three years despite the fact that inflation was at least 50% per annum during the early 1980s.

Of the 108 crop scientists on post in October 1979, 37 had left ARC by July 1983. While little was known about where these scientists had gone, senior ARC personnel estimated that between 30% and 50% of the Sudanese agricultural research scientists with PhDs were working in the oil producing countries or international organizations. These scientists were reported to earn post-tax salaries that were eight to 15 times higher than the salaries paid by ARC.

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(1) S 1.00 = US$0.57; US$1.00 = S 1.75

The ARC received most of its income from the central government, although it was allowed to retain any income earned from the sale of crops and other produce. Its budget was approximately S 8.0 million in 1983, over 80% of which was devoted to personnel costs. This meant that there was very limited funding available to meet all the major recurrent costs of the ARC. This scarcity of funds reduced the output of most research programs and projects.

The annual budget cycle of ARC was a lengthy and complex process. It began in January or March with a directive from ARC headquarters to all station and center heads instructing them to prepare their proposed annual budgets. After consideration by ARC's senior management and the board of management itself, an overall budget was submitted to the Ministry of Finance in March. Lengthy negotiations with ministry officials followed. Once a budget for the ARC had been approved, allocations to individual research stations were made on the basis of recommendations by the director general to the committee on finance and administration. A recent study on the managment of the ARC concluded: "Currently, budgets submitted by station directors seem little different from lists of items desired by scientists and bear almost no relation to past, current, or expected fund allocations. More importantly, budgets are not connected with identifiable projects or units of work, so the consideration of the costs of individual projects cannot become a part of a rational process of priority setting."

A comprehensive review of the agricultural research system in Sudan was undertaken by Sudanese scientists and civil servants working in collaboration with consultants from the the International Agricultural Development Service based in New York. Their report, which was submitted to the government in 1978, made a number of major recommendations (Exhibit 5). The principal structural change which resulted from this review was the attempt to institute nationwide coordination for individual crops, in place of the older pattern of organization by scientific disciplines. By 1983, national coordinators were on post for horticulture, groundnuts, cotton, and wheat research. Coordinators also existed for some discipline areas, such as botany, plant pathology, soil science, and entomology.

The national coordinator of a crop was based at the research station where the commodity had its greatest regional importance. Typically, he was responsible for a wide range of activities: the technical aspects of the commodity program nationwide; transmitting information between stations and from international sources; advising government on the commodity; organizing meetings for all program staff; preparation of annual commodity reports; and reviewing the research projects of program scientists in the field. However, due to the acute financial stringencies confronting the ARC, coordinators were not able to travel regularly from their base stations, and most of the meetings of program scientists could not be held. Consequently, the expected benefits from the new reorganization could not be fully achieved.

The International Center for Agricultural Research in the Dry Areas

The International Center for Agricultural Research in the Dry Areas (ICARDA) was established in 1977 to undertake research relevant to the needs of the agricultural systems of West Asia and North Africa. These two regions comprised 22 countries with a total population of more than 300 million people.

The center had five principal objectives:

1) to conduct research into and develop improved cropping, livestock, and cropping-livestock systems;

2) to serve as an international center for research on barley, lentils, and faba beans;

3) to serve as a regional center, in cooperation with other appropriate international agricultural research centers, for the improvement of other major crops in the region, such as wheat and chickpeas;

4) to collaborate with and foster cooperation and communication among other national, regional, and international institutions in the development, adaptation, testing and demonstration of improved crops as well as farming and livestock systems;

5) to provide and foster training in research and other activities designed to further the objectives of the center.

ICARDA's headquarters are located at Tel Hadya, Syria, about 30 kilometers south of Aleppo. ICARDA is governed by an international board of trustees. Support for ICARDA's core programs in research and training comes from a large number of national governments and international organizations. ICARDA's budget in 1982 was US$ 16.478 million.

The majority of the 65 scientists and social scientists working at ICARDA in 1982 were assigned to four main research programs. Twenty were assigned to farming systems research; 16 to food legume improvement; 13 to cereal crop improvement; and nine to pasture and forage crop improvement. Each program sought to collaborate actively with national agricultural research programs in the region.

THE NILE VALLEY PROJECT

Project Formulation and Organization

ICARDA made a detailed study of faba bean production in Egypt and Sudan in 1978. The study had two major conclusions:

1. With the exception of certain diseases, many of the major constraints to increasing faba bean production were similar in Egypt and Sudan.

2. Experimental results in both Egypt and Sudan clearly indicated high potential for increasing faba bean yields through the use of improved cultivars and agronomic practices. Experimental yields were frequently 50% to 100% greater than the yields obtained by farmers.

In 1978, Dr. Mohamed A. Nour, then Deputy Director General of ICARDA, initiated a dialogue with the governments of Egypt and Sudan on ways of strengthening research and training links with ICARDA, and on the possible role of the center in supporting collaborative research between the two countries. Subsequently agreements were signed by ICARDA with the two governments.

Further discussions between the two governments and ICARDA focused on the establishment of a research project to address the problems of increasing faba bean production in both countries. With full backing from the Egyptian and Sudanese governments, a formal proposal for funding such a project was submitted by Dr. Nour in February 1979 to the International Fund for Agricultural Development. The proposal was accepted by the executive board of IFAD, and a technical agreement was signed in May 1979. The project became operational in July 1979. Funding for the first three years of the project, which covered the period 1979 to 1982, amounted to US$3 million.

The objectives of the Nile Valley Project were stated as follows:

1) to test recommended practices and cultivars on farmers' fields in order to evaluate both the practicality and the potential contribution of these recommendations at the farm level and to provide feedback for further research;

2) to conduct backup research in order to improve current recommendations and to find solutions to new problems identified in on-farm trials and field surveys;

3) to encourage a multidisciplinary approach to research and to increase collaboration among the various research organizations involved in the project;

4) to strengthen the capabilities of national scientists through training, study tours, consultancies, meetings, seminars, and literature exchange;

5) to strengthen the capacity of national programs by providing funds for key research facilities, such as seed stores, greenhouses, laboratory equipment, field equipment, and supplies.

Dr. Nour, as the Deputy Director General of ICARDA, was in overall charge of the project, and Dr. Geoff Hawtin, as leader of Food Legume Improvement Program at ICARDA, was responsible for the technical aspects. While they both continued to be actively involved in the NVP, they also had many other responsibilities. Because of this situation, Dr. Bhup Bhardwaj of ICARDA was appointed Director of Administration and Operations of NVP in 1979.

ICARDA regarded its role in NVP largely as a catalyst, providing administrative and technical support only where necessary. Consequently, Dr. Bhardwaj, with his staff of two secretaries and, from 1982, an accounts officer, were the only full-time ICARDA personnel involved in the project. They were based in Cairo, Egypt. However, Dr. Bhardwaj made frequent visits to Sudan. During the 1982-83 growing season, for example, he visited Sudan four times, staying on average, five to seven days per trip.

While the NVP was supported fully by ARC, the project was planned and managed largely independently of ARC's programming and operational procedures. The evaluation and programming of the NVP was undertaken at the annual coordination meetings which were held alternately in Egypt and Sudan. The day-to-day operation of the project was the joint responsibilty of the director of administration in Sudan and the national project coordinators in Egypt.

In October 1981, ICARDA submitted a proposal to IFAD for funding of a second, three-year phase of the NVP for the period July 1982 to July 1985. It was argued that the project had already made considerable progress. The proposal was accepted by IFAD, and US$4.3 million was made available for the second phase.

Human Resources

Eighteen scientists from the ARC and five from the Faculty of Agriculture of the University of Khartoum collaborated with the NVP during 1979-1982, the period covering the first phase of the project. During the first year of NVP's second phase, a total of 19 Sudanese scientists from the ARC formally participated in the project (Exhibit 6). In addition, Dr. Bakheit Said, Director General of ARC, was asked by ICARDA to act as a consultant for the project. He was a soil scientist with over 20 years of experience and had been appointed director general in 1981.

Each scientist received an honorarium on satisfactory completion of his annual NVP research contract (Exhibit 7). Fewer than 5% of the participating scientists from Sudan had failed to complete the research work stipulated in their contracts. The amount of the honorarium to be paid was decided at a meeting of the national and scientific coordinators and the director general, immediately after the annual coordination meeting. ICARDA personnel were not involved in these deliberations.

Payment criteria were based on individual scientific input as measured by the amount of work and performance in relation to the overall research priorities of the project. Although these criteria were recognized as being rather vague, the honorarium committee rarely had any difficulty in deciding the amounts to be paid. Dr. Bakheit argued: "We can tell who is putting heart and soul into the project and who is not." Scientists received their honoraria on satisfactory completion of the contract. These payments were always made promptly.

Opinions were somewhat divided concerning the relative importance of the honoraria. Most scientists stated, however, that the payment was certainly "very useful", but few felt it was of decisive importance in influencing their participation in the project. As one scientist said, "Paying an honorarium helps to stop the grumbles about working in a remote location."

Honoraria were also being paid by other externally financed projects in Sudan. For example, the United States Agency for International Development was paying a hardship allowance of 30% to scientists involved in the Western Sudan Agricultural Research Project. In general, aid agencies were sympathetically inclined to these kinds of payments but there were some fears that "they were getting out of hand."

Training

During the first three-year phase of NVP, six scientists, three each from Egypt and Sudan, were sent on postgraduate training financed by the project. Four went to the United Kingdom, one to Canada, and one to the United States. Most carried out thesis research that focused on faba beans or food legumes in general. About 20 research workers from Egypt and Sudan visited ICARDA's main research station in Syria during the same three-year time period for training experiences that lasted from one week to six months. In addition, four scientists made study tours to European countries.

During the 1983 Annual Coordination Meeting of the Nile Valley Project, Dr. Habib Ibrahim, the training officer for the Food Legume Improvement Program at ICARDA, held extensive discussions with NVP scientists in order to identify training requirements. It was agreed that two technicians from Hudeiba Research Station would go for six-month training courses at ICARDA and four Sudanese scientists would also make visits of up to one month. Two scientists would start postgraduate courses in economics and pathology, but at local rather than foreign universities, since this would allow them to participate directly in NVP on a continuous basis. Finally, a two- to three-week training course, mainly for Sudanese technicians involved in NVP, and a mid-season meeting of NVP and ICARDA scientists and consultants would be held in the Northern Province in January 1984.

Dr. Ibrahim also asked four of the Sudanese scientists who had been involved with the farmer-managed trials if they would help conduct a workshop on on-farm trials to be held at ICARDA in July 1984. The four scientists agreed to be involved in the workshop.

Physical Resources

Research on faba beans in Sudan was conducted by scientists based at five research stations: Hudeiba, Shendi, Rahad, Shambat, and Wad Medani. Hudeiba research station had the largest number of scientists working on faba beans. It was situated some 300 kilometers north of Khartoum, and the journey from the capital took six to eight hours on an unpaved road, mostly across desert. The station was established in 1960 through the joint efforts of the government of Sudan and the Federal Republic of Germany in order to help boost agricultural production in the Northern Province. In 1963, Sudanese scientists took over the running of the station. Six research units existed in 1983: agronomy and crop physiology, plant breeding, entomology, botany and plant pathology, soil sciences, and horticulture. Scientists from all the units were involved in the NVP.

The research station had good staff housing and intermittent electricity and water supplies. Hudeiba was a particularly uncomfortable place at which to live during the summer months with average temperatures as high as 40 degrees centigrade and frequent sand storms. Visiting ICARDA scientists often commented among themselves on the difficult conditions under which scientists at Hudeiba had to work.

Shambat Research Station, on the other hand, was located only two kilometers from Khartoum near the campus of the University of Khartoum. Seven scientists were stationed there in 1983, one of whom was a member of the NVP.

Wad Medani, the third largest city in the Sudan, is located some 180 kilometers to the south of Khartoum. The station there had over 50 scientists, five of whom were involved in the NVP. The head office of ARC was also located at the research station.

A wide range of field and laboratory equipment was supplied to scientists involved in the NVP. Major items comprised:

1) vehicles for visits to on-farm trials by scientists and support staff: 10 vehicles were specifically assigned for NVP activities at Hudeiba Research Station, another two were for general use, and two more were given to ARC;

2) field equipment, such as tractors, irrigation pumps, sprayers, generators, and innoculation chambers;

3) laboratory equipment. Most of the equipment supplied was simple since it was intended to facilitate the backup research of NVP. Some scientists had requested quite sophisticated equipment (e.g., amino acid analysers), but their requests had been refused on the grounds that research of this type was not compatible with the on-farm research orientation of NVP;

4) office equipment, including typewriters, overhead projectors, and photocopiers.

General operational expenses of NVP equipment were also covered by project funds (Exhibit 8). While the ordering, payment and delivery of imported equipment and supplies was undertaken by the director of administration based in Cairo, it was the responsibility of the national coordinator to ensure that all equipment was well utilized and maintained.

Given the NVP's emphasis on on-farm trials, the provision of transport was of critical importance. Fuel was often difficult to obtain, especially at Hudeiba where only 44 gallons per week were allotted to the project. Dr. Hussein encouraged project drivers and mechanics to take good care of all vehicles. As a result, he had managed to keep most of the vehicles operating for four years, whereas the average life of other ministry vehicles in the Northern Province was only one to two years.

Financial Resources

Detailed budgets were submitted to IFAD as part of the first- and second-phase proposals of the NVP. Once these had been approved, IFAD handed over all responsibility for budgeting activities to ICARDA. IFAD did not place any restrictions on sources of equipment for the project or where formal postgraduate training courses could be undertaken.

The director of administration prepared annual budgets for the ICARDA project administration and the Egyptian and Sudanese research programs which were considered and approved at the annual coordination meetings. These were modified where necessary, to take into account changes in the national programs agreed upon at the meeting. Funds could be transferred easily from one expenditure line item to another, although during each phase of the project total expenditures in Egypt and Sudan had to be about equal.

Communications

NVP scientists had the opportunity to present their research results in the Faba Bean Information Service (FABIS) Newsletter which was published by ICARDA and had a worldwide circulation (Exhibit 9). FABIS was free and was sent regularly to participating scientists. Six newsletters had been produced by June 1983, and over 20% of the Sudanese NVP scientists had had at least one article accepted. Scientists had some hesitation to publish in FABIS during the initial stages of the project, but by 1982, far more articles were being submitted than could be published. Over 10 consultant reports were also commissioned by the NVP on various aspects of faba bean production in the Nile Valley.

In March 1981, NVP hosted the First International Faba Bean Conference in Cairo. It was attended by 150 people, and 50 scientific presentations were made. The proceedings of the conference were published as a book by an international scientific publishing company.

The Annual Coordination Meeting

The 1983 Annual Coordination Meeting began on Saturday, September 10, and finished on Wednesday, September 14. Most of the first three days were spent discussing the results of the research undertaken during the

1982-83 season. Sessions started at eight in the morning and, with a three-hour afternoon rest break, continued until eight at night and sometimes longer. Scientists were expected to make short presentations of their research results and then to answer questions. Initially, this had been a novel experience for most of the Sudanese scientists, since they had never addressed large gatherings as part of a public evaluation of their research work by professional peers. However, at the 1983 meeting session, chairmen faced considerable difficulties in keeping speakers to their allotted times. One scientist complained, "I have worked all year for this opportunity and I'm not going to be given five minutes to present my results."

Also, at the meeting was a group of Sudanese scientists who were interested in joining the NVP. Some had been invited by the project coordinators and the director general, but others were there on their own initiative. The majority of this latter group wanted to start research on faba beans which was not considered to be in accordance with the project's research priorities at that stage, and they were not allowed to join. The national and research coordinators were frequently seen talking with the scientists who wanted to participate in the project. The research coordinator felt particularly pressed, "Since the project offers them better research facilities and the chance to travel to meet other Sudanese and foreign scientists, I am always being pushed by them for inclusion in the group."

At the evening session on Tuesday, discussions began on the research programs for the 1983-84 season. The programming process was undertaken in four stages. The first and most time-consuming were the discussions held among each group of Egyptian and Sudanese scientists. ICARDA personnel were not in attendance. The Sudanese held their first meeting during the rest period on Tuesday afternoon and, although they had to stop with the start of the evening session, reconvened immediately afterwards and did not finish until two o'clock in the morning. And throughout the next day they continued to hold last-minute meetings whenever possible. Dr. Bakheit chaired all these meetings. He observed, "The nature of our meetings has changed. Two years ago there were certain professional rivalries that had to be sorted out but that's a thing of the past. We now focus on really discussing our proposed program."

In the second stage of the programming process, Egyptian, ICARDA, and Sudanese scientists from each of the major disciplines met in separate groups to discuss their research proposals. The deadline for these in-country and discipline discussions was midday on Tuesday.

This deadline marked the beginning of the third stage which was program presentations to the whole meeting. This stage was completed in time for the official close of the coordination meeting in the evening.

The following day, the program committee met in closed session to consider the proposed research programs and to finalize the budget. Membership of the committee comprised Drs. Hawtin and Bhardwaj from ICARDA, the national and research coordinators from Egypt and Sudan, and the Director General of ARC. Dr. Nour from ICARDA was also present.

The Role of ICARDA Scientists

Twelve ICARDA professionals were involved in the NVP during 1982-83 (Exhibit 10). Most were members of the Food Legume Improvement Program, although the economist, microbiologist, and weed scientist were from the Farming Systems Program. Over 50% of the scientists had been involved with the project from its inception in 1979. They visited Sudan in two groups at different times during the 1982-83 season to discuss problems with the Sudanese scientists and, where appropriate, offer advice and assistance. Their other major involvements in NVP were attending the annual coordination meetings and assisting Egyptian and Sudanese scientists and technicians who visited ICARDA during the year for training courses or familiarization tours. In a few instances, ICARDA scientists agreed to analyze faba bean plant materials when the necessary equipment was not available in the Sudan.

Both ICARDA and Sudanese scientists felt that ICARDA's most important role had been in the areas of agronomy and farming systems research. As one Sudanese said, "ICARDA's main input has been to induce us to simplify our on-farm trials by considering fewer factors and continually urging us to develop simple packages of recommendations that can be used by farmers." Collaborative breeding work was more limited in scope because of the large ecological differences between Syria and the Nile Valley.

1982-83 Research Results

The NVP research program was divided into two main components: on-farm trials (OFT) and backup research. From the very outset of NVP, primary emphasis had been placed on undertaking research on farmers' fields. Three distinct types of OFT research had been delineated:

1) scientist-managed OFT where the scientist was in full control of all treatments and farming practices;

2) jointly managed OFT where the farmer was given some autonomy to carry out recommended practices;

3) farmer-managed OFT where scientists played only a monitoring role.

Backup research comprised activities undertaken mainly at research stations and had as its primary objective to analyze all aspects of the production of faba beans in order to develop better sets of recommendations for the farmer. In 1982-83, NVP resources were divided equally between on-farm trials and backup research.

At the Fourth Annual Coordination Meeting, most attention focused on the results of the 1982-83 farmer-managed trials (Exhibits 11 and 12). In Sudan these trials had been conducted in three different areas: Selaim, Aliab, and Zeidab. The trials were designed to compare a recommended package of management practices being used under farmers' conditions. The package consisted of a recommended date of planting, a watering regime, and an insect pest control program. At Selaim, the package also included hand weeding. Each representative farmer adopted the recommended practice on an area of about half a hectare; the remaining part of the farm was not affected. The farmer-managed trials were conducted at seven dispersed locations in Aliab, six in Zeidab, and four in the Selaim area. Soil analysis, insect, pest, disease, and weed surveys were undertaken at all the locations. Quality determination and economic evaluations were also executed.

Conclusion

Dr. Zandstra felt exhausted by the time the coordination meeting finally finished on Wednesday afternoon. He had been so busy listening to the sessions and talking to scientists he had not even set foot outside the hotel during the five days of the meeting. He had learned much about NVP but had not yet had an opportunity to organize his thoughts properly. Many factors had to be taken into account in trying to evaluate the achievements to date of NVP. He thought his first step would be to identify the factors which had had the strongest impact on the work of the NVP and then to mark them in order of importance.

As Dr. Zandstra reflected on the meeting, several questions were on his mind. First, he wondered what factors had been most responsible for the project achievements to date. Second, he wanted to identify the linkages that had been established in the project that could be transferred to research activities in other settings. Third, he wished to delineate the benefits that accrued in this project to the national agricultural research systems of Sudan and Egypt and to ICARDA and, specifically, to identify who had benefited the most from the relationship. Finally, he wondered about lost opportunities -- opportunities for collaboration among the participants that the project offered but that the participants either did not identify or chose not to exploit. The trip from Canada to Egypt had been a long one, but Dr. Zandstra felt that if he could gain insight into the issues raised by the questions on his mind, the journey would have been worthwhile.

Exhibit 1

THE NILE VALLEY FABA BEAN PROJECT

Area Harvested, Yield and Production of Major Agricultural Commodities in Sudan

	Area harvested (1,000 ha)				Yield (kg/ha)				Production (1,000 MT)			
	1969-71	1979	1980	1981	1969-71	1979	1980	1981	1969-71	1979	1980	1981
Cotton	502	435	412	397	1362	935	808	730	1126*	669*	548*	477*
Groundnuts	490	980*	960(F)	950(F)	756	898	844	842	370	880*	810*	800(F)
Maize	39	60(F)	61(F)	65(F)	780	750	738	769	31	45*	45(F)	50(F)
Millet	750	1293	1300(F)	1250(F)	566	425	346	400	424	550	450(F)	500(F)
Sorghum	1828	3025	3000(F)	3100(F)	834	796	733	901	1525	2408	2200(F)	2800(F)
Wheat	118	247	240(F)	240(F)	1136	718	963	750	134	177	231	180(F)
Rice	4	4(F)	4(F)	5(F)	1113	1750	1750	1696	5	7(F)	7(F)	8(F)
Sesame	720	830(F)	830(F)	830(F)	355	247	241	241	256	205*	200*	200(F)
Gum arabic												
Fruit	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	597	754(F)	777(F)	795(F)
Sugar cane	13	26	26(F)	30(F)	65458	66341	58594	8000	825	1700(F)	1500(F)	2400(F)
Faba beans	10	13	16(F)	17(F)	1497	1613	1327	1243	15	21*	22(F)	22(F)
Haricot beans	3	3	3(F)	3(F)	1035	1600	1600	1600	3	4	4(F)	4(F)
Chickpeas	3	3(F)	3(F)	3(F)	907	931	933	933	3	3*	3(F)	3(F)
Castor	10	10(F)	10(F)	11(F)	1020	1000	1000	952	10	10(F)	10(F)	10(F)
Vegetables	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	624	821	834(F)	854(F)

* Unofficial estimate.
(F) FAO estimate.
MT = Metric ton
Source: FAO Production Yearbook 1981.

Exhibit 2

THE NILE VALLEY FABA BEAN PROJECT

... of Faba Beans by Major Producer Countries 1969-71-1979-81

Exhibit 2

THE NILE VALLEY FABA BEAN PROJECT

Area Harvested, Yield, and Production oF Faba Beans by Major Producer Countries 1969-71-1979-81

	Area harvested (1,000 ha)				Yield (kg/ha)				Production (1,000 MT)			
	1969-71	1979	1980	1981	1969-71	1979	1980	1981	1969-71	1979	1980	1981
World	4577	3783	3760	3619	961	1112	1119	1154	4399	4209	4207	4178
Africa	678	761	734	708	1227	1001	969	1012	832	761	711	716
Algeria+	28	46	46(F)	46(F)	687	601	630	630	19	27	29(F)	29(F)
Egypt+	127	105	110*	105*	2196	2250	2016	2495	278	236	221*	262*
Ethiopia+	280	309*	325*	325(F)	1077	880	852	852	302	272*	277*	277(F)
Libya+	3	7(F)	7(F)	7(F)	521	1000	1000	986	2	7(F)	7(F)	7(F)
Morocco	179	208	156	130*	1093	710	670	500	196	148	104	65*
Sierra Leone		1(F)	1(F)	1(F)	1116	1091	1091	1091		1(F)	1(F)	1(F)
Sudan+	10	13	16(F)	17(F)	1497	1613	1327	1243	15	21*	22(F)	22(F)
Tunisia+	51	73	74	77(F)	395	685	689	702	20	50	51	54(F)
Central America	78	62	68	75	588	987	1086	1285	46	62	74	97
Caribbean												
Dominican RP	6	8(F)	8(F)	9(F)	860	934	928	930	5	7	8	8(F)
Guatemala	15	20(F)	20(F)	20(F)	455	446	450	450	7	9	9(F)	9(F)
Jamaica					724	621	586	710				
Mexico	56	35	40	46	594	1307	1443	1716	34	46	57	79
South America	242	220	229	232	545	478	495	498	132	105	113	115
Argentina	1	1	1	1	3289	3448	4458	4231	4	3	4	3
Bolivia	8	11(F)	11(F)	11(F)	607	909	909	909	5	10(F)	10(F)	10(F)
Brazil	183	163	170(F)	173(F)	470	332	353	358	86	54	60(F)	62(F)
Ecuador	22	7	8	8(F)	605	587	580	575	14	4	5	5(F)
Paraguay	4	16	16(F)	16(F)	647	830	844	875	3	13	14(F)	14(F)
Peru	23	23	23(F)	23(F)	901	904	917	913	20	21	21(F)	21(F)
Uruguay					2617	2619	2619	2636	1	1(F)	1(F)	1(F)
Asia	2968	2359	2358	2259	893	1182	1183	1236	2649	2788	2789	2791
China	2900(F)	2300(F)	2300(F)	2200(F)	885	1174	1174	1227	2567(F)	2700(F)	2700(F)	2700(F)
Cyprus+	3	2*	3*	3(F)	877	1217	1296	1231	2	3*	3*	3(F)
Gaza Strip						5000	5000	5000				
Iraq+	18	16(F)	16(F)	16(F)	1036	1058	1063	1049	19	17(F)	17(F)	17(F)
Israel					600	133	235	235				
Japan	7	1*	1*	1(F)	1127	1186	1130	1167	7	2*	1*	1(F)
Jordan+	1				2144	383	675	684	2			
Lebanon+	1				976	3333	3333	3333	1	1*	1*	1(F)
Syria+	8	8	7	8	1223	1700	1857	1834	9	14	13	15
Turkey+	32	31	30	30(F)	1326	1689	1733	1767	42	52	52	53(F)
Europe	610	369	362	335	1212	1316	1395	1324	740	485	504	443
Developed All	617	382	373	346	1211	1290	1397	1328	748	493	521	459
Developing All	3960	3401	3387	3273	922	1092	1088	1136	3652	3715	3686	3718

+ Countries served by ICARDA. * Unofficial estimate. (F) FAO estimate. MT = metric ton.
Source: FAO Production Yearbook 1981.

Exhibit 3

THE NILE VALLEY FABA BEAN PROJECT

Total Area and Average Seed Yield of Faba Beans in Sudan
1965-1980

Cropping Season	Area (in ha)	Yield (metric tons/ha)
1965/66	7,100	1,399
1966/67	7,600	1,587
1967/68	9,700	1,345
1968/69	9,700	1,242
1969/70	9,700	1,552
1970/71	11,300	1,587
1971/72	18,900	2,009
1972/73	12,200	1,395
1973/74	14,700	1,399
1974/75	16,000	1,816
1975/76	18,100	1,825
1976/77	16,000	1,752
1977/78	17,700	1,925
1978/79	13,900	1,587
1979/80	21,400	1,773

Source: ARC.

Exhibit 4

THE NILE VALLEY FABA BEAN PROJECT

Breakdown of Crop Research Activities in Sudan by Scientist Involvement and Number of Experiments, February 1981

Commodity	No. of Scientists Involved	Full-Time Involvement	Number of Experiments
Cotton	46	17	138
Kenaf	3	0	3
Sorghum	14	2	45
Wheat	11	5	68
Millet	1	1	3
Rice	1	0	10
Maize/Barley	6	1	10
Groundnuts	27	5	47
Sesame	11	1	17
Soyabean/Sunflower/Castor	5	3	29
Faba beans	15	3	42
Haricot/Chickpeas/Lentils	7	1	11
Vegetables	25	13	175
Citrus	9	3	81

Source: ARC.

Exhibit 5

THE NILE VALLEY FABA BEAN PROJECT

Main Recommendations of Review of the Agricultural Research System in Sudan Conducted by the International Agricultural Development Service, 1977

The assessment of present research capabilities shows a resource base for agricultural research and education beyond the level of most countries whose stage of development is similar to that of the Sudan. However, this assessment also discloses opportunities for substantial strengthening of the national research capabilities. The following strategies are proposed for improving the research system -- over the Six-Year Plan period and in the time beyond -- so that it can be more responsive to the needs for sustained technology inputs in advancing national agricultural development:

1. improve the organization and operation of the Agricultural Research Corporation so that it will embrace and support the scope of activities transferred to it in recent years, integrate crop and livestock research and development services, and be responsive to the needs of the different types of farming and geographic areas of the Sudan;

2. develop the coordinated, multidisciplinary team approach for major commodity and problem areas in order to ensure effective and efficient application of research resources to constraints on production;

3. strengthen the national research station network in order to allocate more manpower and other resources to the traditional subsistence areas of the West and the tropical regions in the South, and at the same time maintain direct research and technology backstopping for the important food-producing irrigated areas and the mechanized farming schemes;

4. establish procedures for determining manpower needs and for training professional and technical staff, and improve personnel management policies and procedures;

5. strengthen research on (a) the economics of production, (b) marketing, (c) social factors that will become increasingly critical and generate stress as the development and modernization of the country's agriculture accelerate;

6. strengthen capabilities for evaluation and application of new technology, including the transfer of new information through more effective linkages with extension organizations;

7. provide for more effective linkages with external technical cooperation and assistance organizations, including the international agricultural research centers.

Exhibit 6

THE NILE VALLEY FABA BEAN PROJECT

Some Characteristics of the Sudanese Scientists Involved in the Nile Valley Project 1982/83

Discipline	Research Station	Joined* ARC	Highest Qualification	Completed	University	% time devoted to N.V.P.
1. Agronomist	Hudeiba	1972	Ph.D.	1979	Reading	60
2. Economist	Wad Medani	1972	Ph.D.	1982	(Germany)	30–45
4. Agronomist	Hudeiba	1972	Ph.D.	1978	Bangor	60
5. Breeder	Shambat	1957	Ph.D.	1975	Arizona	100
6. Food Technologist	Shambat FRC	1967	Ph.D.	1980	(India)	50
7. Water Relations	Wad Medani	1963	Ph.D.	1979	Reading	50
8. Soil Scientist	Soba	1969	Ph.D.	1979	California	20
9. Microbiologist	Wad Medani	1967	Ph.D.	1980	Reading	30
10. Agronomist	Wad Medani	1963	Ph.D.	1968	Nottingham	50
11. Soil Scientist	Hubeiba	1964	Ph.D.	1968	Aberdeen	60
12. Entomologist	Hudeiba	1972	Ph.D.	1981	Newcastle	60
13. Pathologist	Hudeiba	1962	Ph.D.	1972	Exeter	50
14. Breeder	Hudeiba	1968	Ph.D.	1980	Oxford	33
15. Pathologist	Shambat	1981	B.Sc.	1981	Cairo	30
16. Weed Scientist	Hudeiba	1976	M.Sc.	1980	Ghent	40
17. Food Technologist	Shambat	1978	B.Sc.	1978	Alexandria	35
18. Agronomist	Shendi	—	—	—	—	—
19. Pathologist	Wad Medani	—	—	—	—	—

* Unless otherwise indicated all scientists received their first degree from the University of Khartoum.

Exhibit 7

Proposal for Honorarium for Sudanese National Scientists and Support Staff, 1982-1983

Scientist/Discipline	Honorarium 1981/1982	Proposal 1982/1983
I. Scientist/Location	US$	US$
1. Soil Science, Hudeiba	1,000	1,500
2. On-farm Research and Agronomy, Hudeiba	4,000	4,500
3. Weed Control, Hudeiba	1,450	1,700
4. Agronomy, Hudeiba	1,400	2,200
5. Plant Pathology, Hudeiba	1,875	2,200
6. Agronomy, Shendi	1,500	2,000
7. Water Relations, Wad Medani	Nil	700
8. Breeding and Agronomy, Shambat	4,000	4,300
9. Nutritional Quality, Shambat	650	1,000
10. Water Relations and Agronomy, Wad Medani	1,000	2,000
11. Microbiology, Wad Medani	Nil	700
12. Entomology, Hudeiba	500	1,400
13. Microbiology, Shambat	1,200	Nil
14. Breeding, Hudeiba	1,500	2,250
15. Plant Pathology, Wad Medani	1,000	1,250
16. Plant Pathology, Shambat	750	800
17. Soil Science, Shambat	500	800
18. Plant Physiology, Hudeiba	Nil	1,000
19. Extension	Nil	500
20. Statistics	Nil	1,000
21. Socioeconomics	Nil	1,200
SUBTOTAL	US$ 22,325	US$ 34,250

Exhibit 7 (continued)

THE NILE VALLEY FABA BEAN PROJECT

Proposal for Honorarium for Sudanese National Scientists and Support Staff, 1982-1983

Scientist/Discipline	Honorarium 1981/1982	Proposal 1982/1983
II. Support Staff		
1. Technicians, on-farm research	2,912	3,100
2. Technicians, Shendi	440	600
3. Technicians, Plant Pathology, Hudeiba	1,176	1,200
4. Technicians, Soil Science, Hudeiba	1,176	1,200
5. Technicians, Weed Control, Hudeiba	385	400
6. Technicians, Entomology, Hudeiba	784	1,200
7. Technicians, Microbiology, Shambat	385	500
8. Accountant, clerk, typist, telex operator, and other support staff, Hudeiba	1,960	1,960
9. Drivers	560	600
10. Miscellaneous support staff at Hudeiba and other sites	840	840
11. Support staff, Shambat	792	900
12. Technicians, Agronomy and Breeding, Shambat	728	800
13. Technicians, Nutritional Quality, Shambat	330	350
14. Support staff, Agronomy, Wad Medani	110	300
15. Support staff, statistics	220	300
16. Technicians for extra work load at different sites	3,500	3,500
17. Technicians, Agronomy, Hudeiba	1,960	2,000
	Subtotal	19,750
III. Project Administration and Coordination		
1. National Coordinator	3,500	4,300
2. National Research Coordinator	1,500	1,700
	Subtotal	6,000
	Grand total	60,000

Exhibit 8

THE NILE VALLEY FABA BEAN PROJECT

ICARDA:IFAD Nile Valley Project on Faba Beans
Budget for 1982-1983
(US$ 000's)

	Items of Expenditure	ICARDA	EGYPT	SUDAN	TOTAL
I.	Personnel emoluments				
	Salaries	120.0			
	Other employment costs	85.0			
	Consultants		30.0	30.0	60.0
	Honoraria		90.0	60.0	150.0
	Casual labor daily	2.0	8.0	9.0	19.0
	Subtotal	207.0	128.0	99.0	434.0
II.	General expenses				
	Building and operation expenses	30.0	-	-	30.0
	Research supplies and expenses	5.0	10.0	15.0	30.0
	Travel international	25.0	10.0	11.0	46.0
	Travel local	2.5	15.0	15.0	32.5
	Vehicle maintenance and operation	8.5	13.0	14.0	35.5
	Meeting and conferences	-	15.0	15.0	30.0
	Staff education and training	-	75.0	75.0	150.0
	Printing and publication	-	9.0	9.0	18.0
	Miscellaneous	21.0	8.5	10.5	40.0
	Subtotal	91.0	155.0	164.5	411.0
III.	Items costing US$ 100 or above				
	Motor vehicle	15.0	40.0	40.0	95.0
	Field equipment*	8.0	38.0	42.0	88.0
	Research equipment*	7.0	60.0	60.0	127.0
	Office equipment	8.0	4.0	5.0	17.0
	Household furnishing	3.0	-	-	3.0
	Subtotal	41.0	142.0	147.0	330.0
	Total	339.0	425.0	410.0	1175.0
IV.	ICARDA overhead	-	63.7	61.3	125.0
	Grand total	339.0	489.2	471.8	1300.0

Note: Funds under items of expenditure marked * at the disposal of and/or to be spent in consultation with Director, Administration, ICARDA, Cairo.

Exhibit 9

THE NILE VALLEY FABA BEAN PROJECT

Country Analysis of FABIS Newsletter Mailing List

	Nationals	Nonnationals
NEAR EAST AND AFRICA	160	22
AFGHANISTAN	2	-
ALGERIA	8	-
BANGLADESH	5	
CAMEROUN	-	1
EGYPT	29	
ETHIOPIA	3	-
INDIA	7	2
IRAN	5	-
IRAQ	6	-
IVORY COAST	-	1
JORDAN	10	-
KENYA	-	1
LEBANON	14	1
LIBYA	2	1
MAURITIUS	1	-
MOROCCO	2	3
NEPAL	2	1
PAKISTAN	4	-
QATAR	1	-
SAUDI ARABIA	1	-
SUDAN	24	-
SYRIA (inc. ICARDA)	15	10
TUNISIA	4	-
TURKEY	14	-
YEMEN	1	1
FAR EAST + AUSTRALASIA		38
AMERICAS		59
EUROPE		244

Exhibit 10

THE NILE VALLEY FABA BEAN PROJECT

Some Characteristics of the ICARDA Scientists Involved in the Nile Valley Project, 1982/83

Discipline	Nationality	Approximate age	% of working time devoted to NVP
Agronomist	Indian	mid 40s	15-20
Breeder	British	mid 30s	10
Breeder	U.S.	mid 30s	15
Breeder	Egyptian	late 30s	100
Breeder (lentils)	British	mid 30s	5
Weed Control	Polish	early 40s	10
Pathologist	Syrian	early 40s	15-20
Economist	U.S.	early 30s	30
Entomologist	Columbian	early 40s	10
Biometrician	U.S.	mid 50s	2
Training Officer	Sudanese	mid 30s	5
Microbiologist	Canadian	late 40s	2

Exhibit 11

THE NILE VALLEY FABA BEAN PROJECT

Grain Yield (in kg/ha) of Farmer-Managed Trials Compared with
General Farmer's Yield in Different Locations in Aliab, Selaim, and Zeidab Schemes

	Location									
	1	2	3	4	5	6	7	Mean	S.D.	Level of significance
A. <u>Aliab scheme</u>:										
Farmer-managed trial (improved)	2301	3784	3068	2118	2300	2446	3798	2831	116	*
The remaining farmer's field	1918	2453	2410	1611	2333	2269	3215	2316		
Level of yield improvement	383	1331	658	507	-33	177	523	515		
B. <u>Selaim scheme</u>:										
Farmer-managed trial (improved)	3557	3320	3343	3537				3439	142	**
The remaining farmer's field	3237	2813	2453	2998				2875		
Level of yield improvement	320	507	890	539				564		
C. <u>Zeidab scheme</u>:										
Farmer-managed trial (improved)	3932	3432	2499	4136	2499	4998		3583	143	**
The remaining farmer's yield	3213	2356	875	2549	2124	3665		2464		
Level of yield improvement	719	1076	1624	1587	375	1333		1119		

* Significant at 5% level of probability

** Significant at 1% level of probability

S.D. = Standard Deviation

Exhibit 12

THE NILE VALLEY FABA BEAN PROJECT

Net Benefits for Farmers and Recommended Practices in Farmer-Managed Trials (S£/ha)

Location	1	2	3	4	5	6	7	Mean	S.D*
Aliab									
Recommended (R)	970	1721	1349	856	951	1027	1728	1229	344
Farmer (F)	860	1117	1075	719	1075	1042	1493	1054	223
R - F	110	604	274	137	-124	-15	235	175	217
Zeidab									
Recommended (R)	2062	1743	1218	2181	1218	2653		1846	518
Farmer (F)	1744	1245	385	1358	1128	2023		1314	515
R - F	318	498	833	823	90	630		532	267
Selaim									
Recommended (R)	1971	1871	1911	2015				1942	55
Farmer (F)	1925	1668	1412	1769				1694	187
R - F	46	203	499	246				249	163

Average marginal rates of return were 188% in Aliab, 217% in Selaim, and 307% in Zeidab.

* S.D. : Standard Deviation

Chapter 14

THE KALAMAR HORTICULTURAL INSTITUTE

THE KALAMAR HORTICULTURAL INSTITUTE:

A Management Commentary

"Kalamar Horticultural Institute" (KHI) focuses on a problem of growing importance to managers of agricultural research centers: how to secure and maintain adequate funding. The young institute is in a country facing a major economic crisis, and funds for agricultural research from the government are becoming increasingly scarce. Funding levels are constraining the development of the institute and the establishment of an on-going research base.

The challenges facing the manager of the institute are basic: locating, attracting, and retaining properly trained research scientists in an environment where salary levels are not even competitive with those offered by the universities; the shortage of funds for capital investment; inadequate funds for meeting the operating budget; and the irregular and unpredictable manner in which funds come from the government.

The problems facing the institute do not appear to be temporary. The government, in the face of economic crisis, has embarked on a program of austerity. Funds for agricultural research have been substantially reduced.

The case situation underscores the vital need for the manager of an agricultural research enterprise to give continuing attention to the establishment and strengthening of linkages, both internal and external. The internal linkages are vital for increasing efficiency and enhancing the utilization of funds; the external linkages, for expanding and nurturing the sources of funding.

Strong linkages, both internal and external, are built upon effective two-way communication, internally between the institute's director and the staff and externally between the institute's director and scientists and actual or potential funding sources. Communication to those outside the institute needs to be persuasive. It should focus not merely on the passing of information but also on showing how the activities of the institute are responsive to the interests of the targeted donor or institution and the needs of the country.

Effective external linkages are designed both to maintain existing sources of funds and to capture new sources of funds. Just as environments change, so do donors and their interests or abilities to support a specific research endeavor. Whenever the manager of an agricultural research endeavor secures a new source of funding, he is broadening his client base. This often creates new challenges for the institute because each donor is a client and the institute needs to respond to the interests of each client. At the same time, the broadening of the institute's resource base lessens the impact of the sudden withdrawal or reduction of funds by a specific source and simultaneously reduces the influence of any single donor on the organization's total activities.

However, an institute must guard against being all things to all people. Securing funding from any client may lead to too wide a dispersion of the institute's activities. Too wide a dispersion can cause the institute to lose the comparative advantage it has on what it does best.

An astute manager, whenever possible, involves his staff in planning and budgeting activities. This should not diffuse the energies of research scientists. To the contrary, it should have the impact of making research scientists more sensitive to client interests and helping them to focus their research endeavors.

Furthermore, the carefully designed involvement of research staff in financial activities is an acknowledgment of the core importance of planning, budgeting, and funding to the continuing health and existence of a research center. This involvement, if carefully managed, can enhance the identity of the research staff with the institute. It can lead to the budget being viewed by the staff as our budget instead of being seen as the director's or the institute's budget. At times a research manager may find it appropriate to get professional researchers involved in lobbying or seeking funds. No one can be a more persuasive spokesperson for a research endeavor than a person directly involved in the research.

Securing financial resources is an entrepreneurial activity. Public-sector regulations sometimes constrain an agricultural research manager and his fund-seeking activities, especially with donor sources outside the government. At times, however, these regulations are seen by managers as being more inhibiting and inflexible than they are in actuality, especially during times when the government is cutting funds throughout the public sector. Ultimately, the research manager is responsible for obtaining and maintaining the funding required for his institute to implement its mandate and fulfill its purposes. The effective manager continuously gives thoughtful attention to these responsibilities. Without funding, no research program, regardless of how excellent, can be implemented.

THE KALAMAR HORTICULTURAL INSTITUTE:

A Case Study*

by John McKenzie

"We are Kalamar's youngest agricultural resesearch institute -- the youngest and the most struggling," said Dr. Rajiv V. Gupta, who had been the Director of the Kalamar Horticultural Institute (KHI) in Muresh since its founding.

In June 1983, KHI was seven and one-half years old. The institute had been launched with a mandate to do horticultural research, a development plan, an area of land, a small core of capable officers, and the full support of the government. The government support, however, wavered in the institute's second year as Kalamar slipped into a major economic crisis. From that time on, funding for the development of the institute and its daily operations was continuously less than had been planned.

"Every year we propose a budget to give us enough funding to carry out our development plan and stay operational. Every year the government approves a fraction of what we ask. Then, finally, we end up getting less than was approved. Worse still, the funds arrive intermittently through the year," continued Dr. Gupta.

"We have had tremendous difficulties developing our facilities at the institute and keeping them operating. The government would favor us if we were highly productive but denies us the means to become so. When the government allocates funding, the purse is shared amongst the institutes irrespective of their demands or their peculiar needs.

"The financial situation has been getting tighter. Our trained staff has been leaving us, and we have been having difficulty in maintaining our equipment. A mature adult can withstand starvation for a time but an infant cannot.

"We have to find a solution. Our predicament is becoming critical. We need to find the means to allow us not only to survive but to prosper in a very uncertain and harsh economic environment."

The Kalamar Horticultural Institute

The Kalamar Horticultural Institute was established in November 1975. The site it occupied had originally been designated as the Fruit and Vegetable Research and Demonstration Unit, a three-year joint venture between the Kalamar Government and the FAO/UNDP which began in 1972. KHI, however, for all intents and purposes was a completely new development, requiring buildings, equipment, cleared land, and staff. The institute was given responsibility for researching all aspects of the production, distribution, consumption, storage and processing of fruit and vegetables in Kalamar. It was mandated to do research in a wide variety of crops. The research activities were organized by programs (Exhibit 1).

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* The data and issues presented in this case are based on research of an actual situation, but names and places have been created as a simulation for illustrating specific management issues.

At the time that KHI was founded, the Kalamar government was financially bouyant. Initial plans for capital development and research work at the institute were envisaged on a grand scale.

In late 1975, a five-year development plan, covering the years 1976-80, was drawn up for the institute. In mid-1976, however, the government, in the face of a national economic crisis, embarked on a policy of austerity. This meant that annual subventions to agricultural research institutes were dramatically reduced. KHI reacted by scaling down its research to focus only on the important national crops. These were crops prominent in the daily diet of the people (Exhibit 2).

"Scaling down our number of crops was easy enough," said Jagdesh R. Teja, Chief Planning Officer. "Building up the institute under heavy financial constraints was another matter."

Problems Facing the Institute

An immediate problem the institute faced was in finding personnel. When KHI was established, no pool of horticultural experts existed in Kalamar. This meant that the institute had to take research scientists with experience in other crops or train its own manpower.

Establishing research facilities at the institute dictated how rapidly it could develop its range of projects and its overall program. The most critical constraint on its research program was, however, locating qualified research scientists. The institute had been targeted to have nine agronomists employed by the end of its first five-year plan. By December 1980, it had five, three of whom were away on training, and in the midst of the second five-year plan (1981-1985), between December 1981 and January 1983, the government ordered a freeze on recruitment of staff at all agricultural research institutes in the country.

Mr. Teja commented, "It is hard to get your research work going without scientists. The manpower we needed in 1975 to get our first plan on its way has only just been established in 1983" (Exhibit 3).

"In addition, salary scales at universities and in other parts of the agricultural sector were more attractive than in the research institutes. Difficult as it has been to recruit trained staff, it has been even more difficult to retain them. We need manpower so badly, but are not able to pay a competitive rate for it."

The major problem constraining development of the institute was the low provision of funding (Exhibit 4). Shortage of capital funds severely impaired KHI's work. Many different facilities were required simultaneously for the institute to function.

Dr. Brajinder R. Singh, leader of the fruits program, said, "We have eventually cleared plots and built offices, but we still need laboratories. They are very expensive. The problem is compounded by a trend of sharply rising prices for all goods in the country. For example, if we cannot afford equipment this year, even next year when we have more funds, the cost of it will have risen beyond our means. This lack of recurrent funding means that the institute simply cannot operate adequately because we have few inputs, few spare parts, and a shortage of labor. Horticulture requires intensive hand labor, and labor requires money."

Another serious financial problem facing the institute was the unpredictable way that funds were made available. The government was supposed to issue payment to the institute four times a year on the first day of each quarter. Payments were usually either late, or less than the sum promised. In 1982, for example, the government pledged Hm 2.5 million[(1)] to the institute for capital expenditures. No payment was made in the first quarter. Then in April 1982, a letter arrived indicating that the institute would suffer a 30% reduction in its allocation. The institute planned again to utilize a capital sum of Hm 1.75 million. By the end of the year, however, the actual amount received for capital development totalled Hm 1.54 million (Exhibit 5). In 1983, the subvention was late because the national budget for the calendar year was still being debated in the House of Representatives as late as May.

"The volatility of funding makes our activities almost impossible to plan," said Mr. Teja. "At best I can plan quarter by quarter, but most of our activities are on a longer time scale."

The volatility of funding meant that suppliers and contractors were unwilling to extend credit to the institute. For many goods and services, the institute had to pay cash. Scientific research also suffered because of the unpredictability of funds. For example, much work was seasonal and it was essential that inputs and labor were available at appropriate times of the year. As one researcher said, "Unfortunately the rains do not wait upon the accounts office in the capital at Kurnuka."

Responding to the Problems

"We have been trying to cope with the situation by every means possible," said Dr. Gupta. "This has been in two ways. We have tried to get the very best use from what money we do receive. We are also looking for ways and means of going out and increasing our revenue."

The institute's five-year plan was its master plan for development. The second five-year plan for 1981-85 had been approved by the government as part of its own Fourth National Development Plan. Mr. Singh prepared his annual budget proposals in order to meet the targets of the plan. Despite this, actual subventions granted by the government were consistently smaller.

"There seems to be no relation between what we ask and what we get," said Mr. Singh. "Not only us, but all the institutes {Exhibit 6}. We make our budget proposal program by program, but our allocation comes in two lumps: one for recurrent expenses and one for capital costs. It is hard to believe that our proposal is even read. It never seems to be a question of what we need but of what slice of the annual pie the government can afford to give us."

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(1) In 1983, 1 Hima = US$1.50.

We base our estimates on genuine targets. We know they will be slashed. We are afraid to scale our estimates down because we will be given less again. Anyhow, a good reason for budgeting hopefully is that one year things may improve and we will get what we need for a change."

As soon as Mr. Singh received notification of the government's approved allocation, he could then prepare an actual, or working, budget for each quarter of the year. This would detail financial allocation by capital development or research program. The working budget would serve as a planning document. In the event of a change in allocation, as occurred in 1982 when KHI's capital subvention was cut by 30%, the working budget would be recalculated.

When the funding eventually arrived, Mr. Singh would then disburse it as closely according to his plan as possible. In the event of a shortfall in the actual amount, funding would go to priority activities, and some programs would benefit more than others. This final exercise involved juggling sums between program budgets and occasionally between capital and recurrent budgets.

"The way the wind blows," said Mr. Singh, "keeping this ship on course is a full-time occupation. However hard we try, we never end up where we mean to. The only constant thing is that we are always short of target."

The institute had certain operating expenses that were unavoidable. When planning could not guarantee that money would be available to meet these, the institute had to rely on credit or unsettled bills that could be carried forward until such time as cash was available to settle them (Exhibit 7).

Mr. Singh said, "It may look surprising that we seem to overspend. Last year, for example, we planned to cut back spending on casual labor, so we planned to reduce the number of laborers. Then the government raised the minimum wage per casual laborer from 100 to 125 Hima per month. Of course, we had to plan to reduce our number of laborers once again. By the end of the year our activities had suffered badly because of the labor deficiency, but we still ended up paying more for labor than we had estimated."

The gap between the institute's planning and budgeting, and the actual availability of funding was a consistent problem. A proposal from the planning office to revise the 1981-85 plan was being considered because the institute was so hopelessly behind its targets.

"It would be very useful if we could agree on a five-year plan and stick to it, instead of using it like a sacred chronicle of how things could be in a better world," said Mr. Singh.

"To use scarce funding to its maximum benefit I try to plan the development of the institute according to priorities. I meet with the senior staff at least once a month to discuss our activities," said Dr. Gupta. "Of course, every program leader has something that he considers urgent. But we have had to look at things the other way round: first to try and see what our minimum requirements are. Recently we have been concentrating on getting our central facilities established -- a road and a gatehouse, for example. We select our priorities informally. In a new institute like ours I think that they are self-evident. Of course, circumstances can change from month to month."

In terms of the research program, those tasks directly supportive of research work received the most attention. Clearing land and building offices and laboratories were considered more important than building staff housing. Training was also a low priority. For example, in 1982, the allocation to training was cut from 73,078 Hima to 32,177 Hima.

"In research itself, priority crops 'significant in the diets of the Kalamar people' were identified in 1976," said Dr. Gupta. "Be that as it may, we still do not have enough scientists to undertake research in those crops. In addition, we do not get enough funding to allow the scientists to undertake all their experiments. I suppose you could say our priority is to see that all our researchers are kept busy."

When research projects were threatened by the lack of resources or facilities, contingencies could be made to overcome the problem. For example, the institute had temporary laboratory facilities that were inadequately equipped for certain complex analyses. Samples requiring such analyses were taken to the nearby National Cereals Research Institute for determination.

"Contingencies have to be made to meet uncertainties of funding according to the seasons of the year," explained Dr. Singh. "If we get our first slice of funds for the year in early June, as we have just now, we are already too late for vegetable trials but in good time for fruit trials, so the money will go to fruit. Luckily we have three vegetable crops each year so we can make provision for the second and third seasons."

When funds were short, the research scientists began to find ways of maintaining their output, only more economically.

"Everyone complains of lack of resources" said Dr. V.S. Ram, head of the vegetable program. "On the other hand, you could say that it makes our research appropriate. We face exactly the same constraints as the small farmer."

Research scientists responded to shortages of funds by conducting field trials on smaller plots, with smaller plant populations requiring fewer inputs and less labor. Durable items of equipment were shared between programs. Lack of funding also oriented research toward field trials in areas of agronomy, breeding, entomology, genetic resources, and physiology and away from more costly forms of experimentation requiring laboratory facilities.

"We are omitting some important experiments," said Dr. Singh. "I admit we are staying busy, but I wonder if it wouldn't be more valuable to spend money on critical research even if we could only afford half as many experiments."

The availability of transport was also constrained by cost, and experiments were conducted locally if possible. KHI also collaborated with other institutes in other agroecological zones on projects that its scientists visited periodically.

Dr. Gupta had been active in lobbying representatives of the government. "We deserve special status," he explained. "I have expressed this often in meetings with members of the ministry. Nine of the 12 members of our board of governors are appointed by the president and I hope they are making our plight known in the highest quarters. The most encouraging development, however, is that we are now dealing with a new permanent secretary who is considering grading the agricultural research institutes according to their special needs. We are hopeful that this means we shall be given special consideration."

Over the period since austerity had been declared in 1976, KHI had looked for ways of drawing government attention to its predicament. In 1979, for example, the government embarked on a policy of Green Revolution. This policy was concerned with direct food production. KHI sought to demonstrate the way in which it could further this policy as a means of attracting more government support (Exhibit 8). KHI also sought to keep the Ministry of Science and Technology up to date regarding the institute's achievements and constraints through a quarterly report.

Although the institute was maintained by the Ministry of Science and Technology, it was able to receive assistance and financial contributions from other organizatons. The Food and Agriculture Organization (FAO) had given continuing support to the KHI since the institute's establishment; it had donated US$370,000 worth of equipment, provided eight overseas study fellowships at the MSc and PhD levels, and engaged 26 experts and consultants in projects at the institute. In 1983, FAO's involvement was being scaled down as the majority of its commitments to the institute had been met.

"We hope that FAO will continue to help us," said Mr. Teja. "We are encouraging them to extend their assistance into a second phase."

"The ministry does not discourage profit making as long as it doesn't interfere with the research work in our mandate and, of course, as long as the revenues are declared," explained Dr. Gupta. "KHI has great potential in earning an income from floriculture. Many people want to buy flowers and garden plants and no commercial nurseries or florists exist in the country."

"Because floriculture is rather out of line with our mandated objectives, I suppose I couldn't afford to engage a research scientist in flowers, but perhaps a good technical officer would suffice. I will have to calculate exactly what resources we shall require for, say, a four-hectare nursery. The idea is to make money for our research activities and not drain money away from them."

KHI was conducting a special project in the marketing of fruits and vegetables. Within the project it had three kiosks in Karnuta selling produce grown at the institute. The kiosks had proved extremely popular, and had established a demand for quality fruit and vegetables in the city. They also brought in a modest revenue (see Exhibit 9).

"The kiosks are an experiment," said Dr. Gupta. "We wanted to understand the problems of supplying variety, quality, and reasonably priced produce. In fact, with this experience, I think that if we went in for market gardening, we could do rather well out of it. Fruit and vegetable farming, of course, will consume resources. The list of inputs will be long and costly. Once we have invested, we then face risks. It is a business decision. If we are good farmers, the institute will prosper. If we suffer a crop failure, the consequences can be severe."

KHI sought to improve fruit and vegetable production in Kalamar by transforming traditional farming practices. This meant focusing on the activities of the small farmer. The institute also had the possibility of working with the food processing industry and the large commercial farmers. Some companies had expressed a willingness to pay for projects to be undertaken on their behalf.

"We could be breeding pineapples for the soft-drink industry," said Dr. Gupta, "or suitable tomatoes for canned paste, and be paid for it. The point is that we have so far chosen not to invest in any equipment for food processing research, which is extremely costly. If we want to attract income-yielding commercial projects in the future, we may have to do so. We shall have to think through the trade-offs quite carefully."

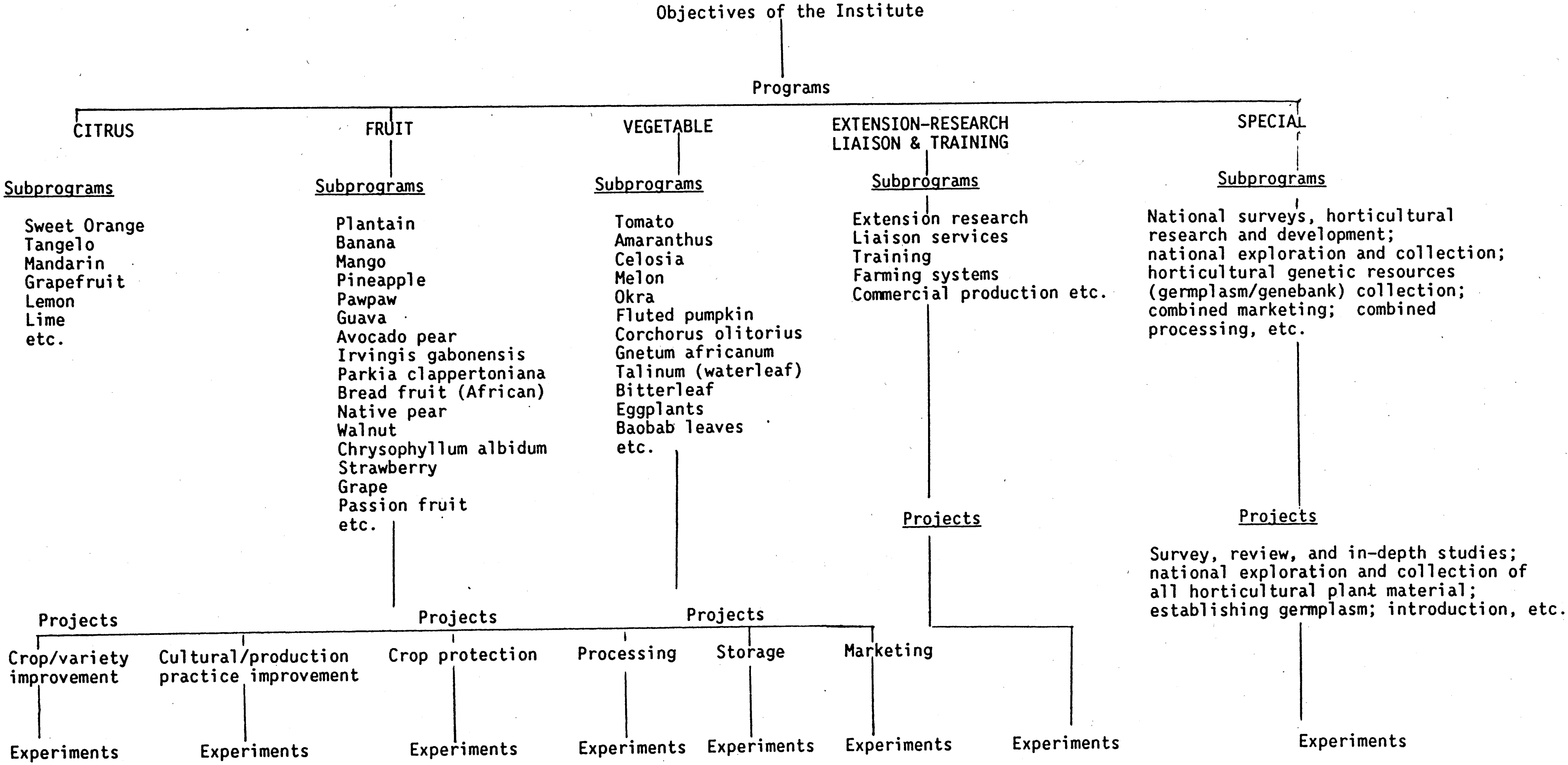
Conclusion

Dr. Gupta considered the various means by which his institute had been seeking to overcome its problems. It occurred to him that some of these means were long-term and could be considered strategies; others were short-term and could be considered tactics. The prime objective of the institute, as stated in its Establishment Order of 1975, was "to achieve a situation in which fruits and vegetables are available in Kalamar at all places, in adequate quantities, in good quality, at all times, and at reasonable prices." Dr. Gupta wondered to what extent present strategies and tactics were furthering the attainment of this objective. Of all the options, he wondered which ones in particular could secure the long-term prosperity of the institute? What should the institute do?

Exhibit 1

THE KALAMAR HORTICULTURAL INSTITUTE

Schematic Representation of the Organization of the Research Work of the Kalamar Horticultural Research Institute into Programs, Subprograms and Projects



Source: KHI Directory of Research, 1975.

Exhibit 2

THE KALAMAR HORTICULTURAL INSTITUTE

Revised Program of the Kalamar Horticultural Research Institute after 1976

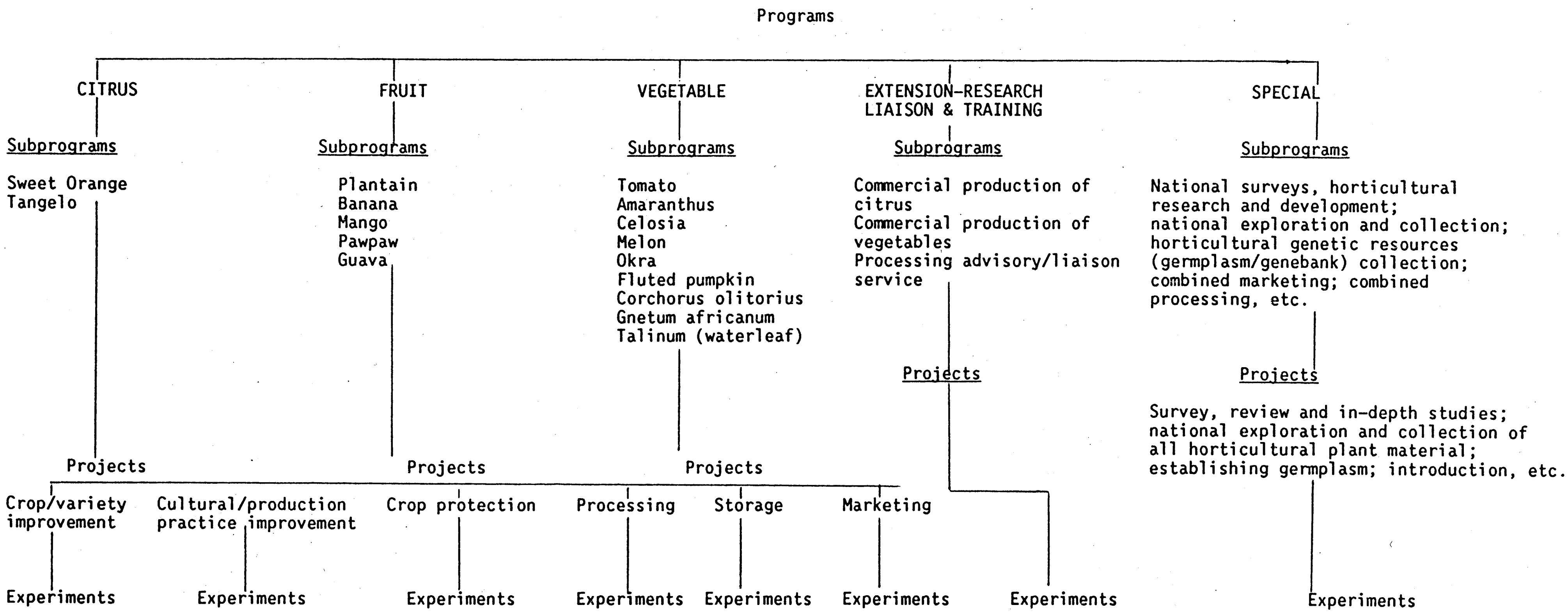


Exhibit 3

THE KALAMAR HORTICULTURAL INSTITUTE

Scientific Staff Disposition as of 31 October 1982

No.	Approved Programs 1981-85	No. Projected by 31/12/82	No. in Post 31/12/82	No. Still unfilled	Remarks
1.	Program I Vegetable improvement	35	17	18	The 18 unfilled places comprise 3 agronomists, 5 breeders, 2 physiologists, 3 crop protection officers, and 5 interdiscplinary staff.
2.	Program II Fruits/citrus improvement	33	19	14	The 14 unfilled places comprise 4 agronomists, 6 breeders, 1 physiologist, and 3 inter-disciplinary staff.
3.	Program III Development of substations	14	7	7	The 7 unfilled places comprise 2 Agronomists, 2 Breeders, 3 Crop Protection Officers.
4.	Program IV Germplasm collection and utilization (including seed technology and post-harvest technology).	17	12	5	The 5 unfilled places comprise 1 genetic resources officer, 1 genetic data processing officer, 1 food analyst, and 2 seed testing officers.
5.	Program V Development of headquarters	-	-	-	This program is mainly infra-structural. The staff comprise those of Development Planning, Estate Management, Farm Management
6.	Extension-research, liaison, and training	5	3	2	The 2 unfilled places comprise 1 production research officer and 1 extension/information officer.

Exhibit 4

THE KALAMAR HORTICULTURAL INSTITUTE

Capital and Recurrent Expenditures Requested by KHI
and Actual Allocated by Federal Government
(All Figures in Thousands of Hima)

Year	Capital Expenditures		
	Requested	Allocated	Allocated/Requested
1975/76	1,065	1,065	100%
1976/77	7,340	2,326	32%
1977/78	7,000	2,160	31%
1978/79	11,550	1,000	8%
1979/80	12,378	1,000	8%
1980*	8,672	500	6%
1981	11,563	3,500	30%
1982	19,400	1,750	9%

Year	Recurrent Expenditures		
	Requested	Allocated	Allocated/Requested
1975/76	362	672	276%
1976/77	960	424	44%
1977/78	2,064	857	41%
1978/79	3,730	785	21%
1979/80	5,279	1,233	23%
1980*	n.a.	n.a.	
1981	n.a.	n.a.	
1982	3,100	1,654	53%
1983	6,056	1,486	25%

* Funding allocated by calendar year as of 1980.

Exhibit 5

THE KALAMAR HORTICULTURAL INSTITUTE

Capital Subvention to KHI, 1982/83
as of June 1983
(All Figures in Hima)

Year	KHI Proposed	Government Approved		(Scaled Down 30%)	Actual
1982					
		Q1	625,000	437,500	nil
	19,400,000	Q2	625,000	437,500	788,000
		Q3	625,000	437,500	358,500
		Q4	625,000	437,500	400,000
			2,500,000	1,750,000	1,546,500
1983					
	9,488,000	Q1	687,500		nil
		Q2	687,500		10,004.72
		Q3	687,500		pending
		Q4	687,500		pending
			2,750,000		

(Continued)

Exhibit 5 (Continued)

THE KALAMAR HORTICULTURAL INSTITUTE

Summary of Subvention for 1982

(All Figures in Hima)

Period	Capital			Recurrent		
	Amount Expected	Amount Received	Surplus/ Shortfall	Amount Expected	Amount Received	Surplus/ Shortfall
1st Quarter	437,500	-	(-437,500)	442,611.90	413,663	(-28,948.90)
2nd Quarter	437,500	788,028.28	350,528.28	442,611.90	413,663	(-28,948.90)
3rd Quarter	437,500	358,528.28	(-78,971.72)	442,611.90	413,663	(-28,948.90)
4th Quarter	437,500	400,000.00	(-37,500)	442,611.90	413,663	(-28,948.90)
TOTALS	1,750,000	1,546,556.56	(-203,443.44)	1,770,447.60	1,654,652	(-115,795.60)

Summary of Actual Expenditure: Recurrent And Capital (Programs)

Item of Expenditure	Actual Expenditure	Unsettled Bills
Personal Emoluments	1,398,952.98	-
Overhead	744,510.83	135,836.81
Capital	1,447,088.51	308,903.76
TOTALS	3,620,552.32	444,740.57

Exhibit 6

THE KALAMAR HORTICULTURAL INSTITUTE

Recurrent and Capital Budgets of All Kalamar Agricultural Research Institutes, 1975/1980
Showing Sum Requested and Sum Allocated
Capital Estimates

INSTITUTES	Capital Request (Million Hima)							Capital Allocated (Million Hima)							ALLC/RQ
	1975/76	1976/77	1977/78	1978/79	1979/80	1980	TOTAL	1975/76	1976/77	1977/78	1978/79	1979/80	1980	TOTAL	
ARS	–	–	–	–	–	–	–	–	–	0.600	0.750	0.900	0.400	2.650	
BEL	1.710	0.320	1.670	0.400	3.000	1.000	8.100	1.093	0.501	1.732	0.200	1.317	0.667	5.510	68.02
BRC	–	1.050	2.500	1.685	6.000	5.500	16.735	–	0.850	0.250	2.186	2.118	2.600	8.004	47.83
DAR	5.399	11.300	3.552	3.927	4.350	–	28.528	1.900	2.900	NIL	2.000	2.250	–	9.050	31.72
DRI	–	–	–	–	–	–	–	–	–	3.328	0.250	1.283	–	4.861	
FIIR	–	2.780	5.360	3.460	4.250	–	15.850	–	0.885	3.200	0.250	2.200	–	5.535	41.23
FRIN	–	1.060	2.307	4.103	2.981	3.421	13.872	–	0.530	0.818	2.429	0.745	2.175	6.697	48.28
GAR	–	–	–	–	5.127	4.704	9.831	–	–	1.042	1.042	1.130	1.000	4.214	42.86
HIK	–	2.102	3.710	4.615	0.181	–	10.608	–	0.921	2.968	0.250	1.680	–	5.819	54.85
HND	–	2.558	2.554	3.430	2.745	–	11.277	–	1.600	0.250	0.500	1.000	–	3.350	29.71
JMP	–	–	–	12.800	13.300	15.600	41.700	–	–	8.900	3.500	1.600	2.200	7.300	17.51
KHI	1.065	7.340	7.000	11.550	12.387	8.672	48.014	1.065	2.326	2.160	1.000	1.000	0.500	7.881	10.58
LERIN	–	1.181	2.078	3.830	5.361	10.369	22.818	–	1.203	1.218	2.290	1.400	4.583	10.694	46.87
MARS	4.559	1.679	6.138	4.929	5.221	4.422	26.948	4.400	2.769	2.900	2.768	2.462	1.500	16.799	62.34
MTL	–	–	–	–	–	–	–	–	–	1.999	2.014	0.764	0.966	5.743	
NCRI	–	8.674	1.189	1.931	1.444	3.445	16.445	–	6.661	1.189	1.075	0.200	–	9.125	55.49
POPS	1.000	2.986	2.880	2.220	1.000	–	10.086	1.000	0.400	1.600	1.080	0.306	–	4.386	43.49
RIM															
STA	–	–	10.000	2.396	3.031	15.362	30.789	–	0.270	3.000	0.500	1.000	1.626	6.126	19.90
WOR	–	5.500	9.450	3.400	3.650	5.000	27.000	–	2.200	0.140	1.800	0.750	1.600	6.490	24.04

Source: Report of Research Institute Review, 1980-81.

(continued)

Exhibit 6 (Continued)

THE KALAMAR HORTICULTURAL INSTITUTE

Recurrent and Capital Budgets of All Kalamar Agricultural Research Institutes 1975/1980
Showing Sum Requested and Sum Allocated
Recurrent Estimates

INSTITUTES	Capital Request (Million Hima)							Capital Allocated (Million Hima)							ALLC/RQ
	1975/76	1976/77	1977/78	1978/79	1979/80	1980	TOTAL	1975/76	1976/77	1977/78	1978/79	1979/80	1980	TOTAL	
ARS	0.613	0.761	1.506	0.850	0.875	2.187	6.792	0.536	0.568	0.589	0.536	0.717	0.717	3.626	53.39
BEL	3.169	2.168	5.400	3.500	4.021	–	18.708	2.500	2.100	2.618	3.518	1.929	–	12.665	67.70
BRC	–	–	–	2.000	2.600	–	4.600	1.284	0.550	1.360	1.621	1.272	–	6.092	62.89
DAR	3.603	4.611	3.449	3.738	4.480	–	19.887	1.900	2.400	3.600	2.700	2.750	–	13.350	67.13
DRI	5.807	6.606	7.280	7.170	5.906	–	32.769	5.452	6.331	4.420	3.350	4.200	–	23.753	72.49
FIIR	–	3.045	3.236	3.266	4.372	–	13.919	–	1.200	2.448	1.908	1.932	–	7.448	53.80
FRIN	0.824	1.010	2.175	2.608	2.400	–	9.017	0.824	0.606	0.875	0.663	0.687	–	3.655	40.53
GAR	–	–	–	2.833	3.370	–	6.203	–	0.796	0.946	1.124	0.796	–	3.662	30.95
HIK	–	0.910	2.803	3.024	2.351	–	9.088	–	0.723	0.765	0.535	0.626	–	2.649	29.15
HND	–	1.494	3.398	3.200	3.433	–	11.525	–	1.300	1.020	0.985	1.058	–	4.363	37.86
JMP	–	–	7.000	8.500	11.300	–	26.800	–	4.300	2.400	6.400	4.200	–	17.300	48.51
KHI	0.362	0.960	2.064	3.730	5.279	–	12.035	0.672	0.424	0.857	0.785	1.233	–	3.971	32.99
LERIN	5.453	2.849	3.533	4.519	5.350	–	21.704	1.851	1.605	1.810	2.467	3.024	–	10.757	49.56
MARS	3.274	4.490	4.380	5.157	5.259	6.396	23.956	2.174	3.410	3.110	1.700	0.500	2.169	13.063	54.51
MTL	1.594	1.918	1.504	1.410	1.799	–	8.225	0.787	1.028	0.764	0.966	1.386	–	4.931	59.95
NCRI	4.078	7.478	8.628	15.007	13.503	–	48.694	4.030	3.772	3.435	2.180	2.749	–	16.166	33.20
POPS	3.586	3.571	1.615	6.684	4.120	–	19.576	1.600	1.680	1.615	1.239	0.988	–	7.133	36.44
RIM	–	–	–	–	–	–	–	0.079	0.442	0.702	0.854	1.804	–	2.881	–
STA	1.331	2.467	5.440	6.005	5.521	–	20.764	1.252	1.274	1.197	1.016	2.223	–	6.962	33.53
WOR	4.860	3.400	2.800	2.840	6.800	–	20.700	1.500	1.400	0.960	0.650	1.500	–	6.010	29.03

Source: Report of Research Institute Review, 1980-81.

Exhibit 7

THE KALAMAR HORTICULTURAL INSTITUTE

Statement of Accounts for the Period 1 January - 31 December 1982
Overheads (Unavoidable Expenses)
(ex Hima)

Code	Details of Service	Estimated Expenditure 1982	Actual Expenditure 1982	Unsettled Bills	Gross Total (Actual Expenditure and Unsettled Bills)
B-1	Research Material and Equipment	27,000.000	12,468.30	4,489.10	16,957.46
B-2	Local Transport and Travelling	40,000.00	46,003.34	-	46,003.34
B-3	Office & General, Utilities & Insurance	70,000.00	82,822.03	12,880.72	95,702.75
B-4	Library, Documentation, Publication & Materials	1,500.00	2,639.25	3,622.84	6,263.09
B-5	Motor Vehicles Maintenance & Running Cost	50,000.00	58,892.70	11,856.89	70,749.59
B-6	Maintenance of Buildings & Grounds	50,000.00	30,157.64	8,526.35	38,683.99
B-7	Labor Wages	100,000.00	111,878.46	54,070.99*	165,949.99
B-8	Staff Development & Training	73,078.00	32,117.21	-	32,117.25
B-9	Overseas Official Duty, Passages & Expenses, Allowances	10,000.00	6,329.85	-	6,329.85
B-10	Local Seminars, Consultancy & Legal Matters	3,000.00	8,500.00	-	8,500.00
B-11	Upkeep of Outstations	110,000.00	226,400.00	-	226,400.00
B-12	Governing Board Allowances & Meeting Expenses	30,000.00	52,083.00	-	52,083.27
B-13/1	Staff Loan -- Motor Vehicle	-	-	-	-
B-13/2	Staff Loan -- Motorcycle	-	-	-	-
B-14	Pension Fund	15,000.00	-	-	-
B-15	Purchase of Official Vehicles	20,000.00	12,117.80	7,795.00	20,712.80
B-16	Rent	60,000.00	3,300.00	29,950.00	62,950.00
B-17	Staff Welfare	25,000.00	24,065.59	-	26,065.59
B-18	Upkeep of Guest House & Canteen	1,669.00	317.25	1,706.00	2,023.25
B-19	Audit Free	4,000.00	9,500.00	-	9,500.00
B-20	Press & Publications	15,000.00	13,732.64	937.92	14,670.56
B-21	Uniforms and Protective Clothing	1,000.00	7,444.00	-	7,444.00
B-22	Subscriptions to Societies	2,000.00	3,241.50	-	3,241.50
		708,247.00	774,510.83	135,836.81	910,347.64

* Due to implementation of the recent N125.00 minimum wages.

Exhibit 8

THE KALAMAR HORTICULTURAL INSTITUTE

Yields of Farmers' Plots Compared with Those Obtained in KHI

Crop	Average Yields	
	Farmers' Plots	KHI Plot
FRUITS	(kg/ha)	(kg/ha)
Plantain	7,408	16,064
Banana	6,864	10,296
Pineapple	14,370	42,222
Guava	48 ***	377 ***
VEGETABLES	(tons/ha)	(tons/ha)
Tomato	2 - 5	15 - 20
Okra	2 - 4	8 - 10
Amaranthus	3 - 5	15 - 20
Celosia	4 - 6	18 - 25
Corchorus	4 - 5	15 - 20

*** N° of fruits/annum.

Exhibit 9

KALAMAR HORTICULTURAL INSTITUTE

Income Statement
Period 1 January to 31 March 1983

Sources	Hima
Balance B/F (as at 31/12/82 Bank Balance Recurrent FC 2617)	(-29,003.53)
Subvention 1st Quarter Paid on 25/2/83	371,552.00
2nd Quarter Paid on	
3rd Quarter Paid on	
4th Quarter Paid on	
Subtotal	371,552.00
External Research grants received, if any	- -
Sales (of Vegetables and Fruits)	12,245.03
Bank Interest	- -
School Fees	- -
Vehicle Advance Recoveries	7,349.26
Rent/Water	275.00
Other -- Sales of Tickets, Unclaimed Salaries & Wages, Photocopying & Press, etc.	2,229.80
Subtotal	393,651.09
Less Balance B/F	29,003.53
TOTAL	364,647.56

Source: KHI Quarterly Report, January-March 1983.

MANAGEMENT PERSPECTIVES FOR AGRICULTURAL RESEARCH:

AN OVERVIEW

Chapter 15

THE APPLICATION OF MANAGEMENT PERSPECTIVES TO AGRICULTURAL RESEARCH

AN INTRODUCTION TO THE APPLICATION OF MANAGEMENT PERSPECTIVES TO AGRICULTURAL RESEARCH

A classic story of agricultural research is embedded in "Seed Corporation of the Philippines." It tells the tale of a research output by an international agricultural research center, the challenge of diffusing agricultural research results, the tensions that can exist between the public and private sectors in the spread of a powerful new technology, and the opportunities and obstacles that simultaneously exist in converting a research breakthrough into an instrument of development.

Making a research breakthrough is not an end unto itself. The breakthrough must be adopted and used. The core question that needs to be asked before the research is undertaken is for whom is the research being done? In marketing terms, the issue is who is to be the client of the product of the research or who is the target audience?

This question is not always an easy one to answer. Often the targeted client is not one group but several. In the instance of "Seed Corporation of the Philippines," the prime target could be the national government, large farmers who own their land, tenant farmers, or the landlords whose land is farmed by the tenant farmers. In addition to these four primary groups, a strong case can be made that provincial governments and seed distributors are also targets of the new technology, since they may be heavily involved in the diffusion of the new seed.

A question closely related to the definition of the target market is what is the product? The characteristics of the technology that come from a research center influence the way the output is perceived and the speed with which it is adopted. Technology that offers definable advantages and benefits is viewed more favorably than research outputs whose benefits are more difficult to discern. Research that lends itself to experimentation by potential users on just a portion of the crop or livestock herd rather than demanding complete adoption speeds the acceptance of the research output.

An agricultural research institute can influence a technology's definition by the manner in which the product is released and presented to the targeted audience. For instance, the seed for a new variety may be released for distribution as a means to increase crop production. On the other hand, the same variety may be released as part of a new input package that includes fertilizer and pesticides. In the former case, the research output may be defined simply as a new seed; in the latter case, it is more likely to be defined as one component of a new production package. This same research output, however, could be presented as a means to increase a farmer's income. In this instance, the perception of the research would be as a means of enhancing one's living conditions or increasing one's social status.

Hence, technologies are defined not simply by the objectives or focus of the creators and the physical description of the research output. The characteristics of the technology, the way the technology is released, and the perceptions of different potential users also contribute to fashioning the definition of a research output. This means that a given research output can be defined along a wide continuum. In the instance of "Seed Corporation of the Philippines," the technology can be viewed as ranging from being simply an improved rice variety to being the catalyst for economic development.

The management of agricultural research actually begins in the early stages of planning and conception. A clear identification of the target of the research and a forthright understanding of the needs and values of the targeted group are prerequisites to research that has impact. At times, the target will be multiple and this complicates agricultural research management.

Agricultural research with impact seldom has sectoral boundaries. The research output flows between the public and private sectors. This flow must also be planned and managed. This requires establishing linkages and communication channels. It also requires scanning the environment for early adopters who may use the technology in unforeseen ways which may lead to new opportunities.

The links among participants in an agricultural system, and hence the flow of information regarding technology, can be informal or formal. They can range from one tenant farmer showing or telling another tenant farmer about a new agricultural practice, to a formal pact or agreement signed by the Ministry of Agriculture with a private-sector seed company.

The links can be among individuals or among organizations. They can be horizontal linkages as found when there is a connection between two farmers or vertical linkages, as seen in the diffusion of knowledge directly from a research center to a farmer group. The form or nature of the linkage is not of key importance. Key importance is found in how effectively the product of a research center is spread to its targeted groups.

The stories told in the preceding chapters testify that there is no right or wrong way to achieve productive linkages in agricultural settings. The most important criterion in fashioning a linkage is "Will it work?" And the answer to this question is the product of a multiplicity of factors: the goals of the research, the characteristics of the participants in the food system being affected, tradition, government policies, incentives, and the nature of the innovation or research output.

The impact that a managerial perspective can have upon the actions and decisions of participants in an agricultural research endeavor is seen in the case of "Seed Corporation of the Philippines." The management of the company did not clearly identify its target group. The salesmen were focusing on the producers of rice in general. The company was seeking to sell to large producers, small producers, landlords, and even considered a government agency and the national subsidiary of a multinational company as potential customers. Though an argument sometimes can be made for a broad definition of the target market, in this instance the need is for a more focused definition.

Also, the management did not clearly articulate what it was selling. It treated its product as if it were merely a new improved rice seed. In reality, the company was marketing a whole new method of rice farming.

The seed by itself did not result in enhanced yields. Yield enhancement required the proper use of fertilizer and pesticides as well as careful water control and increased labor. The purchased inputs were costly and, therefore, farmers needed credit or cash to purchase them. Finally, the use of the new rice was counter to the traditional method of obtaining seed, which was saved from one's harvest or bartering with a neighbor whose rice appeared to be higher yielding.

In addition, the management of Seed Corporation of the Philippines did not appear to have clearly articulated the company's goals. At times, management sounded as if its purpose was to enhance the movement of the country toward self-sufficiency in rice production. At other times, it seemed that the company's goal was to be a provider of quality agricultural inputs to the agricultural sector. These goals were vastly different and influenced the company's definition of its target market, the manner in which its product was defined, and its role in the agriculture system of which it was a part.

Seed Corporation of the Philippines was marketing a revolutionary technology -- one that indeed represented a new method of rice farming. At the time, the typical farmer in the Philippines cultivated two hectares of land and produced about 27 cavans of rice per hectare, making the annual yield of a typical farmer 54 cavans. Of this amount, approximately 35 cavans were saved by the farmer as food or as seed for the next year. The remaining 19 cavans were marketed, usually a cavan at a time being carried by the farmer on his back to the market.

The new rice variety's potential yield was much higher than the 27 cavans per hectare. Consider that a farmer using the proper inputs doubled his yield, producing 54 cavans per hectare or a total of 108 cavans on his land. This twofold increase in yield represented an almost fourfold increase in marketable surplus, considering that the farmer continued to save 35 cavans for home use.

A fourfold increase in marketable surplus brought about by the output of agricultural research was bound to have far-reaching effects on the whole system. These impacts needed to be anticipated and identified early in the technology's life. In this instance, the increase in marketable surplus had a strong impact on a wide range of factors, such as rice prices, transportation requirements, storage needs, processing demands, and even things as mundane as bags in which to store the rice.

The recognition of the impact of this technology on the system, though belated, helped the managers of Seed Corporation of the Phillipines to redefine the role of the company. The company managers recognized that the company did not have the capital or human resources to provide the information and technical assistance required if the new variety were to be adopted by the majority of the farmers. As a result, the company managers decided that the company's market should be the larger farmers -- those who were likely to be most receptive to the new technology and to have the financial resources to purchase the inputs the technology required. The government was best equipped to promote the new variety among the traditional or small farmers.

The company managers also recognized that their primary role was not in providing inputs. Their contribution to the industry could best be made by going into rice processing. Management saw that processing would be a constraint on handling the nation's increased yields that resulted from the widespread adoption of the new variety. This was an area in which the government had not made substantial investments.

Seed Corporation of the Philippines found its place in the rice system of the country by analyzing the entire commodity system, understanding the roles of the public and private sectors in the system, anticipating the changes that the new technology would bring to the system, more narrowly defining its goals and targeted audiences, and recognizing that the changes in the environment gave it new opportunies to define its role. Thus, a managerial understanding of the environment led a participant to redefine its role in an agricultural system -- and enhanced the impact of an agricultural technology on a country and its economic development.

This case has also become a classic in the study of the management of agricultural development. While the specific rice varieties presented in this case have been replaced by higher yielding varieties, the management problem of reaching the farmers remains the same.

Chapter 16

SEED CORPORATION OF THE PHILIPPINES

SEED CORPORATION OF THE PHILIPPINES:

A Case Study

by Edward L. Felton Jr.

As Mr. Miguel Gonzales, the Vice-President of Sales for Seed Corporation of the Philippines (SEED CORP), was walking down the corridor to his office, he was thinking about the poor sales performance of the company's IR-8 palay[1] seed. The preceding afternoon, Mr. Gonzales had received a report which summarized the sales of IR-8 seed during the first six weeks that the seed had been on the market. The report showed that only 467 cavans[2] of IR-8 palay seed had been sold between October 1 and November 12 1966 (see Exhibit 1).

IR-8 was a new variety of rice that had been developed by the International Rice Research Institute, located 65 kilometers southeast of Manila at Los Baños, Laguna. Because of the variety's remarkably high-yielding capability, it had been called "miracle rice". "Miracle rice" had received extensive publicity through the news media because many scientists and agriculturalists claimed that IR-8 had the potential of eliminating the current shortage of rice in Asia (see Exhibits 2 and 3).

SEED CORP on its farm in Bay, Laguna, had produced 10,000 cavans of the "miracle rice" seed. The company placed this seed on the market on October 1 and had expected the demand for IR-8 seed to be so heavy that the company's supply would be sold quickly.

Yet, six weeks after the seed had gone on sale, SEED CORP had over 9,500 cavans of unsold IR-8 palay seed on hand.

Discussing the poor sales performance of the IR-8 seed, Mr. Gonzales said, "I've never been so badly fooled by a product. I thought that with all the publicity about 'miracle rice' our entire stock would be almost exhausted by the end of October. Here we are now in the last half of November, and we have sold less than 500 cavans of the seed. I simply don't know what's wrong."

The Company

SEED CORP was founded in 1960 for the purpose of providing products and services to the agricultural sector of the Philippine economy. In addition to the main office in Quezon City which served Luzon, the company had branches in Bacolod City and in General Santos, Cotabato, which served Visayas and Mindanao, respectively. The Bacolod branch was established in 1962, and the Cotabato branch in 1963.

Last year SEED CORP had sales of almost P1,400,000[3] (see Exhibit 4). Irrigation equipment was responsible for approximately P1,000,000 of these sales; seeds, approximately P325,000; and insecticides, approximately P75,000. The company was predicting that its sales during the current year would be between P1,850,000 and P1,900,000.

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(1) Palay was rough rice -- rice that had been neither hulled nor milled.

(2) A cavan of palay was 45 kg.

(3) Philippine P1.00 = US$ 0.256; US$ 1.00 = P3.90.

SEED CORP had carried irrigation equipment since its founding. In 1962 the company added imported vegetable and flower seeds to its product line; in 1963, forage seeds; and in 1964, insecticides and locally produced rice and corn seeds.

The company was continuing to expand the services and products that it offered to its customers. Early last year, SEED CORP had formed a farm management division. By the end of October, this division was managing under contract 4,500 hectares of land. The 10 farms making up this hectarage were scattered throughout the Philippines. The company was planning to add veterinary medicines to its product line early next year.

As Exhibit 5 indicates, each of SEED CORP's outlets divided its sales force into two divisions: irrigation and agriculture. The nine salesmen in the irrigation division had bachelor degrees in engineering. These men were responsible for marketing the company's irrigation equipment and received base salaries of P200 per month plus commissions of three to five percent on all sales.

The company had 13 agricultural salesmen, all of whom had Bachelor of Science degrees in agriculture. These salesmen were assigned specific sales territories and were responsible for all seed and insecticide sales within their respective territories. The agricultural salesmen received base salaries of P200 per month plus a three percent commission on net sales.

SEED CORP furnished jeeps to all of its salesmen and gave each salesman a fixed gasoline allowance of P75 per month. In addition, each salesman received a living allowance of P125 per month.

<u>IR-8 Rice</u>

The International Rice Research Institute (IRRI) was established in 1960 as a private, nonprofit world center for the study and improvement of rice, the principal food for more than 60% of the world's population. IR-8 was the first new variety of rice developed by IRRI that had been given an official name and released to the public.

This new strain of rice was developed from a cross between Peta, a tall Philippine variety that had originated in Indonesia, and Dee-geo-woo-gen, a short variety from Taiwan. IR-8 was a lowland variety[4] of rice. The strain could be grown in any season in the tropics, and it matured approximately 120 days after seeding. Because of IR-8's nonseasonal characteristic and its moderately early maturity, a farmer using the variety with irrigation could produce three rice crops per year.[5]

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(4) Lowland rice was any rice crop with impounded water (the source of the water could be either irrigation or rainfall) and was to be distinguished from upland rice which was rice grown without maintaining a layer of water on the surface of the land. Upland rice was directly seeded and was grown on rainfall as one might grow a crop of wheat.

(5) Traditionally, the Philippine farmer had thought in terms of a maximum of two rice crops per year.

Unlike most tropical rices which were noted for their height, IR-8 was a short, sturdy variety, approximately 100 centimeters high. IR-8 was resistant to lodging(6) which in some varieties caused a grain loss of over 50%.

While discussing IR-8, a member of the IRRI research staff said, "The news media have labeled IR-8 'the wonder rice' or 'the miracle rice'. This of course, is an exaggerated nomenclature, but IR-8 does hold great promise for Asia and its food problem. Asia alone produces and consumes over 90% of the rice grown in the world".

"IR-8 has performed remarkably in every country where it has been raised. Its response to nitrogen fertilizer in terms of yield has been impressive. Under good management, IR-8 has yielded more than twice as much palay per hectare as have traditional varieties under similar management.

"Of course, the miracle of IR-8 is not found in the seeds alone. It is also found in the farming practices. To get high yields, the farmer must use fertilizer, have an adequate water supply, protect his paddies from rats and insect damage and, in general, follow good farming practices. By good farming practices, I mean giving attention to such matters as being sure the land is properly prepared before transplanting and seeing that the rice is properly weeded. These practices cost money. In fact, one of the agricultural economists here at the institute told me the other day that the input of materials, such as nitrogen and chemicals, that a farmer must make if he is to successfully raise IR-8, costs about P250 to P300 per hectare. A farmer who plants a traditional variety and follows recommended cultural practices spends only about P60 a hectare for supplies and materials. But IR-8 responds to these additional investments by the farmer, and the resulting high yields make the investment worthwhile.(7)

"IR-8, as you know, is not a perfect variety. The strain is highly susceptible to rice blast fungus and also is susceptible to bacterial leaf blight. This susceptibility to disease underscores the importance of using adequate fungicides and insecticides when raising IR-8.

"Also, the IR-8 grain has certain shortcomings. The grain is only medium length, is chalky, and seems to break easily. Despite these weaknesses, we feel that the rice will be acceptable to most consumers. But as you can see, we haven't developed the perfect rice though IR-8 represents the kind of breakthrough that we are seeking in our research activities."(8)

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(6) Lodging refers to the falling over of plants prior to harvest.

(7) See Exhibit 6 for information on the production costs and returns per hectare for IR-8 compared with other varieties of rice.

(8) See Exhibit 7 for a comparison of the characteristics of IR-8 with the characteristics of other high-yielding rice varieties.

Distribution of IR-8 Palay Feed

SEED CORP was the first commercial firm in the Philippines to offer IR-8 palay seed for sale. Up until the time that the company entered the market, IR-8 palay seed had been distributed primarily by government agencies.

According to Mr. Antonio Zulueta, the Executive Vice-President of SEED CORP, "The government has a general program for dispersing the 'miracle rice' seed and is easily the biggest distributor. Under the government program the APC[9] -- that's the old Bureau of Agricultural Extension -- and the RCA[10] work together in the procurement and distribution of the seed.

"The APC workers have the responsibility of telling the farmers about the 'miracle rice' and its high yields and of persuading the farmers to plant IR-8. When a farmer indicates an interest in planting IR-8, the APC worker puts him in touch with the nearest RCA warehouse that has the seed in storage. The APC worker, of course, also gives the farmer any technical advice or guidance that he might need in planting and growing the rice.

"The RCA under the government program is responsible for buying the IR-8 palay seeds that are to be resold to the farmers and for providing the warehousing for storing these seeds. The RCA warehouses around the country are, in effect, distribution centers for the seed.

"The RCA obtains its seed primarily from farmers who are producing IR-8 palay from stock that they themselves obtained originally from a government agency or from IRRI. IRRI, for example, has distributed free around 2,500 small 2-kg packets of IR-8 seed.[11]

"The farmers who sell their IR-8 palay to the RCA for seed purposes have to raise their rice under supervised conditions. When the farmer plants the rice, he has to indicate that he would like to sell the harvest for seed.

"The APC is responsible for supervising the technical aspects of the seed production, and so one of their workers visits the farm periodically. The APC, for example, checks to see that the rice is being properly rogued.[12] When the palay is harvested, the APC certifies that the palay is IR-8 and that the farmer has followed recommended practices in producing the seed stock.

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(9) Agricultural Productivity Commission.

(10) Rice and Corn Administration.

(11) A 2-kg package of palay seed should plant no less than one-tenth of a hectare. Some farmers planted only 600 square meters with their packets, while others planted as much as 1,200 square meters.

(12) Roguing is the removal of alien rice varieties and other undesirable plants from a rice stand for the purpose of protecting the purity of the seed that is to be harvested.

"The RCA buys rice with this certification from the farmers for P25 per cavan, which is a premium to the farmer of about P7 over the regular market price. The RCA then resells this same seed to other farmers for P25 a cavan. So you can see that, under the government program, the RCA provides the money and storage facilities for the seed and the APC provides the men to supervise the seed production and to furnish technical advice to the farmers.

"In addition to the government's seed multiplication program, there is the Rizal Agricultural Development Commission. The Commission is financed by provincial funds and was organized by the provincial government for the purpose of promoting the production of IR-8 in Rizal.

"Under the Commission, just as in the national program, farmers who produce the IR-8 seed are not guaranteed any specific price for their palay. However, if the palay is produced under supervised conditions and has been properly rogued, the provincial government has been buying it for 25 pesos per cavan. This palay in turn is sold to farmers in the province for the same price.

"The provincial government finances this program with its own funds. It has established IR-8 demonstration plots throughout the province and has trained agriculturalists in the field working with the local people. However, the provincial government does rely upon RCA warehouses for storing the palay and depends upon the RCA for the dryers needed to dry the palay. I estimate that under this program, Rizal will be distributing around 5,000 cavans of IR-8 seed during the coming growing season.

"Besides ourselves, we know of only one other large independent IR-8 rice producer. He is a large farmer in Tarlac and this past growing season, he planted 65 hectares in IR-8, and I understand that he produced about 8,000 cavans of palay. About 50% of this palay was produced under the supervision of the APC and was sold to the RCA for seed purposes at the price of 25 pesos per cavan. The remaining 4,000 cavans he is trying to sell for 25 pesos per cavan to private farmers for seed purposes, but I hear that he's not having very much success in moving his inventory in this manner."

SEED CORP's IR-8 Palay Seed

SEED CORP's IR-8 palay seed sold for 40 pesos per cavan. Mr. Gonzales, the Vice-President of Sales, said, "Nowhere in the Philippines today can the farmer purchase IR-8 palay seed that compares in quality to the seed that we sell. But judging from our sales to date, everyone isn't aware of that. The problem is how do you communicate to the public that our seed is of superior quality?

"And look at who our major competitor is when it comes to selling IR-8 seed. It's the government. How can a business organization compete with the government? Look at the expenses we have to cover. There are warehousing expenses, salaries of our personnel, transportation for our salesmen -- now just look at that one item as an example. We furnish jeeps to all of our salesmen. We figure that each jeep we have in the field costs us about P175 per month. That includes the cost of insurance, maintenance, depreciation -- everything except gasoline. Now when you have expenses like that, you've got to cover them and you've got to show the stockholders a profit; it makes it rough when you're competing against the government.

"Well -- that's a favorite subject of mine as you can tell. Coming back to the palay seed -- we here at SEED CORP cannot afford to sell anything but the highest quality seed. During the past three years we've built a strong reputation for having excellent seeds, and we must be careful to avoid doing anything to jeopardize that reputation.

"We produce our IR-8 palay seed under the most carefully controlled conditions. Since we want our palay to be clean of any other seed, we are continuously roguing and checking our fields. Then after the palay is harvested, it is artificially dried under closely supervised conditions. We then grade the seed, treat it chemically to protect it from fungi, and then check it for germination. After the palay has gone through these operations, we store the seed in an area where the temperature is controlled and where the seed will be protected from rats and other infestations. The government has neither the trained manpower nor the facilities to produce and store palay seed under such carefully regulated conditions.

"And, of course, our goals are different. We want to produce high-quality palay seed. To be assured that we have superior seed, we spend about P7 per cavan in processing our palay after it has been harvested. Quality, on the other hand, is not the government's primary concern at this point. Its goal is to get as wide a distribution of IR-8 palay seed as possible.

"One good example of the difference in the IR-8 seeds that we sell and the seeds that the farmer can buy from the RCA is seen in the germination rates. As you know, we guarantee a germination of at least 90% for our seed. The germination rate for the RCA seed is much lower. I am told that it varies between 50% and 70%. Of course, this is higher than the farmers are accustomed to. For traditional varieties, the germination rate is somewhere between 40% and 60%."

Selling IR-8 Palay Seed

According to Vicente Montenegro, SEED CORP's agricultural salesman in the Cagayan Valley area, "Philippine farmers for generations have been meeting their rice seed requirements by saving enough palay out of each harvest to plant their land the next season. Literally, over 99% of the farmers fulfill their seed requirements in this manner. This cycle is continued season after season and is generally not broken unless a neighbor happens to have a bumper harvest. When this happens, the farmer may decide that his neighbor has better rice and he will then barter his neighbor for a cavan or two of the palay. In this kind of transaction, there is very rarely an exchange of money involved. The transaction involves an exchange of goods."

"Vicente is right," said Nicolas Guzman, SEED CORP's agricultural salesman in Central Luzon. "This is the way that farmers handle their seed needs, and this system has been in operation for years.

"Of course, this makes it difficult when you're selling palay seed. It's not like selling vegetable seeds. Over 80% of our vegetable seed sales are made to independent agricultural supply dealers. These dealers, in turn, sell the vegetable seeds to the farmers.

"But with palay seed, it's a different matter. My guess is that less than 5% of our palay seed sales are to agricultural supply dealers. The farmers simply don't go to the dealers for the palay seed. So selling palay seed is a hard job. You must go directly to the farmers, and this is time consuming.

"Approximately 50% of our rice farmers are tenant farmers. And to really sell IR-8 under a landlord-tenancy arrangement, you've got to talk to both the landlord and the tenants. The landlord is important, for he is the one that has the cash. He is the one who is going to have to buy the seed, the fertilizer, and the other inputs that are necessary for a successful IR-8 rice crop. And before the landlord will put out this additional outlay of capital, he has to be convinced that it is a good investment -- that the investment will pay dividends.

"There is often the problem of finding the landlord. There is a lot of absentee ownership. And, of course, farms vary in size -- anywhere from less than one hectare up to more than a thousand hectares.

"And you've also got to talk to the tenant. He may seem unimportant, for he only cultivates one or two hectares. But he's the key. He is the one who has to plant the rice and apply the nitrogen and the insecticides. When you ask the tenant to plant IR-8, you're really asking him to abandon the way he has been doing things for years. Most of the tenants don't know anything about fertilizers and insecticides. They've never used them. And so there is a selling job involved here because the tenant is not going to use his time to apply the nitrogen and chemicals that the landlord has bought unless he's convinced it's worthwhile. In fact, I can recall cases where a landlord has had it delivered to the tenant. Instead of using the seed or the fertilizer, the tenant has taken the item to town and has sold it, using the money for personal needs or wants.

"At any rate, calling on farmers takes a great deal of time because you really can't make more than three or four calls a day. And the irony is that in selling IR-8 seed, you will seldom have a repeat customer. Once the farmer has bought the seed, he'll save his own seed out of his harvest. And if he has a good rice harvest in terms of yield, he'll become your competitor in a sense. His neighbors will want some of the seed and will barter with the farmer for some of the palay.

"Of course, I am speaking from my own experience which has been primarily in Central Luzon. I don't know whether Vic has had the same experiences up in the Cagayan Valley area or not."

"I think what Nicolas has said applies to all of the Philippines," responded Mr. Montenegro. "It describes the situation in the Cagayan Valley. I also worked in Visayas for a short while, and what he says applies there, too.

"And it is hard work to sell the farmer. Successfully producing IR-8 requires the farmer to use new methods of rice cultivation, and he is reluctant to change. As Nicolas says, cash is also a problem, because a the farmer raising IR-8 has to have fertilizers and chemicals. The average rice farm is only about one to two hectares in size and in most cases the farmer just won't have the money for these things -- unless he is a tenant and has a benevolent landlord. For the small landowner, getting money for such things as insecticides is quite a problem. And even if he can borrow the money, he is reluctant to -- and for good reason. Suppose there's a typhoon that destroys his crop. It would be impossible for him to pay the money back.

"I know that Mr. Gonzales is really disappointed in the IR-8 sales, but I don't think he fully realizes what we're up against. IR-8 is really a new product, and farmers are slow to adopt new ways of farming. They have confidence in their time-honored ways of doing things and to abandon ancient practices seems risky to them."

Mr. Gonzales' Views

"I know you've talked this morning to Montenegro and to Guzman," began Mr. Gonzales, "and I am sure that they have told you that selling IR-8 palay seed is a hard job. And judging from the sales results to date, they may be right.

"I had lunch today with Tony Zulueta, our Executive Vice-President, and we discussed our poor IR-8 sales. We even came up with the idea of approaching Esso Fertilizer and moving our IR-8 seed through them. Esso has well-trained salesmen and over 400 outlets. Then we remembered the Rice and Corn Act[13] and so that's not the answer.

"As I was walking back to the office I though that maybe we shouldn't have gotten into the production and selling of IR-8 seed in the first place. But the fact is that IR-8 really is a 'miracle rice'. It has the potential of solving our rice shortage.

"Do you realize that our rice yield per hectare in the Philippines has remained essentially unchanged during the past four decades? Let me show you the figures {see Exhibit 8}.[14] This means that our increase in national production has been the result of an increase in the hectarage planted in rice rather than an increase in yields.

"IR-8 can change that story and can do it quickly. Some farmers using IR-8 have realized increases in yields of 200% to 300%. I did some figuring just a few minutes ago and came out with some interesting results. Assume that there will be 50,000 cavans of IR-8 planted this coming season and that this rice will be planted on 50,000 hectares. Now, if the harvest from these 50,000 hectares averaged only 80 cavans per hectare, there would be four million cavans of palay seed available for the next season. That would be more than enough to plant all the rice in the Philippines.

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(13) The Rice and Corn Nationalization Act provided that only Philippinos or corporations wholly owned by Philippinos could engage in the distribution of rice or corn.

(14) See Exhibits 9, 10, and 11 for data regarding rice production in the Philippines.

"It takes more than a little number pushing to solve the nation's rice problem, but we might be on our way if we could just sell the IR-8 seed that we have on hand. I told Tony I wanted to do a little more thinking about this seed. I made a date with him for Friday morning, the 18th. Between now and then, I want to come up with a marketing plan designed to move our IR-8 seed so that we can discuss it during our meeting."(15)

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(15) In preparation for the task of preparing a market plan, Mr. Gonzales requested a memorandum from a member of his staff on advertising rates. See Exhibit 12 for a copy of the memorandum that was submitted to Mr. Gonzales.

Exhibit 1

SEED CORPORATION OF THE PHILIPPINES

Sales of IR-8 Palay Seed

	Quezon City Outlet				Bacolod Outlet				General Santos Outlet			
	Over-the-Counter Sales		Sales by Salesmen		Over-the-Counter Sales		Sales by Salesmen		Over-the-Counter Sales		Sales by Salesmen	
Week Ending	No. of Sales	Amt. of Sales (cavans)	No. of Sales	Amt. of Sales (cavans)	No. of Sales	Amt. of Sales (cavans)	No. of Sales	Amt. of Sales (cavans)	No. of Sales	Amt. of Sales (cavans)	No. of Sales	Amt. of Sales (cavans)
October 8	13	51	0	0	5	17	1	10	2	3	1	1
15	9	19	3	5	10	33	1	2	8	19	0	0
22	17	37	5	9	4	12	3	4	5	8	1	18
29	14	17	1	2	13	19	2	7	3	11	2	7
November 5	11	23	2	7	7	17	4	5	6	12	2	6
12	19	48	4	6	10	14	1	3	5	8	1	7
TOTAL	83	195	15	29	1 49	112	12	31	29	61	7	39

Exhibit 2

SEED CORPORATION OF THE PHILIPPINES

A Miracle to Feed Hungry Asia(*)

MANILA (A-ANS) -- A new strain of rice, now popularly known as "miracle rice" because of its high-yielding quality, may provide the answer to Asia's hunger problem.

Scientifically known as IR-8-283-3, the new rice variety is the result of a series of crossbreeding experiments carefully studied by plant breeders at the International Rice Research Institute in Los Baños, 40 miles east of Manila.

The IRRI, where scientists of many nations concentrate on high-yielding hybrids of rice, is a P7,500,000 ($1,923,000) plant. It is a joint project of the Ford and Rockefeller Foundations, with the cooperation of the University of the Philippines.

According to Dr. Robert F. Chandler, Director of the Institute, the experimental results leave no doubt about the yield potential of IR-8. He said, "It is the heaviest yielding rice (from 150 to 200 cavans per hectare) so far tested at the Institute and has consistently topped yield figures, not only on the Institute's experimental farm, but on the farmers' fields and in other Asian countries where it has been tested."

For the average farmer, it will spell the difference between hardship and a better standard of living. In the Philippines -- where there is a chronic rice shortage -- the annual per capita income in rural communities is pegged at P300 (roughly $75).

With the so-called "miracle rice," which can be planted and harvested twice or even thrice a year, it will mean an estimated annual income of P4,000 for Philippine farmers, or a 13-fold rise.

There seems, however, to be one drawback to the campaign to increase rice production by planting the IR-8. Growing the new rice strain involves added investment in terms of fertilizers, insecticides, and certified seeds. And farmers are wary of the added expense involved, not to mention doing away with antiquated and outmoded practices of planting rice.

(*) The Evening News, November 30, 1966.

Exhibit 3

SEED CORPORATION OF THE PHILIPPINES

The Miracle Rice(*)

The "miracle" rice currently being harvested could bring about a very vital transformation within the nation. We are not referring to an end of the rice shortage, although that is also very good, but to the fact that if "miracle" rice will increase yield at least three times, this is a benefit that should reach the farmer directly. Let us assume that such a rice strain could safely double the income of the farmer. This would be a very important change within the country, for the farmer is the most in need of economic stimulation. In other words, if the farmer can increase his income we are assured of economic progress, political stability, and a chain-reaction of cultural benefits.

The farmer represents 80% of our population. The farmer has the lowest income at present; statistics say he earns less than P2,000 a year per family. If the farmer increases his income he will be able to purchase goods; and an increase in the buying of consumer goods would not only boost industrialization, but bring down prices through more volume of production. At present, many products can be produced locally, and many barrio folk need these products, but they do not have the money. Most marketing firms have been faced with the fact that the major problem of sales in the Philippines is that of financing, so that at present long-term, easy payments have been the only way to make sales.

If the farmer can increase his yield and easily double his income, then he would not only desire and avail of more goods, he would be stimulated into using new tools, new technology, and new ideas. If he buys a radio he will be awakened to news events. When he sees how he has managed to increase his yield, he will be more open to other innovations and technology that will make the rural area amenable to much-needed change. If the farmer can have a bigger income, he will be able to educate his children better, whereas at present 60% drop out after fourth grade for diverse economic reasons.

(*) The Manila Times, November 18, 1966.

Exhibit 4

SEED CORPORATION OF THE PHILIPPINES

1965 Operating Statement
(Last Calendar Year)

	Pesos	Percentage	Pesos	Percentage
NET SALES			P1,398,747	100.0
COST OF SALES			767,423	54.9
GROSS PROFIT ON SALES			631,324	45.1
OPERATING EXPENSES:				
Salaries and Wages	P129,379	9.3		
Commissions	87,976	6.3		
Transportation and Travelling	92,136	6.6		
Packing and Delivery	46,771	3.3		
Interest and Bank Charges	39,171	2.8		
Depreciation	28,596	2.0		
Repairs and Maintenance	17,693	1.3		
Rental	11,500	0.8		
Telephone, Postage, and Telegram	8,131	0.6		
Professional Fees	6,000	0.4		
Provision for Doubtful Accounts	9,000	0.6		
Light and Water	4,968	0.4		
Taxes and Licenses	5,311	0.4		
Stationery and Office Supplies	4,767	0.3		
Representation and Entertainment	5,994	0.4		
Insurance	4,269	0.3		
Amortization of Development Costs	2,219	0.1		
Social Security Contributions	2,471	0.2		
Advertising and Promotion	5,317	0.4		
Miscellaneous	6,486	0.5		
TOTAL	518,155	37.0		
OPERATING INCOME BEFORE TAXES	P113,169	8.1		

Note: Figures in this exhibit have been disguised.

Exhibit 5

SEED CORPORATION OF THE PHILIPPINES

Organization Chart

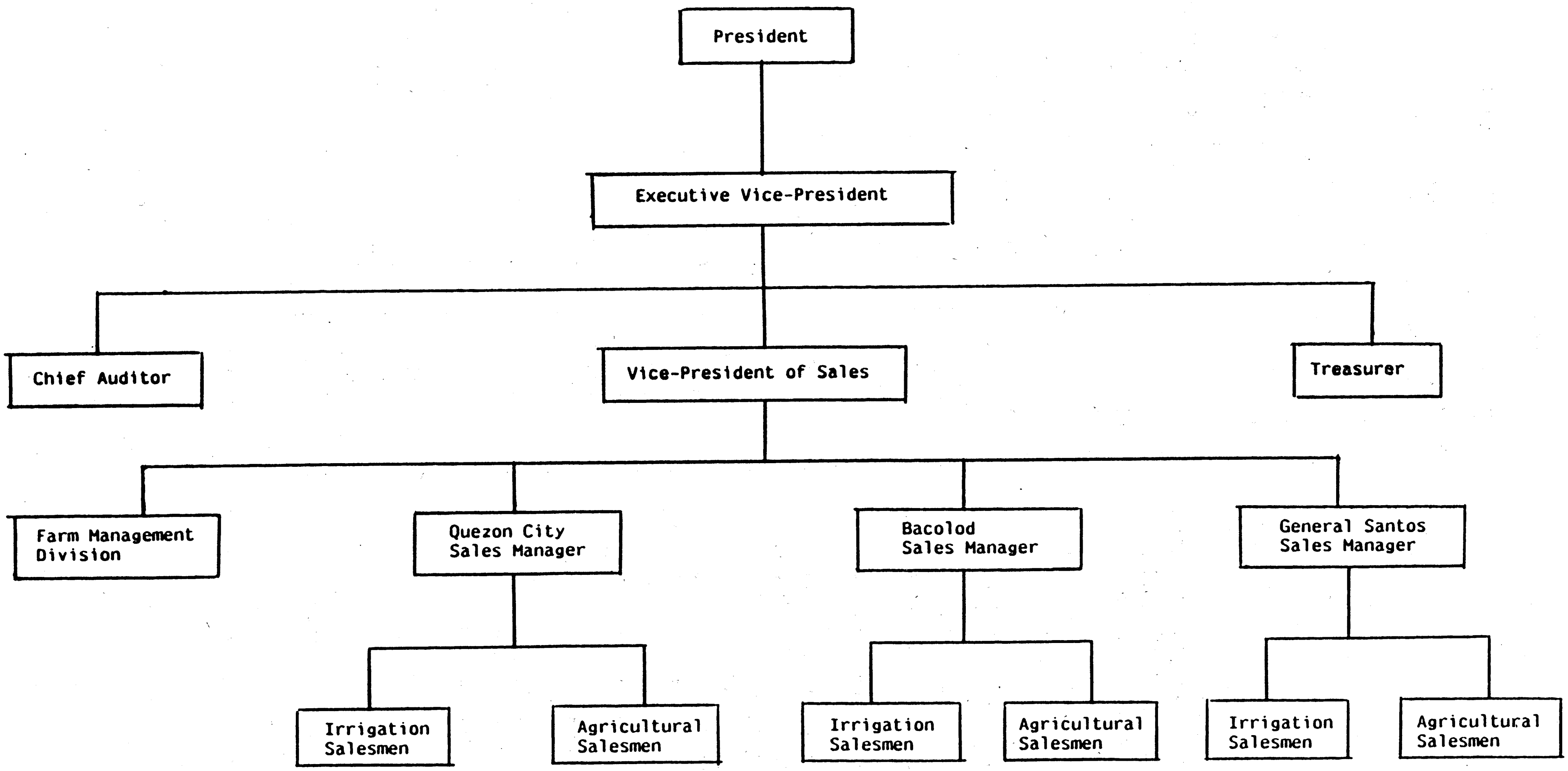

Exhibit 6

SEED CORPORATION OF THE PHILIPPINES

Cost per Hectare to Produce Rice
Following Recommended Agricultural Practices

EXPENSES	WET SEASON: Traditional Variety(1)	WET SEASON: Improved Variety (BPI-76)	WET SEASON: IR-8	DRY SEASON: Traditional Variety(1)	DRY SEASON: Improved (RP1-76)	DRY SEASON: IR-8
<u>Direct:</u>						
Seed (assumes 1 cav./ha)	P 18	P 25	P 25(2)	P 18	P 25	P 25(2)
Weed Control	0	15	15	0	15	15
Insect Control	10	44	132	10	44	132
Water	12	12	12	200	200	200
Fertilizer (nitrogen)	20	56	84	35	96	144
Total Direct Expenses	P 60	P 152	P 268	P 263	P 380	P 516
<u>Land and Labor Inputs:</u>						
Land Preparation	P 120	P 120	P 120	P 120	P 120	P 120
Labor to Apply Insecticides and Herbicide	3	10	28	3	10	28
Seedbed (dapog bed)(3)	10	10	10	10	10	10
Transplanting (straight rows)	60	60	60	60	60	60
Hand weeding	50	50	50	50	50	50
Harvesting and Threshing(4)	210	300	440	245	350	520
Cleaning and Drying(4)	25	35	50	30	40	65
Sacks(4) (P1.50 each)	90	127	187	105	150	225
Rat Control	?	?	?	?	?	?
Land Rental	200	200	200	200	200	200
Total Value Land and Labor Inputs	P 768	P 912	P1,145	P 823	P 990	P1,278
<u>Return per Hectare:</u>						
Yield (in cavans)	60	85	125	70	100	150
Value of Yield at P18 per Cavan	P1,080	P1,530	P2,250	P1,260	P1,800	P2,700
Less Direct Expenses	- 60	- 152	- 268	- 263	- 380	- 516
	P1,020	P1,387	P 982	P 997	P1,420	P2,184
Less Value of Land and Labor Inputs	- 768	- 912	-1,145	- 823	- 990	-1,278
Net Return (Profit) per Hectare	P 252(5)	P 446(5)	P 837(5)	P 174(5)	P 430(5)	P 906(5)

(1) Farmers planting traditional varieties seldom followed the recommended practices regarding insect control and fertilizer, and their yields were lower than those shown in this exhibit (see Exhibit 11).

(2) Assumed the use of RCE palay seed.

(3) The use of a regular seedbed would be P25 instead of P10.

(4) These expenses varied with the yield. See the last part of the chart for the yield assumed for each variety.

(5) Farmers normally did not place a value on the land and the labor inputs of their families and themselves in figuring the profit made on a rice crop.

<u>Note:</u> These costs assumed that general agricultural recommendations were followed. In actual practice, few farmers raising the traditional varieties use insecticides or fertilizer. The costs of chemicals, fertilizer, labor, and irrigation water varied with locality, as did the local customs by which harvest laborers were paid.

<u>Sources:</u> The International Rice Research Institute and Seed Corporation of the Philippines.

Exhibit 7

SEED CORPORATION OF THE PHILIPPINES

Characteristics of Recommended High-Yield Rice Varieties

	Variety	Region of Planting	Season of Planting	Days to Heading	Lodging Characteristics	Grain Yield (cav./ha)	Pests and Diseases	Milling Recovery	Eating Quality
LOW	B-F-3	Luzon, Visayas	Wet season only	over 135	Medium	61-80	BB, CLS HLS, RSS, SR	68%	Very good
	BPI-76	Luzon, Visayas	Any time of the year if water is available	116-135	Resistant	80-100	BB, RR, SR	61%	Very good
LAND	Peta	Philippines	Anytime of the year if water is available	115	Medium	61-80	BB, CLS, HLS RSS, SR	67%	Fair
	Niere mas	Luzon, Visayas	Anytime of the year if water is available	115	Lodged	61-31	B, BB, CLS, HLS, RSS	63%	Fair
UP	IR-8	Philippines	Anytime of the year if water is available.	120	Resistant	125-150	B, BB	Uncertain	Fair
	Azucena	Philippines	Wet season only	92	Slight	46-60	B, BB, CLS, RSS, SR	63%	Very good
LAND	Taiwan	Philippines except Cayan Valley	Anytime of the year if water is available	over 92	Resistant	61-75	B, BB, CLS, SR, RSS	68%	Fair

Abbreviations:
B - Blast
HLS - Helminthosporium Leaf Spot
SR - Stem Rot
BB - Bacterial Blight
RR - Root Rot
CLS - Cercospora Leaf Spot
RSS - Rhizoctonia Sheath Spot

Source: University of the Philippines College of Agriculture and Department of Agriculture, Bureau of Plant Industry.

Exhibit 8

SEED CORPORATION OF THE PHILIPPINES

Rice Yields per Hectare (in cavans), The Philippines,
by decade 1920s to 1950s

Decade	Average Yield Per Hectare
1920 - 29	26.2
1930 - 39	25.9
1940 - 49	24.6
1950 - 59	26.8

Source: The Philippines: Long-Term Projection of Supply of and Demand for Selected Agricultural Products, p. 112.

Exhibit 9

SEED CORPORATION OF THE PHILIPPINES

Palay Production in the Philippines during 1965
(in 000's of cavans)

Region	All Palay			Lowland First Crop			Lowland Second Crop			Upland and Kaingin
	Total	Irrigated	Non-Irrigated	Total	Irrigated	Non-Irrigated	Total	Irrigated	Non-Irrigated	
PHILIPPINES	92,560	39,415	53,145	68,900	28,937	39,963	13,723	10,478	3,245	9,937
Ilocos	4,768	2,521	2,247	3,976	2,136	1,839	387	384	3	404
Cagayan Valley	12,214	6,459	5,755	9,144	4,005	5,139	2,666	2,454	213	404
Central Luzon	23,422	10,664	12,758	21,905	9,259	12,646	1,438	1,405	33	78
Southern Tagalog	12,574	5,303	7,272	7,541	3,653	3,888	2,255	1,650	605	2,779
Bicol	12,515	6,797	5,718	6,831	4,239	2,592	3,452	2,558	894	2,333
Eastern Visayas	5,098	1,481	3,618	3,709	940	2,769	1,059	540	519	330
Western Visayas	9,375	2,255	7,120	7,212	698	5,514	1,429	557	872	73
Northern and Eastern Mandanao	2,784	423	2,361	1,621	325	1,296	175	98	77	988
Southern and Western Mandanao	9,810	3,513	6,297	6,963	2,682	4,281	861	831	30	1,985

Source: Bureau of Agricultural Economics, Department of Agriculture and Natural Resources.

Exhibit 10

SEED CORPORATION OF THE PHILIPPINES

Hectarage Planted in Rice in the Philippines During 1965
(in 000's of Hectares)

Region	All Palay			Lowland First Crop			Lowland Second Crop			Upland and Kaingin
	Total	Irrigated	Non-Irrigated	Total	Irrigated	Non-Irrigated	Total	Irrigated	Non-Irrigated	
PHILIPPINES	3,109	950	2,149	2,009	678	1,331	494	282	212	606
Ilocos	145	65	79	114	53	60	12	12	-	19
Cagayan Valley	354	135	219	275	86	188	58	49	9	21
Central Luzon	519	230	289	480	195	285	36	35	1	3
Southern Tagalog	467	142	325	218	91	127	90	51	39	159
Bicol	367	135	232	163	80	83	92	55	37	112
Eastern Visayas	323	58	265	209	34	175	79	24	55	35
Western Visayas	378	65	313	231	46	184	80	19	60	68
Northern and Eastern Mandanao	145	21	124	73	13	60	15	8	7	57
Southern and Western Mandanao	410	107	303	246	78	168	32	29	3	132

Source: Bureau of Agricultural Economics, Department of Agriculture and Natural Resources

Exhibit 11

SEED CORPORATION OF THE PHILIPPINES

Number of Cavans Produced per Hectare in the Philippines during 1965

Region	All Palay			Lowland First Crop			Lowland Second Crop			Upland and Kaingin
	Total	Irrigated	Non-Irrigated	Total	Irrigated	Non-Irrigated	Total	Irrigated	Non-Irrigated	
PHILIPPINES	29.77	41.03	24.73	34.30	42.67	30.03	27.76	37.13	15.30	16.40
Ilocos	32.94	38.50	28.35	34.98	40.04	30.50	31.72	31.71	32.12	21.46
Cagayan Valley	34.46	47.75	26.26	33.30	46.43	27.28	45.71	50.07	22.62	18.86
Central Luzon	45.10	46.28	44.16	45.60	47.38	44.39	39.96	40.15	33.19	26.44
Southern Tagalog	26.91	37.24	22.38	34.52	39.96	30.60	25.04	32.36	15.41	17.50
Bicol	34.11	50.37	24.65	41.87	52.76	31.31	37.64	46.85	24.09	19.92
Eastern Visayas	15.76	25.50	13.63	17.74	27.65	15.62	13.38	22.46	9.42	9.34
Western Visayas	24.81	34.53	22.78	31.26	36.68	29.90	17.97	29.30	14.41	20.85
Northern and Eastern Mandanao	19.19	19.94	19.06	22.27	24.80	21.72	11.62	12.08	11.07	17.26
Southern and Western Mandanao	23.92	32.72	20.80	28.28	34.26	23.45	26.62	28.34	10.03	15.09

Source: Bureau of Agricultural Economics, Department of Agriculture and Natural Resources.

Exhibit 12

SEED CORPORATION OF THE PHILIPPINES

Memo on Advertising Rates

To : Mr. Miguel T. Gonzales November 15
From : Mario Mendoza
Re : Advertising Rates

In response to your request for information on advertising rates, I submit the following information:

I Newspapers

The newspaper advertising rates you requested are as follows:

Newspapers	Rates	Circulation
Bulletin	P 8.50/col. in	53,900
Chronicle	P11.00/col. in	67,500
Daily Mirror	P 6.00/col. in	38,900
Evening News	P 7.00/col. in	36,200
Herald	P 8.50/col. in	47,600
Times	P19.00/col. in	182,000

The above is the basic rate per column inch. Each full newspaper page is 8" x 21 col. in size or 168 col. inch.

II Magazines

The magazine advertising rates you requested are as follows:

Magazines	Rates	Circulation
Agricultural & Industrial Life	P320/full page	20,000
Philippine Farms and Gardens	P420/full page	32,000

III Radio

The advertising rates on provincial radio stations vary greatly as the following data indicate:

Length of Spot	Range in Cost
5 sec.	P1.50 to P 3.60
10 sec.	P2.00 to P 5.50
30 sec.	P3.00 to P 7.50
60 sec.	P5.00 to P12.00

Chapter 17

THE AGRICULTURAL RESEARCH ENVIRONMENT: EMERGING CHANGES AND CHALLENGES

CONCLUSION:

EMERGING CHANGES AND CHALLENGES

IN THE AGRICULTURAL RESEARCH ENVIRONMENT

The challenges being faced by agricultural research managers in developing countries will continue to evolve. By using the managerial perspectives set forth in this volume, the agricultural research manager can continue to scan the environment, monitor changes, and take advantage of the opportunities that change may bring. A marketing perspective, for example, identifies for the manager the need to target disfranchised clients, those clients that the "Green Revolution" has ignored or for whom the technological packages developed have been less appropriate. Pressures can already be discerned for the researcher to focus on maximizing farm family income, as opposed to focusing exclusively on maximizing crop yields. Several of the cases, such as "Rice Self-Sufficiency in the Dominican Republic" and "Guaranteed Prices of Maize in Mexico," point towards the need to target neglected clients.

The number of actors and institutions in the food system with which the agricultural research manager must work will be increasing. The pressures on developing countries to diversify agricultural exports will force the research manager to become aware of the needs of the relevant participants in additional food systems. The rise and development of a middle class in many developing countries will change the kinds of food as well as the presentation and distribution of many foods. The research manager will have to be responsive to the "pull" demands of various client groups. Consumers with greater purchasing power often demand processed foods in cans, boxes, or bottles. The research manager will have to be aware of the food processing requirements of national and international markets.

Nurturing a systems perspective will help an agricultural research manager know who the relevant participants in evolving food systems are. Many of the management case studies demonstrate that food systems are becoming more complex in both horizontal and vertical dimensions. In a horizontal dimension, the relevant target groups are being segmented into more precise groups. Research managers no longer talk only of farmers, but of commercial farmers, medium-scale farmers, subsistence farmers, and cash-crop farmers, and the targeting becomes more specific. On the vertical dimension, the number of participants with whom the agricultural research manager must contend is also increasing. Food processors (as in "Sabritas, S.A."), government commodity-buying agents (as in "Cashew Nut Research in the Tanzanian Agricultural Research Organization"), seed companies (as in "Kenya Seed Company"), urban consumer groups (as in "Guaranteed Prices of Maize in Mexico"), and others are dramatically expanding the universe that is relevant to the research manager. The international links and the growing global interdependence that is developing give greater emphasis to the need to maintain a systems perspective.

A partnership perspective can permit an agricultural research manager to cope with the growing complexity of food systems. "Sabritas, S.A." and "PATRONATO: The Agricultural Research and Experimentation Board of the State of Sonora, Mexico" showed private-sector institutions that reached back towards the public sector for support. "Kenya Seed Company," "CIAT: The Cassava Program, (Colombia)," and "Seed Corporation of the Philippines" demonstrated that agricultural technology generally has flowed from the public sector towards the private sector. The public sector had a greater responsibility for more basic types of research; and the private sector, for the actual delivery of embodied technology.

These roles may change, as is demonstrated in the case "Biotechnology: The Challenge to Bombalaya." In the future, technology likely will originate in the private sector, and under this circumstance the role of the public sector in technology adaptation and transfer is uncertain. While in the past the private sector has had to reach back at times to the public sector for assistance in technology development, in the future it is the public sector that may have to seek assistance from the private sector. The private-public sector linkages are going to be radically altered. This presents many developing countries with a dilemma and a very difficult challenge.

Developing countries will have to forge linkages with the international private sector in order to keep abreast of modern agricultural technology. Countries will need to grapple with the issue of what kinds of linkages are effective and acceptable and will be challenged to define what the role of their own national private sectors should be in the process. However, control of the technology will be with the international private sector. This will magnify North-South development issues. It will make the North-South dialogue more complicated because many of the arguments of the public sectors in the South will not appear "rational" to the international private sector in the North. New accommodations and new formulas will need to be found, and the agricultural research managers in developing countries will need to help define their own roles in the new relationships.

A dilemma that biotechnology presents to developing countries is that the countries face making a choice between two alternatives, neither of which may be successful. On the one hand, a developing country can wait for the international public sector, such as the international agricultural research institutions, to forge linkages to the sources of biotechnology. In this instance, the country expects that the channels that worked for the Green Revolution for delivering technology to developing countries will work for the Biotechnology Revolution. On the other hand, the developing country can act by itself and seek to establish its own links to the sources of biotechnology. It seems uncertain that either of these options can be reasonably achieved. However, it is clear that developing countries should be preparing a cadre of specialists that understand biotechnology and who, at a minimum, can give a developing country sufficient knowledge to negotiate for access to the products of biotechnology.

As the implications of the Biotechnology Revolution emerge, the agricultural research manager can use a systems perspective to monitor developments, a partnership perspective to help conceptualize what new relationships are possible and desirable, and a marketing perspective to stay abreast of the changing needs of the relevant participants in the system.

The pressure on agricultural research managers to produce more results with fewer resources will continue to mount. As governments in both developed and developing countries continue to face pressures to constrain spending, the agricultural research manager will increasingly have to target the research effort more precisely and make those efforts more efficient. As "The Kalamar Horticultural Institute" shows, the research manager may be forced to be innovative and entrepreneurial in seeking new sources of funding and in finding new ways to sell the benefits of agricultural research.

The rapid change in population growth and in the generation and transfer of agricultural technology is also accelerating the need and pace of decision making. Managers will have to make more decisions and make decisions with more far-reaching consequences. The agricultural research manager in developing countries is being steadily drawn into the one-world system of agribusiness, where there is a harvest somewhere in the world every day, and where cheaper transportation and cheaper communications are dramatically shortening distances. The agricultural research manager can no longer be concerned only with crops. He also must focus on the growing industrialization of food as the number of ways food is packaged, stored, processed, or transported is increasing. The agricultural research manager is being required to consider issues of energy, foreign exchange, the conservation of the environment, and the equity of income distribution. The agricultural research manager may be asked to be all things to all people. This will not be possible, but the agricultural research manager with managerial perspectives may be able to define what he wants to be.

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