9. AFNS Project Evaluations

- Sorghum (Ethiopia)
- Cassava (Indonesia)
- By-Products (Mexico)
- Aquaculture (India)
- Forestry Technology (Andean Pact)
- Grain Milling and Storage (Nigeria)

Not included in presentation made to the Board of Governors

COMMON PROJECT FEATURES

The six project evaluations enclosed in this document illustrate certain common elements or problems which the Division has experineced in many of its projects. While the Division regularly examines these common problems and refines its policies to alleviate their effects, the extreme diversity in the capability and organization of recipient research institutions, the experience and attitude of scientists, and the political and administrative variations among countries make it difficult to establish any definitive guidelines. The following comments are illustrative of some of the common project problems encountered in these and other Division projects.

1. Multidisciplinary Research

The Division is conscious of the need to determine the economic as well as the technical viability of new technology, and to ensure that the technology is designed to meet the needs of the target beneficiary within the limitations of the beneficiary's resources and constraints. These projects indicate that one of the main obstacles to the development of new technology which the rural community can and will use is the difficulty of incorporating an effective social science component into projects. Many of the institutions the Division supports do not have any social scientists on staff. In cases where other institutions are drawn in to provide this expertise, the economists and other social scientists are often oriented to the macro-economic and broader social implications of new technology and neglect the importance of village production studies or the economic viability of the new technologies being developed. This attitude is often paralleled by that of the natural scientists who visualize the social scientist as having an input only after the technical merits of new technology have been determined rather than playing a role in the definition, development and testing of new technology.

Of the six projects evaluated, two (Andean Pact and Ethiopia) are examples in which the recipient institutions did not employ a social scientist. In the case of Nigeria, IDRC provided the services of several agricultural economists as consultants during the stage of project definition,

and later to assist in preparing a major development program for widespread utilization of the new milling system.

In two of the projects (Indonesia, India), there was one agricultural economist or farm management professional involved but their effectiveness was limited due to other outside responsibilities and limited manpower support provided to them in the project. The Mexican project had a strong socio-economic research component built into it from the beginning. However, the emphasis was on macro-element studies which had only a limited usefulness for the technical scientists.

As a result of these kinds of difficulties, the Division has increased the number of agricultural economists on staff to work as a group more closely with the program officers so as to build in a stronger economics component into each of the Division's projects.

2. Appropriate Research Institutions

These evaluations reflect the dilemma faced by the Division in selecting institutions to support. Universities and other research institutions often have a significant research capability in terms of experienced and well qualified scientists plus adequate research facilities. IDRC support for these institutions can result in the development of a research program with a practical problem-oriented approach which can influence the attitudes and perceptions of a generation of agricultural scientists as well as producing useful technical results. However, these institutions often have no effective links with the government agencies responsible for the widespread adoption of new technologies by the rural community.

Secondly, these institutions often lack access to sufficient financial resources to ensure that they will be able to maintain their research program after external financing is terminated. The organizational structure of universities makes it difficult for a group of scientists to carry out a long-term research program involving extensive field testing with the rural community or the establishment of a pilot project such as

the Maiduguri milling system (Nigeria) to determine the technical and commercial feasibility of new technology.

On the other hand, Government Ministries which have a mandate and sometimes the funds and organizational capability to work with the rural community often lack the necessary research capability to develop new technology.

The six projects examined in this study provide examples of IDRC support to both kinds of institutions. In some cases the Division has attempted to strengthen the often weak scientific capability of government agencies, while projects the Division supports at universities are usually designed to try and strengthen the collaboration between the universities and government agencies. For example, the evaluation report on the Indonesian project indicates that the dialogue between IDRC, Brawijaya University and CRIA - the national agricultural research organization - has progressed to the point where it appears that the cassava program at Brawijaya will become part of the national cassava research program with the likelihood of continuing financial support from CRIA for the University research team.

In the Mexican By-Products project, the increasing financial resources and political influence of the government's national research coordinating agency (CONACYT), along with the present negotiations for future financial support from the Mexican Association of Sugar Producers, provide some grounds for believing that the universities and government institutions involved will be able to continue to work together after IDRC support is terminated.

3. Developing the Delivery System

Continued acceptance of the traditional concept that agricultural research must precede extension by X years, is believed to be one of the reasons why much of the research undertaken in the past has clearly been inappropriate and unacceptable to the proposed user. Division staff have

emphasized the need to develop research projects in which scientists work closely with the potential users of new technology - defining the research project to address problems faced by a particular group in the rural community and testing new technology under typical on-farm conditions to determine its effectiveness and acceptability. While this approach increases the likelihood that new technology will be acceptable to the rural community, the impact of this technology may be seriously delayed or even lost by the lack of an effective delivery system.

The resources needed to ensure the widespread adoption of new technology are often of such magnitude that developing countries require additional external assistance. IDRC' s capability to assist in the development of a national delivery system is limited both by its mandate and resources. Thus the Division has decided to work more closely with CIDA and other donor agencies who have the mandate and financial capability to support a major development program.

The Nigerian project demonstrates a case where it appears that a superior technology has been developed, and there is a need for continued external support to deliver this technology to the intended beneficiary.

The objectives established for the milling system developed at Maiduguri in Nigeria have been achieved and IDRC staff have identified a survey team who are examining the potential for establishing these mills throughout Northern Nigeria, and identifying the kind and source of equipment necessary along with the required management training programs and operating procedures. While IDRC staff are assisting in the design of an extensive development program for the Maiduguri milling system, IDRC is unable to provide personnel or funds beyond this stage. In this case, the National Grains Production Company (NGPC) of the Nigerian Federal Government has agreed to provide the funds to establish a number of mills with IDRC staff and consultants providing technical guidance. IDRC is exploring, with CIDA, its interest in providing financial support for the establishment of mills in other African countries with similar cereals and milling requirements.

4. Building the National Research Infrastructure

The decision to structure IDRC on a global program rather than on a geographical basis has allowed IDRC to create a uniquely successful system of networks which link scientists across national boundaries in a coordinated attack on common problems. At the same time, the Division has been conscious of the importance of supporting national projects which fit within national research priorities and has therefore placed three liaison officers in various regional offices within the last year. One of their primary duties is to determine these priorities in each of the countries in the region, and to ensure that projects accepted by the Division contribute to the strengthening of the national research system and to work more closely with various national research coordinating agencies where they exist. The Cassava Indonesia project is one example where IDRC supported a project in a relatively small and isolated university (Brawijaya) but shortly after approval of the project initiated discussions with CRIA, the national agricultural research organization, in order to establish a national cassava research program which would incorporate the work at the university.

5. IDRC's Role and Involvement

The achievement of Division objectives, reflected in the evaluation criteria, is an uncertain process which Centre staff can influence only to a limited extent in any given project. The achievement of technical objectives in agricultural research is a time consuming process in which weather changes, or disease and insect attacks, may eliminate a whole year's trials. The process of strengthening and making more effective and efficient use of scientific resources is similarly a complicated and long-term process.

The Nigerian milling project provides an example in which a national government agency, with the mandate to develop the post-harvest sector, was created only after the project had been operational for four years. This occurred despite a government commitment made during the initial negotiations to ensure the widespread utilization of the project's results.

As Division staff have identified more constraints to the achievements of project objectives, they have attempted to provide additional support to research institutions. This has involved going beyond the original focus of defining research projects to strengthen individual institutions and to linking them with research organizations working on the same problems in other countries. Division staff feel that they can provide a useful service to research institutions through frequent visits to provide advice, to those less capable, on the technical aspects of the research program and to encourage project leaders to make decisions, plan and evaluate their research programs more effectively. AFNS staff have encouraged the development of integrated research projects linking different disciplines and institutions together in a systems approach to agricultural research. However, it appears that the more institutions linked in a project, or the more integrated the overall research program, the greater the project management requirement and supporting IDRC inputs are necessary. Division staff provided in excess of two man-years during the first five years of the Nigerian project, while the program officer responsible for the Andean Pact Forestry project devoted a minimum of one month a year in the first two years and in excess of three months in the third and last year.

AFNS involvement in supporting research institutions has gone considerably beyond direct involvement with the recipient. It is estimated that the Division will devote more than six man-months in the FY1978-79 in discussions with CIDA and other development agencies to ensure that external financial and technical resources are made available to allow the widespread adoption of useful new technologies developed in some of the projects.

The expansion of activities in support of projects has resulted in a diversification of the responsibilities of Division staff. While the staff feel that this expansion has been necessary, they are conscious that their role must remain catalytic and supportive without reducing the initiative of recipient institutions. There must be a constant trade-off between the demands on program staff to encourage and support the development of more

research projects and their responsibility to respond to the opportunities and constraints identified in their on-going projects.

A. BACKGROUND

Evaluation is the process of determining the relative worth or importance of something and assessing to whom it is of value. In the present context the evaluation relates to several projects supported from the AFNS budget. Since all are applied research projects, their purpose is to benefit a target group. Consequently the evaluation is as much concerned with who is to benefit and how the benefit is to be realized, as with technical achievements.

Evaluation is a continuous process starting from the time project proposals are submitted until the projects are complete; and involves an examination of technical, socio-economic and administrative criteria. Ex ante, interim and ex post facto examinations seek to assess the potential and realized value of the technology to the beneficiary, the elements of the delivery process, along with the formal and informal systems of interaction and cooperation among scientists, technologists and beneficiaries.

The AFNS Division is composed of three overlapping groups which cooperate in the system of project development, support and evaluation.

1. Program Staff

This consists of Associate Directors and Program Officers, each experineced in and responsible for projects in their special discipline be it Crops, Animals, Fisheries, Forestry or Post-Production Systems. All but one of the Program Staff reside in either a developing country or a Canadian University.

2. Research and Evaluation

This consists of a small group of social scientists whose concern, throughout the life of each project, is with the economic, social and human influence and impact of the research undertaken and of any new or modified technology that ensues.

3. Operations Group

This group is responsible for the Division's input in terms of administration, budgetary management and a variety of other supporting services.

Evaluation reports on six AFNS projects are presented, two from Crops and Cropping Systems and one each from Animal Sciences, Fisheries, Forestry and Post-Production Systems. All of the projects chosen, which are listed below, have been in progress for at least three years, and each has encountered a variety of difficulties and complications.

- Sorghum (Ethiopia)
- Cassava (Indonesia)
- By-Products (Mexico)
- Aquaculture (India)
- Forestry Technology (Andean Pact)
- Grain Milling and Storage (Nigeria)

The evaluation includes analyses of information retrieved during on-site visits and from reports from the project staff, together with the recipient's assessment of IDRC and the project.

B. EVALUATION CRITERIA

The criteria used in AFNS project evaluations conforms to a pattern but are not absolute or restrictive. They are the outcome of the study of many proposed systems of applied research evaluation but it is believed they are somewhat unique and reflect the AFNS philosophy of applied research for human benefit.

1. The Research Problem

This section contains a brief description of why, how and by whom the research problem was defined, the recipient institution(s) to be supported and the project's objectives. The format is subdivided into:

a) background
b) project development
c) recipient institution, and
d) objectives

The background examines the rationale for defining the research problem and describes why and by whom the problem was perceived to be important. In addition, it is important to define the intended beneficiary and how the technology will be delivered to that beneficiary.

The subsection on project development describes the particular way in which IDRC and the recipient institution agreed to undertake the project. The 'Recipient Institution' describes the organizational structure, along with the physical, financial and human resources of the recipient, available at the time the project was defined.

There then follows a note on the objectives which is a statement of what the project intends to achieve. Where applicable, it is noted when and why objectives have changed between phases of a project.

2. Project Performance

This section on project performance forms the core of this evaluation exercise. It is essentially analytical as it involves an assessment of results with respect to the effectiveness of the project in relation to its objectives.

a) The research program

A review is made of the development of the research program. Has the project maintained its original scheduled time frame of activities and if not, what are the key variables responsible for these delays?

b) Personnel and resource use

A general examination is made of the financial, institutional and human resource pattern which has been used throughout the operation of the project.

c) Technical achievements

The technical achievements are examined in relation to each of the stated objectives.

d) Institutional and personnel development

One of the main aims in every project is to develop the institutional and human resource base. Key variables which define institutional development include:

- a change in the research focus of the institution
- an increased commitment on the part of the institution to the IDRC supported research activity
- an enhanced role for the institution within the national context
- the relationship of the project to the on-going activities of the institution

The development of the human resource base is the foundation for any future research program and therefore a comment on the development of personnel on the project is an important component in all projects. Training programs are the principal formal mechanisms for developing personnel. To analyze the scope and importance of a training program in a project, attention must be given to:

- the number of personnel trained
- the type and relevance of training programs
- the activities of trainees who have completed formal training
- the relevance of the training program to the project.

e) Management and program planning

A key variable influencing the successful completion of a research project is its management.

In many AFNS supported projects an attempt is being made to approach a problem from a new perspective. Undertaking applied research entails a non-traditional interdisciplinary approach to scientific concepts. The implementation of this approach requires innovative management structures within an institution and effective coordination between institutions. The intention in this section is to examine the structure that has been established and to relate this to the overall operation of the project.

f) Administrative and financial problems

As in the case with management, effective administration is a requirement for successful project operation. Certain administrative aspects involving direct IDRC input, are commented on in Section 3 - IDRC's Role and Involvement. A study of the project administration includes:

- the time required to recruit project staff and trainees
- problems related to the purchase of equipment and supplies from local and foreign sources
- financial control mechanism
- the nature and scope of authority and responsibility assigned to the project leader by the recipient institution, and
- a financial analysis comparing actual versus budget expenditures

g) National linkages

AFNS has encouraged cooperation and communication between the recipient institution and other national institutions. A review is made of linkages which have been established between the recipient and other government, university and private research institutions. This examination reveals the nature and scope of inter-institutional cooperation in a particular country.

h) Regional linkages

AFNS has endeavoured to initiate and strengthen institutional linkages on a regional and international basis through a scientific exchange and supporting services such as workshops, publications, state of the art reviews, and training. Where there are no existing regional or internationally recognized institutions, IDRC has promoted a network to link IDRC projects with similar or related activities. An analysis and assessment of the nature and effectiveness of these linkages, and their points of contact among individual projects is reviewed in this section.

i) The delivery system

An examination is made of the mechanisms which exist to facilitate a working relationship between the scientist and the beneficiary and to what extent these mechanisms promote direct adoption of new technology by this beneficiary. Are scientists working closely with the beneficiary? How close are the links between project staff and the agencies such as extension and training organizations which have the mandate and organization to promote widespread adoption and adaptation of new technology?

j) Beneficiary

It is essential that in an applied research project involving on-farm or field testing that the beneficiary and his resources, constraints and needs be identified. These must be known in order to incorporate the beneficiary's involvement in the planning and on-going experimentation of newly developed or adopted technologies. Research beneficial to the small farmer must focus on his production system and identify structural limitations, particularly those that could be advantageously modified or removed; research for small industry must take account of his limited resources of capital and of the nature of the products required by the industry's customers.

3. IDRC's Role and Involvement

The intention of this section is to determine the role that IDRC has played in this project (technical and administrative) and to obtain an assessment of the recipient's perception of IDRC.

IDRC's involvement in a project varies according to the project and the institution. At a minimum, our involvement is represented by monitor visits and comments on financial and progress reports. AFNS involvement in a project becomes much more visible when a project advisor is placed in a project.

IDRC's style of operation which minimizes donor interference in a project is, we believe, unique. A comment on the extent of IDRC's involvement and the recipient's perception of this philosophy will provide useful feedback in assessing our performance. Questions to be asked include:

- Have IDRC's requirements and regulations created excessive restrictions on the institution?
- Has the role of the project advisor impeded or assisted the development of the research project?
- What has been the role of AFNS program staff and would a more intensive system of monitoring and guidance have been useful?
- Has the use of visiting consultants been beneficial and would more or less consultant advice have been desirable?

4. Development Implications

This section addresses broader issues concerning the significance of the project achievements in the national, regional, and international context.

At the national level, we wish to determine:

- the potential impact of the technology developed
- what institutional change in the agriculture and/or industrial sector has resulted
- what commitment has been made by policy makers to continue the research program when IDRC support terminates
- what investment funds will be provided to further develop and exploit the technology

At the regional and international levels, what if any broader benefits are being, or will be, exploited through the transfer of knowledge or new projects in other countries.

CASSAVA (INDONESIA):
AN EVALUATION

Phase I - 3-P-73-0043

Phase II - 3-P-76-0060

RECIPIENT INSTITUTION: Faculty of Agriculture
Universitas Brawijaya
Malang, Indonesia

DURATION: Phase I - Nov. 1973 to Oct. 1976
Phase II - Nov. 1976 to Oct. 1980

IDRC CONTRIBUTION: Phase I - $ 98,000
Phase II - $328,000

October 1978

1. THE RESEARCH PROBLEM

1.1 Background

Indonesia, with a yearly production of 11 million tons of fresh root, is the second largest cassava-producing country in the world and the second largest exporter of cassava (200,000 tons dried cassava).

Cassava is a small farmers crop in Indonesia. It is consumed mostly as fresh roots, with a small but increasing amount as pelleted animal feed for export. It is the third most important crop in Indonesia after rice and corn, although yields are low with an average of about 7 tons per hectare. One reason for these low yields was that there was very little research capability at the time the project began, with almost no research work being undertaken.

East Java, one of the most densely populated regions of the world, and the most important cassava-producing region in Indonesia, is the home of a potentially very significant production innovation developed by a local farmer, Mr. Mukibat, in 1952. This technique was adopted by a number of farmers in East Java, but before this project was undertaken, only a few unsystematic experiments had been carried out to determine the merit of this new technique.

1.2 Project Development

The project can be seen as a follow-up of a cassava workshop held in London in January 1973, during which a working relation between Brawijaya University and the Centre was established. Dr. G.N. de Bruijn from the Department of Tropical Crops, Agricultural University, Wageningen, was the mediator of such contacts.

The cassava network established by IDRC with substantial back-up from CIAT scientists, had gradually expanded from Latin America to include most of the important cassava-producing countries. Indonesia was difficult to bring into this network since it lacked even a minimal research nucleus around which one could build a strong research program.

The AFNS Associate Director concerned with the cassava program decided to encourage Brawijaya University in East Java to prepare and submit a research project to further investigate the Mukibat system.

The Mukibat cassava system consists of grafting the tree cassava (M. glaziovii), a perennial that does not produce tuberous roots, onto the normal cassava (M. esculenta). It was estimated (based on sketchy data) that under comparable conditions, yields using the Mukibat system at least doubled those from the traditional system. Another indicator of the new system's potential was its spread to a small but increasing number of farmers in East Java.

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1.3 Objectives

A project was developed with the following three objectives (which remain essentially the same in Phase II except for the addition of d):

a) To study and further develop the potential of the Mukibat system of combining tree and normal cassava;

b) To link Indonesia into the CIAT Cassava Research Network; and,

c) To provide practical training in cassava research and development for staff and graduate students at Brawijaya University.

d) In Phase II it was decided to undertake studies on a variation of the Mukibat technique called the Satrawi system, named after a local farmer also. This new system involves the simultaneous grafting of one M. glaziovii scion (the leafy canopy of the cassava) onto three M. esculenta stocks planted to form a tripod. It is hoped that this plant structure will improve resistance to wind damage and increased yields will result. The Mukibat system will be compared to the Satrawi system and with normal cassava.

1.4 The Recipient Institution

The Brawijaya University was chosen because it was located in East Java. It was the only institution that had done previous work on food crops and livestock, but more importantly, IDRC's Associate Director was impressed by the Faculty of Agriculture's small (14 staff members only), young, but very enthusiastic team of scientists who had an interest in cassava research.

2. PROJECT PERFORMANCE

2.1 Personnel and Resource Use

While there has been a general shortage of staff, the project has benefited from the strong leadership of the two Project Directors. The project originally relied largely on student fieldwork with part-time staff guidance, but given the shortage of students in particular fields at times, and the other commitments of staff, the project has switched to using a mixture of full-time project staff and student workers to carry out the research. In terms of the research staff, there are five agronomists, two entomologists, two soil scientists, one food technologist, and one economist involved. The Faculty of Agriculture has made the majority of their office space and equipment available for use by the project research staff.

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2.2 The Research Program

In the beginning, experiments were often interrupted or delayed due to shortages of staff and material, unforeseen national events, and also because of the staff's inability to judge how much work they could comfortably handle. This situation has improved largely by restricting the geographic dispersal of experiments, which makes them easier to manage. The problem here is that experimental results may not be as applicable to all ecological regions of East Java.

2.3 Time Frame

Despite the difficulties outlined below, Phase I was completed on schedule and Phase II is progressing according to the original program. The project leader, Dr. Soetono, feels that a definite answer to the value of the Mukibat system could be had by 1980, but this will require more conclusive answers as to how the system contributes to the farmers' present overall cropping pattern. It is also felt by consultants that the project will have to involve more experimental station testing to meet the 1980 deadline.

2.4 Technical Achievements

Project results have been presented in a series of progress reports, two publications, and seminars. They can be summarized as follows:

a) Comparison of yields between normal and Mukibat cassava has shown that increases from the Mukibat system are anywhere from 114 per cent to 347 per cent on a dry matter basis, the value most often incurred being approximately 130 per cent to 150 per cent. It should be noted, though, that these results are based on a growing season of 10 months for normal cassava and 15 months for Mukibat cassava.

b) Mukibat cassava continues to fix dry matter up to a period of 18 months, compared to only 14 months with normal cassava. Furthermore, at any time during the period of dry matter fixation, the dry matter content is higher in Mukibat cassava. At 10 months dry matter of Mukibat cassava is 26.2 and 23.3 per cent for normal cassava; at 12 months the values are 30.5 and 29.2 per cent respectively; at 14 months it is 34.7 and 31.8 per cent. The increased period of dry matter fixation in Mukibat cassava allows the farmer to store his cassava roots in the ground for a longer time without fear of root decomposition.

c) Although digging planting holes is traditionally used in the Mukibat system, it has been demonstrated that this laborious practice is not necessary. This is an important finding since one of the primary reasons cited by farmers (in a survey in 1973) for not

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switching from normal to Mukibat production was the greater labour requirements for Mukibat.

d) Significant fertilizer response has been obtained, but only following the application of nitrogen.

e) The superiority of Mukibat cassava in terms of yield is greatest for the slow growing varieties preferred by consumers.

f) It is possible to use the grafts for more than one planting, enabling farmers to spread their grafting costs over more than just one growing season. Re-use at present appears to be limited by the fear of a carry-over of pests and disease, and the susceptibility of the graft to wind damage.

g) Preliminary results on the Satrawi system indicate that it provides no significant benefits over that of the Mukibat system. Other preliminary results on pest control, growth cycle, planting season, etc., are highly encouraging. However, more experiments are needed to clarify more precisely the technical and economic implications of these technologies.

2.5 Personnel and Institutional Development

The project has produced some interesting results and has also raised a number of questions, not only for the future development of the Mukibat system in Indonesia, but also on the whole mechanism of root thickening in cassava. As a result, the project has attracted a lot of attention elsewhere. This has been particularly important for the morale of the young and small Brawijaya University. Brawijaya University has made substantial progress in learning how to manage a research project and in developing a team of scientists who will be capable of carrying on a major research program. The recognition achieved by this project has encouraged the Dean and staff members to attempt to create a Cassava Research Institute at Brawijaya University which, given the importance of cassava in East Java, could become one of the main centres for cassava research in Indonesia.

While the Faculty has only one Ph.D on staff at present, there will be an additional three by the end of Phase II in 1980. One scientist now studying towards his Ph.D. at Wageningen University in Holland, is expected to do his fieldwork on cassava at Brawijaya through project funds. Two of the full-time project staff have been offered Ph.D. scholarships in Australia. It is unlikely that any arrangement can be worked out to ensure that they will be able to do their Ph.D. work on cassava, but this possibility is being explored.

While the number of students who will undertake research on some aspect of cassava production for their Ingénieur's degree by the end of the second phase in 1980 will not be as large as originally planned (45) due to the difficulty of recruiting sufficient

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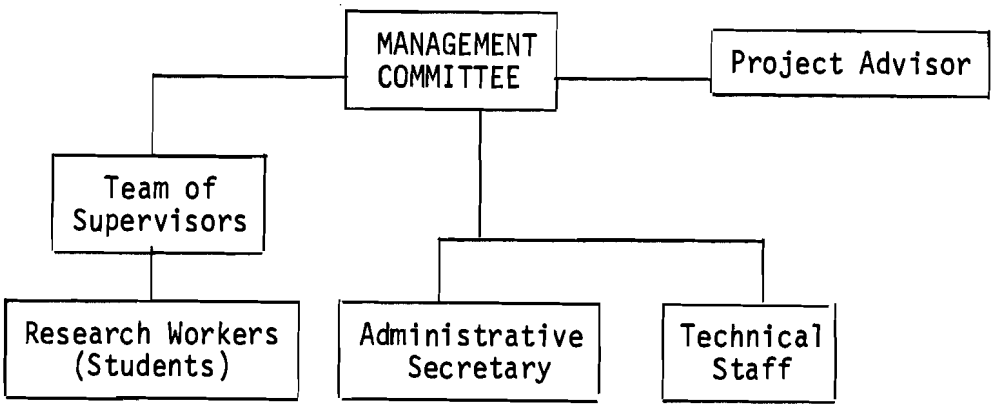
students of the right type and then providing adequate supervision, the total number will represent an increase of 18 graduates experienced in cassava research in Indonesia.

2.6 Management and Coordination

The following is a diagram of the management structure.



The management of the project has been broadened from the project leader to a four-man committee, composed of four university staff, all of whom are involved in the project. This structure has been relatively successful in ensuring completion of experiments given the limited number of staff and students available. The Management Committee has met frequently and has been active primarily in the first two of the following three functions normally carried out by a project management committee:

a) Administrative control;

b) Direction of the scientific program; and

c) External liaison with other government departments, research institutions, and extension services.

2.7 Research Planning and Evaluation

The primary consultant used in the project, Dr. de Bruijn, has played a major role in helping the project staff plan each year's trials and evaluating the results of previous work. As de Bruijn had spent several years at the University before the start of the project working on cassava research, he was familiar with both the staff and capability of the University. This has allowed him to provide detailed guidance on the University's experimental program, many aspects of which were completely new to the staff before the project started.

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Right from the beginning, IDRC project officers have felt that the project staff have had a very logical procedure for developing its annual research design and has been prompt in submitting six progress reports to IDRC. Where they have developed noticeably is in being able to conduct experiments through to conclusion. Furthermore, IDRC staff and consultants have commented very favourably on the development of the project team's self-confidence and their ability to determine and defend their own research program.

As regards evaluation, the socio-economic analysis and evaluation of the project's results is almost negligible. Some information on farmer practices was collected in a 1974 survey but on a fairly limited basis. The university staff involved in this project tend to evaluate the project in terms of what it is doing to increase the number and level of trained staff rather than in terms of what the research program may be able to achieve. Thus there is a tendency to try to send as many staff as possible for up-grading from project funds. Given the limited number of staff with post-graduate degrees in the University, this is not a surprising or perhaps an unreasonable focus.

2.8 Financial and Administrative Problems

Appendix A shows the project budget versus actual expenditures for Phase I and Phase II. Appendix B shows the relationship between the budget versus actual expenditures for both Phase I and Phase II (Year 2 of Phase II are estimates).

The most difficult aspect of dealing with IDRC in this project has arisen from complications in the transfer of funds. The different project managers involved have had no experience in managing and accounting for project expenditures before becoming involved in this project.

In Phase I the first two financial reports were both incomplete and late in arriving. This resulted in delays of two and four months respectively in the sending of project funds to Indonesia. As the project progressed, however, improved financial statements allowed the third and fourth payments to be made ahead of schedule.

The start-up date of Phase II presented considerable difficulties for the project leaders. Since the commitment date for Phase II was November 25, 1976, the project leaders tried to assign subsequent expenditures to either Phase I or Phase II according to the use of the money, not the timing of the expenditures. The expenditures on the 1975 crop (harvested up to May 1977) were assigned to Phase I. All other expenditures were assigned to Phase II. AFNS has now adopted the practice of arranging reporting times most appropriate to local conditions, such as fiscal year or harvest period.

Part of the overall delay in the receipt of funds has been the policy of transferring funds to the University through the Indonesian Institute of Sciences (LIPI). In order to minimize

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delays, LIPI has now asked IDRC to send future payments directly to the University.

2.9 National Linkages

The links between Brawijaya University and other research institutions including the Central Research Institute for Agriculture (CRIA)* are limited but improving. No representatives of the Ministry of Agriculture or other institutions have been invited to participate in the regular coordinating committee meetings of the cassava project or involved in the preparation of the project proposal and the annual preparation of the research program.

Similarly, the University has not kept close contact with LIPI which must approve all requests for external donor assistance from Indonesian institutions and Indonesia's counterpart contributions. Thus LIPI's awareness of, and interest in ensuring continuing financial support in the project after IDRC support is withdrawn, is limited.

2.10 The Delivery System

The University has begun to cooperate with the small CRIA unit in East Java, and the Project Leader presented a paper on the results of their research at a recent CRIA conference in Kalimantan, where the Government is beginning to promote large-scale production of cassava. Three of the University staff now serve as consultants to the local CRIA unit and CRIA has provided land for one of the project's experimental sites. CRIA also began to pay the per diem costs of field students at this site in the last year. The local director of the CRIA station has approached the University suggesting that a formal agreement of cooperation between the two groups be established with CRIA's financial responsibilities outlined. If such an agreement is reached, this would create the first official links between the Ministry of Agriculture and the University within the region and help set the framework for incorporation of a cassava research program at Brawijaya into a national program.

However, until an effective national program and delivery system is established it will be difficult for Brawijaya to disseminate its results and have any major impact on small farmer production. The results of its program are likely to be of more immediate benefit to the larger cassava plantations and small farmer production units surrounding these plantations which are now being established in Kalimantan and Sumatra.

2.11 The Beneficiary

In 1974, the Faculty carried out a survey of cassava and

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*Established in 1966 and placed under the scope of the Department of Agriculture. Its mandate is to find new technology to stimulate food production and which is also acceptable to the small farmer.

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Mukibat production practices involving 292 farmers who used the Mukibat system. This baseline survey published in 1976 was a major achievement for the Faculty which had never organized and run a farm survey before. While this survey was useful in providing some information on production practices (the survey indicated that the average Mukibat farmer had a holding of .88 hectare of which about 20 per cent is planted with normal cassava and 17 per cent with Mukibat plants and that most Mukibat cassava is grown in farmyards where soil fertility is considerably higher), much more information on production techniques and on the integration of Mukibat and normal cassava production within the farmers' overall cropping system is required. Field data collection and analysis is a time-consuming and difficult exercise, and the Faculty at the moment lacks the experience and personnel to carry this out. Thus it will be difficult to develop recommendations for farmers which are tailored to their specific environments.

An encouraging note is that the Agricultural Development Council (ADC) is placing a team of two experienced ADC employees at Brawijaya University. Discussions have taken place among IDRC, ADC, and the University on how this team could undertake some village level studies of the farmers' socio-economic environment and cassava production practices.

2.12 Regional Linkages

The project has had regular visits from scientists outside the country and several staff have travelled abroad. This has contributed to the growing self-confidence of the scientists in the project, and to a lesser extent, is beginning to create links between the scientists in the project and those elsewhere, although the University is still fairly isolated. There is a noticeable lack of interchange among scientists in the region.

There have been several CIAT staff who have visited the project but no one who has ever visited Brawijaya University more than once. The most hopeful initiative to create more effective regional links and to ensure some continuity in CIAT's relationship with the national programs in Asia, was the appointment about one year ago of an Asian scientist as a regional CIAT cassava coordinator through funds provided by IDRC. This coordinator will regularly visit each of the cassava research projects in the region, passing on information from CIAT and other national programs and helping to arrange workshops, training, and travel. One of the young scientists at Brawijaya will be attending an intensive four-month training program on cassava at CIAT this year with 24 other young Asian scientists. The young scientists will benefit not only from the training program but from the personal contact with other young scientists working in the same problems in the region.

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3. IDRC'S ROLE AND INVOLVEMENT

There does not appear to be any feeling of excessive direction on IDRC's part, as the project staff in the University and the staff at CRIA and LIPI all feel that cassava research has been grossly neglected and that IDRC's involvement has accelerated the development of a research program that they now want to establish on a major basis as soon as possible.

However, it does raise the question of how far IDRC can go as a catalyst in creating the right conditions for producing research results that can be utilized by the small farmer. In this case, IDRC support has helped develop a small but effective research team at Brawijaya University, but more effort may be required to ensure ongoing financial support so that the cassava program at Brawijaya can continue after IDRC funding terminates in 1980. National research has just been reorganized with assistance from the World Bank and after two or three years of indecision the Government has decided to give a strong focus to cassava. IDRC feels that Brawijaya University has had some influence on this decision. Related to this, and as an essential component in ensuring that the results of Brawijaya's research can be fed into the Ministry of Agriculture's extension services, is the development of a stronger national program managed by CRIA. CRIA has approached IDRC to assist in the development of a national cassava research program, with IDRC support being sought primarily to help CRIA draw on the resources of the international cassava network, and to provide guidance on the development of CRIA's program rather than for any financial contribution IDRC might provide. Support from IDRC for a cassava project at CRIA could have a major impact in developing this national program and in helping to ensure that the strong cassava team at Brawijaya University is linked with and supported by this national program.

The project staff in their assessment of IDRC's involvement commented particularly on the advantages of IDRC's operating style. They felt that IDRC's operating procedures allowed them to develop and operate this project at little cost and administrative effort relative to other externally supported projects. They listed projects which they are developing with other donor agencies and commented that the resulting negotiations with the few senior staff at the University are extremely time-consuming and frustrating.

One particular policy of IDRC which has caused financial problems was the IDRC policy of providing only 90 per cent of estimated project requirements for the first installment. This policy of partial payment was originally established as many recipient institutions were not able to spend their full allocation in the first year. IDRC now provides full payment of the first installment.

The project staff have appreciated and benefited from the visits of the two IDRC consultants because they have considerable experience in the type of work the project staff are doing and because

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they have consistently visited the project and followed up promptly with correspondence, commenting on the research program and suggesting practical adjustments which the staff can implement. The project staff emphasized the importance of using the same consultants since they are familiar with them and they receive consistent recommendations without having to continually educate new consultants. IDRC staff responsible for the project feel that the use of the two consultants in this project was a crucial factor in providing technical advice and encouraged staff to plan a realistic program of experiments each year.

4. BROADER DEVELOPMENT IMPLICATIONS

It was originally hoped when designing the project that it might be possible to prove that the Mukibat cassava production system was a highly profitable innovation, and that a set of recommendations and promotion of this new technology could be accomplished in a short period of time. However, this has not proven to be the case as the research to date indicates that there is considerable variation in the usefulness of this system, depending on such factors as the availability of labour and condition of the soil.

A scientific base for determining and improving on Mukibat cassava techniques is being laid; with the expected addition of several ADC personnel to the University, the project should be able to expand this to relate their experimental program and innovations to the existing production practices of the farmer and to determine the acceptability of new techniques.

The primary achievement of this project may well be, however, the development of the institutional and personnel capacity of the University which has acquired the confidence and ability to carry out future research programs of comparable complexity.

The major remaining questions are whether institutional links between Brawijaya and CRIA, the national agricultural organization, can be created to ensure continued financial support for agricultural research at Brawijaya, and whether the Government's delivery system will be developed to encourage farmers throughout Indonesia to adopt this system. It must be emphasized though that the dialogue between CRIA, IDRC, and Brawijaya University has been extremely encouraging. After three years of inconclusive discussion with the Government regarding the national cassava policy, a much sharper focus has developed. This has arisen from the fact that the leaders of the program from CRIA, the Agricultural Faculty from the University at Bogor, and Brawijaya University jointly participated in January 1978 in a one-month cassava production training course (funded by IDRC). During this course, these three scientists presented a first draft proposal to IDRC staff for support for a CRIA centered national program.

APPENDIX A

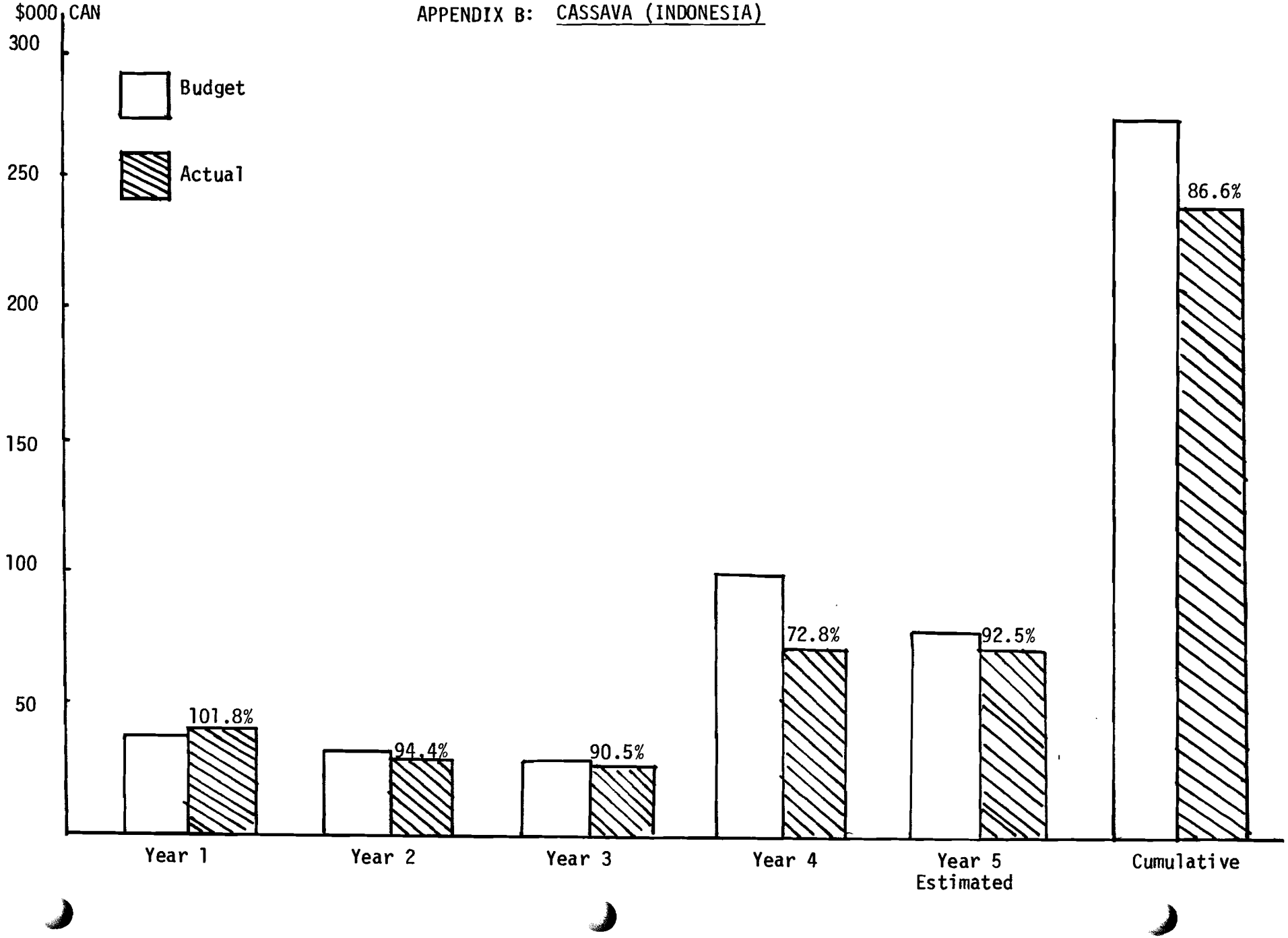
Total Budget and Actual Expenditures

CASSAVA (INDONESIA)

	PHASE I									PHASE II								
	YEAR 1			YEAR 2			YEAR 3			YEAR 4			YEAR 5			CUMULATIVE		
	Budget	Actual	% Spent	Budget	Actual	% Spent	Budget	Actual	% Spent	Budget	Actual	% Spent	Budget	Actual*	% Spent	Budget	Actual	% of Total
Salaries & Allowances	3,840	3,805	99.1	6,660	6,518	97.9	6,630	6,518	98.3	11,350	9,533	84.0	12,490	14,594	116.9	40,970	40,968	100.0%
Training	-	-	-	-	-	-	-	-	-	16,100	4,959	30.8	20,100	3,698	18.4	36,200	8,657	23.9%
Research Expenses	7,999	11,098	138.7	13,625	10,159	74.6	7,409	8,153	110.0	23,550	26,035	110.6	22,300	25,010	112.2	74,883	80,455	107.4%
Capital Expenses	14,504	11,160	76.9	2,161	5,223	241.7	-	-	-	28,300	14,358	50.7	1,000	11,698	1169.8	45,965	42,439	92.3%
Travel	4,062	4,192	103.2	6,177	5,874	95.1	7,853	6,534	82.2	9,550	7,032	73.6	9,550	7,423	77.7	37,192	31,055	83.5%
Publication	-	-	-	-	-	-	1,305	508	38.9	1,000	1,172	117.2	1,000	1,856	185.6	3,305	3,536	107.0%
Consultancy	7,000	7,000	100.0	-	-	-	4,500	3,190	70.9	4,000	2,920	73.0	4,000	-	-	19,500	13,110	67.2%
Services & Supplies	694	1,518	218.7	2,029	1,159	57.1	1,200	1,243	103.6	8,150	8,219	100.9	8,700	8,921	102.5	20,773	21,060	101.4
TOTAL	38,099	38,773	101.8	30,652	28,933	94.4	28,897	26,146	90.5	102,000	74,228	72.8	79,140	73,200	92.5	278,788	241,280	86.6%

* Estimated

APPENDIX B: CASSAVA (INDONESIA)



SORGHUM IMPROVEMENT (ETHIOPIA): AN EVALUATION

Phase I - 3-P-72-0095

Phase II - 3-P-74-0023

RECIPIENT INSTITUTION: Ethiopia Sorghum Improvement Program
Nazreth, Ethiopia

DURATION: Phase I - May 1973 to Dec. 1975
Phase II - Jan. 1976 to Dec. 1978

IDRC CONTRIBUTION: Phase I - $195,000
Phase II - $560,000

October 1978

1. THE RESEARCH PROBLEM

1.1 Background

Sorghum is the most widely grown food crop in Ethiopia. It thrives in a range of agro-climatic zones including high and low altitudes. High altitude sorghums grow satisfactorily at altitudes as high as 2,500 meters where mean temperatures range from a minimum of 14°C to 26°C. In general, sorghum yields have been relatively low in Ethiopia. In 1976 approximately 1 million hectares of sorghum were under cultivation. Average yield was 1 ton per hectare. About 90 per cent of the production is consumed as 'injera', a staple food in Ethiopia. Sorghum is also used in home brewed beverages; and sorghum stocks and leaves are used as fuel, as building materials and as feed for livestock.

Ethiopia is probably the original home of sorghum and is the source of many wild and cultivated forms adapted to a wide range of growing conditions. Consequently Ethiopia is a valuable reservoir of diverse genetic material for sorghum breeders throughout the world.

Sorghum research began in Ethiopia in the mid 1950s at the Alemaya College of Agriculture. Local collections and U.S. introductions were screened for high yield and adaptability to highland environments by a team from Oklahoma State University who had developed the College under a grant from the United States Agency for International Development (USAID). In the late 1960s the Ministry of Agriculture formed the National Crop Improvement Committee (NCIC), and delegated the national responsibility for sorghum improvement to the Alemaya College of Agriculture. This national responsibility entailed organizing the annual sorghum National Yield Trials (NYT) for all experimental stations. Although Alemaya served well in identifying suitable cultivars for highland areas, NYT results confirmed that it was impossible to develop and screen suitable varieties for lowland and low rainfall conditions at Alemaya. It became evident that a national sorghum improvement program was required to cater to the needs of all the sorghum growing zones of Ethiopia.

1.2 Recipient Institution

In 1971, the East Africa Cereals Research Conference was held at the Alemaya College of Agriculture. Soon after IDRC was approached by the Dean of the Faculty of Agriculture at Alemaya College concerning support for a national sorghum improvement program. It was envisaged that IDRC support would establish a national sorghum improvement program and that Ethiopia would become a major participant in the proposed international sorghum network to be coordinated by the Institute for Crops Research in the Semi-Arid Tropics (ICRISAT) in India.

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Phase I of the project was initiated in 1973. The Alemaya College of Agriculture of Haile Selasse University (now Addis Ababa University, AAU) was chosen as the recipient institution because:

a) the College had national responsibility for sorghum improvement;

b) a very competent Ethiopian plant breeder was on staff at the College;

c) the College could provide research assistants and trainees; and

d) essential research facilities and administrative support could be provided.

In Phase II, the Ethiopian Sorghum Improvement Program (ESIP) was established. This is a semi-autonomous research institution which has been given the national responsibility for sorghum improvement research. ESIP is administratively linked to AAU, since the IDRC agreement is with the University. ESIP is operationally linked to the Institute of Agricultural Research (IAR), which has the national responsibility to coordinate agricultural research and maintains an overview of the ESIP research program. IDRC has been the exclusive financier of ESIP, and in this way ESIP has remained independent of the Government structure. ESIP was conceived by the project leader in Phase I. Two key factors which allowed the development of the institution in Phase II were:

a) the project leader was released from his responsibilities as Head of the Plant Sciences Department at the College; and

b) the Institute of Agricultural Research (IAR) provided the program with experimental sites at six research stations throughout the country.

ESIP has established headquarters at Nazreth, situated in a lowland zone about 50 miles southeast of Addis Ababa. There is a staff of 25 consisting of the project leader, a professional agronomist, an administrator, a secretary and research assistants (see Graph 1). Altogether there are seven research sites, four of which are located in lowland zones and three in the highland zones.

1.3 Objectives

In Phase I, the project was limited to improving sorghum varieties in the highland zones because of the location of the Alemaya College of Agriculture.

The objectives of the project were:

a) to screen the existing sorghum collection in order to identify the best types and to add to this collection as opportunity offers; and

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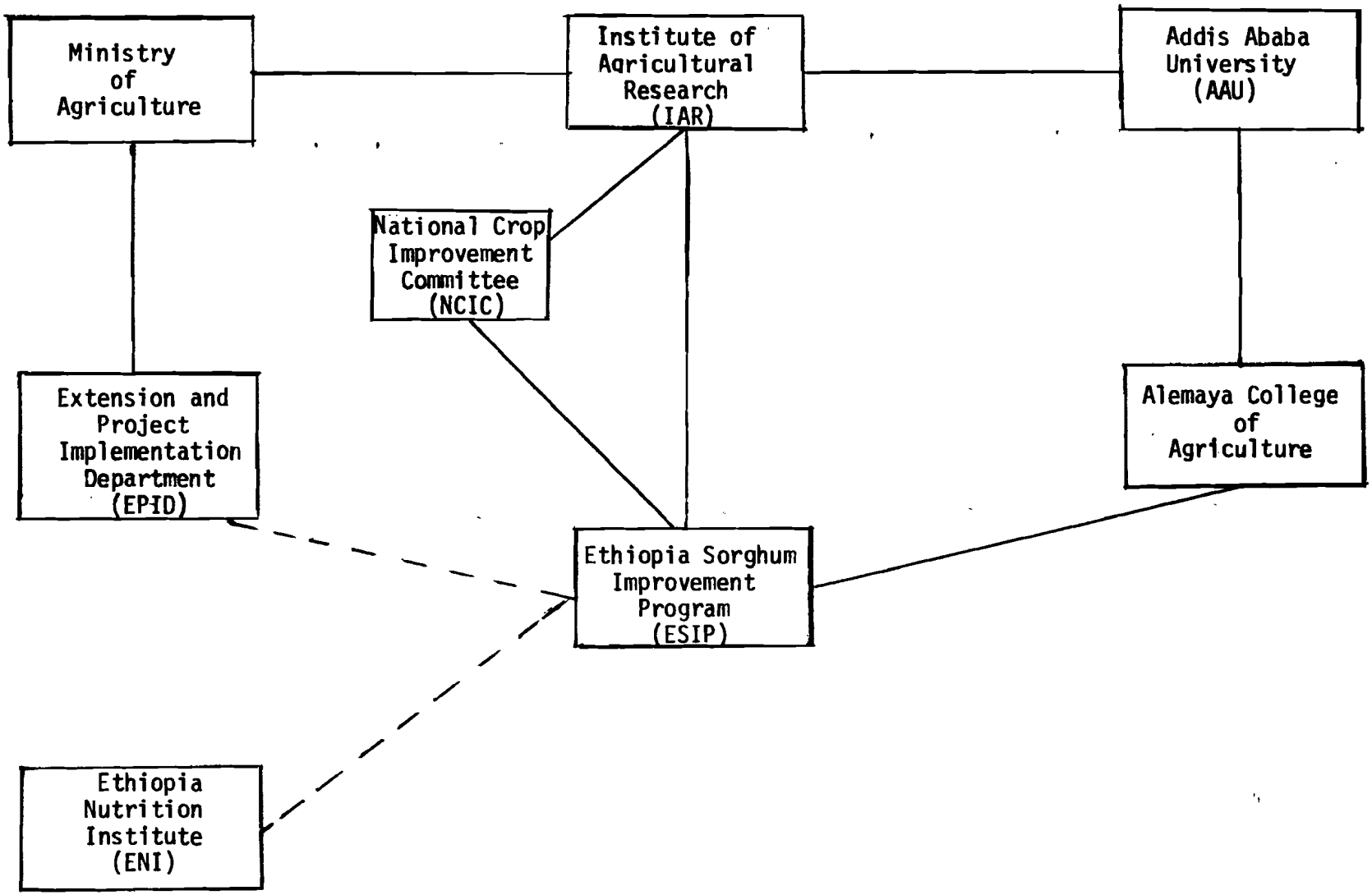
PROJECT MANAGEMENT STRUCTURE



b) to intercross identified superior types, and also to cross these with elite lowland types from other countries in order to obtain sorghums which combine better yield and plant type with acceptable grain quality for the highland areas of Ethiopia.

In Phase II, the objectives were considerably expanded to include improvement of both highland and lowland sorghum varieties. The specific objectives were:

a) to systematically collect, classify and screen the valuable indigenous sorghum germ plasm for its suitability as breed-material in better Ethiopian sorghums;

b) to screen and test improved sorghums in the various ecological zones of Ethiopia;

c) to continue and expand studies on crop agronomy and the determination of optimum inputs needed to provide maximum gain to the small farmer;

d) to initiate trials conducted by farmers in their own fields;

e) to develop resistant varieties and crop protection technology to control pests, diseases, and the parasitic witchweed Striga;

f) to evaluate for their quality as a source of 'injera' (the local food) those sorghum lines which perform well under trial;

g) to provide continued training of local personnel; and

h) to develop a test cooking and quality control facility.

2. PROJECT PERFORMANCE

2.1 Technical Achievements

Technical achievements deal with results from the first five objectives outlined above. In addition, work has been initiated on quality evaluation of sorghum as a source of 'injera' and the test cooking facility, however, no reports are available to document the results.

The technical achievements are summarized below.

a) Two high-yielding cultivars, Alemaya 70 and Awash 1050, were identified and released to farmers for use in the high and intermediate altitude zones. Both substantially out yield farmers' present cultivars. In the low rainfall areas these new varieties give approximately 5.0 tons/ha and in the high rainfall areas they

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give in the neighbourhood of 8.0 tons/ha. Both values are under experimental conditions and compare to an average on-farm yield of 1 ton/ha.

For lowland areas, suitable maturing varieties are almost absent. One variety Kobomash 76 has been released due to a crisis situation resulting from the drought. Kobomash 76 is a variety which has performed well in other parts of the world but has not been tested extensively under Ethiopian conditions. In 1976 it had yielded 3.5 tons/ha under experimental conditions.

b) Work has been done to determine the relationship between population density and yield. A trial conducted in 1973 using Alemaya 70 at seven plant densities indicated the superiority of 75 cm by 15 cm spacing which gave 90,000 plants/ha. A second trial showed declines in yield when row spacing below 20 cm. In 1974, a further trial using four varieties at six population densities showed that under adequate moisture and fertilizer conditions, tall varieties (e.g. Alemaya 70) gave a positive response in terms of yield to higher populations (166,000 plants/ha).

c) With respect to rates of fertilization, it was found that there is a positive response to increased applications of phosphorous but not for nitrogen when applied to the highland varieties. So far the optimal application rates appear to be 46 kg of nitrogen per hectare and 48 kg of phosphorous per hectare.

d) Intercropping trials, though limited, indicate that total yields were increased by less than 15 per cent when sorghum was intercropped with Ethiopia 10 haricot beans. In some cases, a poor choice of intercrops, such as cowpea, resulted in decreased yields of as much as 40 per cent. This is apparently due to the vigorous competition on the part of the cowpea for soil nutrients.

e) An important part of the research program has been to determine the major diseases and pests of sorghum in Ethiopia along with the most commonly found weeds, and to develop methods for their control. Surveys have shown that weed control is important since losses from weeds can reduce yields by 25 per cent. Tests conducted on the major broad leaf weeds, indicate that atrazine-based herbicides are the most effective form of control. A major unsolved problem is the development of a control for striga. It is believed that if the weed can be effectively controlled, a major hurdle will be overcome in increasing Ethiopian sorghum output. A limited striga control program is presently being undertaken in the project.

The surveys have also identified 12 major sorghum diseases and 13 types of pests, which have been classified into general, highland or lowland specific, and/or high rainfall-low rainfall specific. This classification allows researchers to estimate the frequency of occurrence of the various pests and diseases by region, and to concentrate their control efforts in those areas.

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f) One of the objectives of ESIP has been the collection of Ethiopian sorghums. As of the 1977 crop season there was a collection of Ethiopian sorghum varieties numbering over 5,700. This collection has been made freely available to other cooperating national programs and to ICRISAT. The varietal development program has concentrated on pure line selection, the pedigree method and hybridization. For pure line selection, ESIP has been gathering between 500 to 1,000 new Ethiopian sorghums every year and growing them out for evaluation purposes. The pedigree method is the crossing program involving Ethiopian and exotic varieties. In total there are 137 parents involved in 11 major combination blocks. A hybrid program started in 1977, and is based on 10 male sterile lines and 163 pollinators. Combinations were made in the off season nursery and 1,630 different F_1 hybrids were planted for yield trials in 1977.

2.2 Institutional and Personnel Development

ESIP is a unique research institution in Ethiopia, because of its semi-autonomous structure. This structure has facilitated the rapid expansion in the research program because program decisions made by the project leader have been implemented immediately without bureaucratic delay.

The opinion of staff and the rapid expansion and accomplishments of the program suggest that the semi-autonomous structure has been an effective method of running the program. At the same time, this structure can only be maintained in its present form if external funding continues. ESIP will probably have to become formally associated with IAR, if it intends to secure government funds for future operations.

Before 1973, there were no Ethiopian scientists working full-time on sorghum improvement. During this project, four Ethiopian students, who had obtained undergraduate degrees in plant science from the Alemaya College of Agriculture and worked on the project for one year, have completed M.Sc. degrees in North America. Three of the trainees were funded directly from the project and one condidate was able to obtain an independent scholarship. Prior to the graduate training, two of the candidates had taken short training courses (4 months) at ICRISAT to acquaint them with the operation of a crop improvement program.

Due to the political situation in Ethiopia, one of the four students has returned to Ethiopia and is working as the agronomist on the project. The other three are continuing their studies at the Ph.D. level in North America and plan to return to Ethiopia when the political climate becomes more favourable. It is hoped that future graduate training can be obtained at a university close to ICRISAT to enable students to combine course work with practical experience.

In addition, ESIP has trained a total of 16 research assistants. The trainees are high school graduates who receive on-the-job

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training which enables them to undertake the majority of ESIP field and laboratory studies. For one month the research assistants undergo a training seminar at Nazreth which reviews the technical activities of the year and prepares the research program for the new year. With only two professional scientists on staff, the research assistants have made an important contribution to the project. There is also a training program for 20 young female high school students who take a short course every year at Nazreth to train in the techniques of sorghum emasculation.

An agronomist trainee, who returned to ESIP following an M.Sc. course in Canada provided the following assessment of the training program. First, it was valuable to have worked in the project for a year prior to the start of the post-graduate training (a normal policy of the Ethiopian Government). Next, the guarantee of a permanent job in the project following the training program provided an incentive to return to the project, and finally that it would be valuable if postgraduates were allowed to spend time at an International Agricultural Research Centre (IARC) to gain up-to-date information on recent advances in their field of interest.

2.3 Management and Program Planning

Because ESIP is a small organization, there has been no management or advisory committee established in the project. The project leader is responsible for decision making and project operation. Staff turnover has been very low, and the project leader and IAR staff stated that the morale and enthusiasm of ESIP staff has been consistently high. These indicators suggest that the management has been successful.

ESIP program planning and review is the direct responsibility of the project leader. In the national context the IAR has established the National Crop Improvement Committee (NCIC) which reviews all agricultural research programs annually. For each of the main crops there is a subcommittee and coordinator. In the case of sorghum, the leader of ESIP is the coordinator of the sorghum subcommittee and reports on ESIP's activities to the NCIC. This formal linkage with the NCIC has kept the IAR and the Government fully aware of ESIP's activities and program.

Program planning and evaluation also results from contacts with external organizations through exchange visits, workshops, field days, etc. For example, the ESIP workshop in October 1977, had invited guests from ICRISAT and Texas A & M University who discussed the ESIP program thoroughly with the staff.

The only written record of ESIP's activities appears in the four Progress Reports which have been prepared for IDRC, and in the proceedings of the October workshop.

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2.4 Administrative and Financial Problems

With the establishment of ESIP in Phase II, an integral administrative system was developed. Problems in the project include the following:

a) Since ESIP is not legally constituted, all financial transactions between IDRC and ESIP must be transferred through AAU and the Alemaya College of Agriculture. This procedure creates delays for receiving funds of up to one month.

b) AAU requires financial statements from ESIP every two months before funds will be released. These statements are structured differently from those by IDRC which has forced ESIP to write two different accounting reports, one for AAU and one for IDRC.

c) Expenditures have not occurred at the rate outlined in the original budget. On a cumulative basis (1973-1977) 69 per cent of the budgeted funds were spent. The rate of expenditure has varied from 39 per cent to 172 per cent of budget levels. (See Appendix 'A'). Two items for which actual expenditures have not met the planned budget are training and capital purchasing.

i) The training program did not become operational in Year 1 of the project because of a government regulation which required the students to undertake on-the-job training for one year.

ii) All local purchases have been made by the ESIP Administration. There have been continuous problems with the purchase of foreign items because it is difficult to obtain clearance for foreign exchange expenditures; suppliers have been reluctant to ship supplies to Ethiopia; and agricultural research equipment has a low priority for customs clearance and handling.

d) ESIP has recruited and hired staff independent of IAR or AAU. However, no terms of service or personnel policies have been developed. ESIP has not provided for superannuation or insurance for personnel. These basic procedures are requirements of Ethiopian law and it is difficult to determine how ESIP has operated without abiding by these regulations. Arrangements are currently being worked out with IAR to account for these procedures.

e) The project leader estimates that he spends up to 25 per cent of his time on administration, financial reports and equipment purchasing. The procedure of hiring an administrative assistant has released the project leader from many of the administrative duties allowing him to devote more time to the research program.

2.5 National Linkages

ESIP has established an informal association with the Ethiopia Nutrition Institute (ENI). In Phase II, ESIP approached

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ENI for assistance by testing high lysine sorghum varieties for nutritional quality and acceptability. Five high lysine varieties have been tested at three intervals.

In Phase II, ESIP also established a kitchen in Alemaya which tests improved varieties with village women for cooking, taste and visual qualities. The kitchen is run by a high school graduate with training in home economics. IDRC has provided technical advice on the operation of the test kitchen. In both of these cases it is difficult to determine progress achieved because no reports have been made available of the test results.

ESIP recognizes the importance of testing sorghum varieties for nutritional quality and acceptability amonst consumers and to this end they have developed an association with ENI. It was the impression of IDRC staff that formal liaison should be developed between ESIP and ENI. ENI's input into the operation and management of ESIP's test kitchen would be a logical point for association, however, ESIP would have to make resources available to allow ENI to become involved in the project.

2.6 The Beneficiary

One area of ESIP's program which has developed slowly relative to the improvement program is the relationship between research, extension and the beneficiary. Sorghum is an important subsistence crop and there is no doubt that sorghum production will be increased if an effective extension service is able to work with the farmers.

The importance of links with the extension services were recognized by the project leader at the beginning of the project. Although there was no direct relationship between the College of Agriculture and the Extension and Implementation Department (EPID) of the Ministry of Agriculture, the project organized demonstration plots on farmers' fields within easy reach of Alemaya showing the advantages of new varieties with little fertilizer and good agronomic practices.

Over the life of the project the amount of work which has taken place directly between ESIP and farmers has been limited because:

a) ESIP has had few varieties ready to be released; and

b) there is no effective extension unit or seed multiplication system in Ethiopia.

Despite these problems, in 1977 ESIP released improved varieties and worked directly with farmers in the following ways:

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a) The Alamake Ikobo Regional Development Project for the Relief and Rehabilitation Commission has planted about 17 hectares of Kobomash 76 in the Kobo region for seed multiplication. The seed will be released to farmers in the region as soon as it is available.

b) ESIP is cooperating with a government farm in the Chercher Highlands by providing sorghum seed for multiplication. Thirty hectares of Alemaya 70 and Awash 1050 were planted on this farm for distribution to farmers in the region.

c) ESIP has encouraged IAR research stations participating in the sorghum National Yield Trials (NYT's) to release seed from the experimental plots of the varieties which perform best at the station.

d) ESIP provided seed to EPID in the Naza Area which was subsequently multiplied and distributed to about 40 farmers. The harvest for 1977 has not been completed and therefore results are unavailable.

e) Research assistants have been working directly with farmers at the research stations. Farmers have been coming to the station inquiring about improved varieties and management techniques.

f) Cooking, taste and visual testing of sorghum varieties have been carried out with village women at the ESIP test kitchen in Alemaya.

2.7 The Delivery System

In future ESIP will have to consider mechanisms which ensure a firm relationship is established between ESIP staff, the farmers and users of sorghum. To this end, ESIP should continue to develop relationships with EPID staff by providing information on ESIP varieties and by making seed available. ESIP should also encourage the development of complementary mechanisms to EPID. The following have been discussed:

a) The Food and Agricultural Research Sub-Council of the Ethiopian Science and Technology Commission has in conjunction with IAR and EPID developed a program in six pilot villages whereby the farmers, extension workers and scientists will work together in defining the requirements and constraints of farmers, and developing methods that will make technology available to the farming community. The results of this work could have a dramatic effect on the future structure of EPID.

b) A National Seed Council (NSC) has been established to recommend a policy to the Government on the multiplication of seed for release to farmers. The suggestion is to encourage peasant associations to grow seed in large quantities. The NSC will buy the seed and distribute it to farmers through EPID. The process of seed

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multiplication is very complex and it is unlikely that a program will be implemented in the near future.

These mechanisms to strengthen the linkage between the research and the beneficiary are longer term propositions. In the short term ESIP will be required to expand their mandate to include the multiplication and distribution of improved seed to farmers. In fact, ESIP has planned that one of the returning graduate students will take the position of Farm Trials Officer to improve the relationship between ESIP and the farmers.

2.8 Regional Linkages

ESIP has developed strong links with regional programs and international institutions. The strongest international linkage has developed with ICRISAT, and includes seed exchange, exchange of technical information, workshops, and short training courses.

In the past, ESIP cooperated with the Arid Land Agricultural Development (ALAD) Program (now ICARDA) by providing ALAD with the facilities and support for an off-season nursery. Other seed exchange programs have developed between ESIP and Texas A & M University, Nebraska University, Purdue University, FAO Near East and North Africa Regional Project on Field Crops, and the CIMMYT Cold Tolerant Sorghum Program.

At the regional level, ESIP represents Ethiopia at the Semi-Arid Food Grain Research and Development (SAFGRAD) Project located in Ouagadougou, Upper Volta. Seed exchange programs also exist with the following national programs: Sudan, Kenya, North Yemen, India, Zambia, Rwanda and Nigeria. Finally, it is proposed that a regional program devoted to high altitude sorghum improvement will be established with ESIP as the principal coordinating centre.

3. IDRC'S ROLE AND INVOLVEMENT

It was evident from discussions with ESIP staff that the philosophy of IDRC was well understood and appreciated. It was not unusual to hear the comment, "we are always encouraged by IDRC".

Over the five year life of the project, there have been 13 visits by 7 IDRC staff members and consultants. ESIP staff did not feel that all of these visits were critical to the continued operation of the ESIP research program. The important visits were the ones associated with developing the Phase II of the project. The number of visits by IDRC staff (2.6 per year) is higher than the norm of 2 monitor visits to projects per year, however, not all of the visits were directly related to the operation of the project.

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Specific comments from ESIP staff on IDRC's style of operation follow:

a) The Project Agreement was signed with AAU. This had led to long time delays for transferring funds. In the future, it has been suggested that an agreement with IAR would reduce this type of delay.

b) Progress Reports should only be required one per annum, preferably at the end of the harvest season in February/March.

c) Financial statements should coincide with the financial year of the recipient institution.

d) In some cases it may be expedient for IDRC to purchase equipment on foreign markets.

In general, ESIP found that IDRC was able to respond quickly to requests for administrative support. ESIP considered the lack of interference by IDRC in the operation of the program to be an important factor in the rapid expansion of the program.

A project advisor was attached to the project in Phase I to assist the project leader with the development and operation of the program while graduate students were on training programs overseas. The advisor was a young Canadian plant breeder with the Canadian University Service Overseas (CUSO) program. The role of the project advisor was to act as an assistant to the project leader. Initially, the Ethiopians expressed disappointment that the advisor was not an older and more experienced scientist. However, at the termination of Phase I, it was concluded by IDRC, the project advisor and ESIP staff that this arrangement had worked well. The project advisor joined the project at the same time as the four graduate students from the Alemaya College of Agriculture with whom he worked directly during the first year. In the second year when the four departed for overseas studies, the project advisor and the project leader were left to operate the program with the help of local research assistants. The project advisor terminated his contract on schedule and left the project in the third year. At that time no trainees had returned leaving an apparent gap in the continuity of the project. Fortunately, no collapse occurred with the departure of the project advisor. In fact, by this stage the research assistants had been sufficiently trained to provide the project leader with the assistance required to carry on the project. Project continuity was maintained and a returning graduate student was placed into the project with no difficulty.

In summary, the ESIP staff appeared very conversant with, and appreciative of, IDRC's philosophy and style of operation. Monitor visits by IDRC staff were important, especially the technical and scientific inputs into the program at the time of the review and development of Phase II of the project.

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4. DEVELOPMENT IMPLICATIONS

The most significant accomplishment of this project has been the establishment of a national Ethiopian research unit responsible for the improvement of sorghum.

The single most important reason for success has been that the project developed under the very strong, capable and committed leadership of the project leader. He has motivated a competent team of researchers and as a result ESIP has been established as an independent research unit which is not formally responsible to any Ministry or parastatal institution but has nevertheless developed very close linkages with these Ethiopian organizations.

Aside from the technical achievements, the project has achieved substantial progress in the following areas:

a) A core of scientific expertise on sorghum improvement has been established.

b) ESIP has gained national respect and become an important component of Ethiopian agricultural research.

c) ESIP has also gained international recognition and forms an essential part of the global sorghum network.

d) To a limited extent, ESIP has initiated work with farmers.

It is the opinion of both ESIP and IDRC staff that in the future ESIP will have to address itself to the following:

a) ESIP will have to work closely with farmers and consumers of sorghum to determine the requirements and constraints of the beneficiary. Formal liaison with institutions in Ethiopia should be formed. ESIP should also develop within its structure, an extension unit under a Farm Trials Officer.

b) As the ESIP program matures, it should become systems oriented. Besides the improvement program, research should include storage and milling problems for the small farmer and utilization of sorghum in traditional and new foods.

c) To date, ESIP has been totally financed from external sources.

In the future, ESIP will have to become formally linked to the IAR; if it intends to obtain government financing. Therefore, any proposed agreement between ESIP and IDRC should be arranged with IDRC and IAR.

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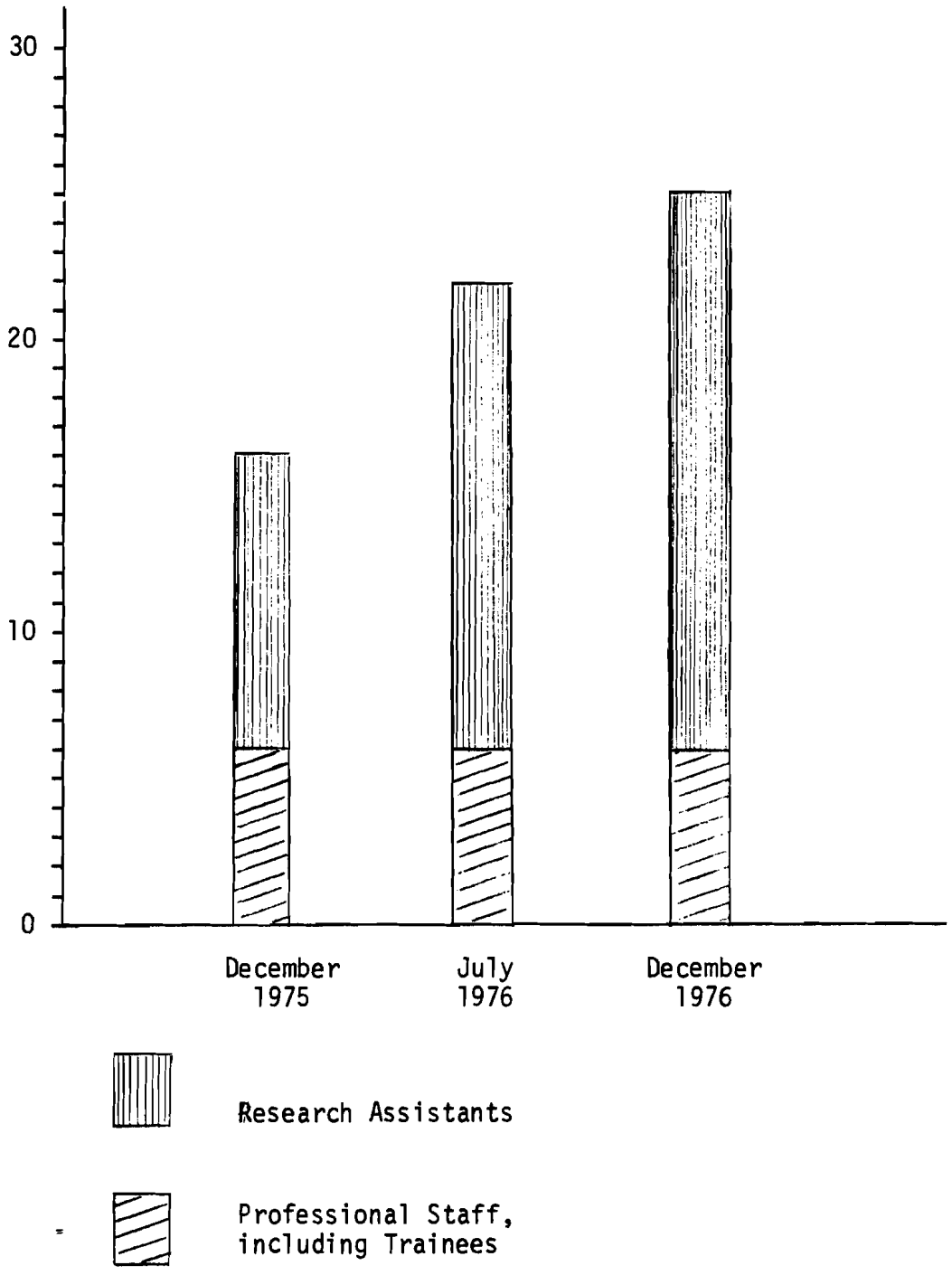
In conclusion, the project leader suggested that it would have taken at least 10 years to accomplish what has been done at ESIP in five years under normal circumstances.

APPENDIX A

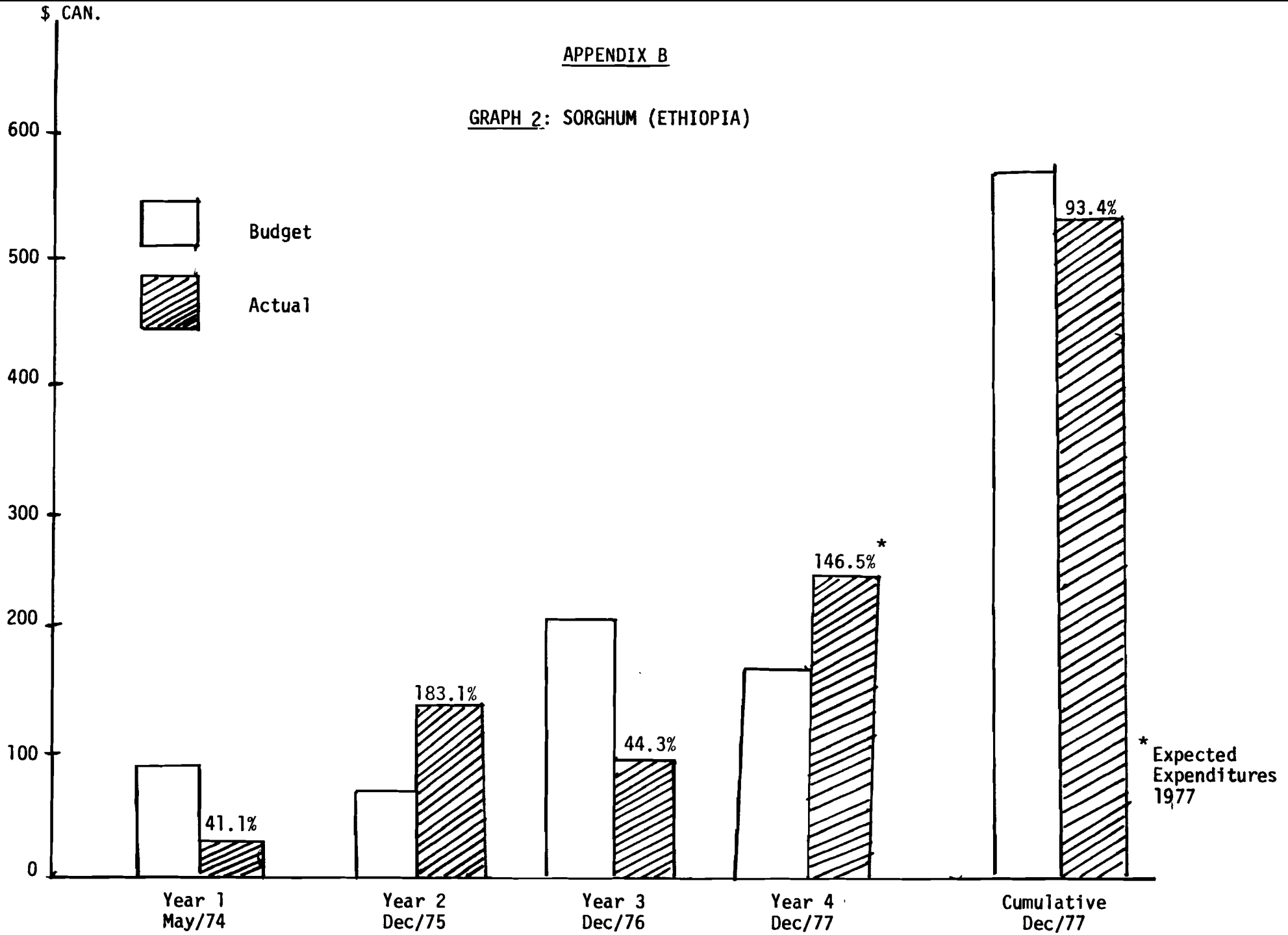
GRAPH 1

GROWTH OF ESIP STAFF



APPENDIX B

GRAPH 2: SORGHUM (ETHIOPIA)



APPENDIX C

Total Budget and Actual Expenditures by Year and Cumulative

SORGHUM (ETHIOPIA)

	PHASE I						PHASE II								
	YEAR 1			YEAR 2			YEAR 3			YEAR 4			CUMULATIVE		
	Budget	Actual	% Spent	Budget	Actual	% Spent	Budget	Actual	% Spent	Budget	Actual*	% Spent	Budget	Actual	% Spent
Salaries & Allowances	55,600	32,817	59.0	49,700	65,690	132.2	73,600	39,037	53.0	85,900	85,900	100.0	264,800	223,444	84.4
Research Expenses	-	-	-	-	1,916	-	27,750	25,712	92.7	28,500	28,500	100.0	56,250	56,128	99.8
Capital Expenses	26,000	7,246	27.9	2,000	33,802	1690.1	94,000	18,696	19.9	18,000	93,400	518.9	140,000	153,144	109.4
Training	20,000	29	0.2	20,000	38,319	191.6	2,500	-	0	9,500	12,000	126.3	52,000	50,348	96.8
Publications & Workshops	-	-	-	-	-		-	-	-	3,000	3,000	100.0	3,000	3,000	100.0
Travel	6,000	4,146	69.1	6,000	2,568	42.8	9,500	9,335	98.3	17,000	17,000	100.0	38,500	33,049	85.8
Consultancy	-	-	-	-	-		3,000	360	12.0	3,500	4,500	128.6	6,500	4,860	74.8
TOTAL	107,600	44,238	41.1	77,700	142,295	183.1	210,350	93,140	44.3	165,400	242,300	146.5	561,105	523,973	93.4

*Expected

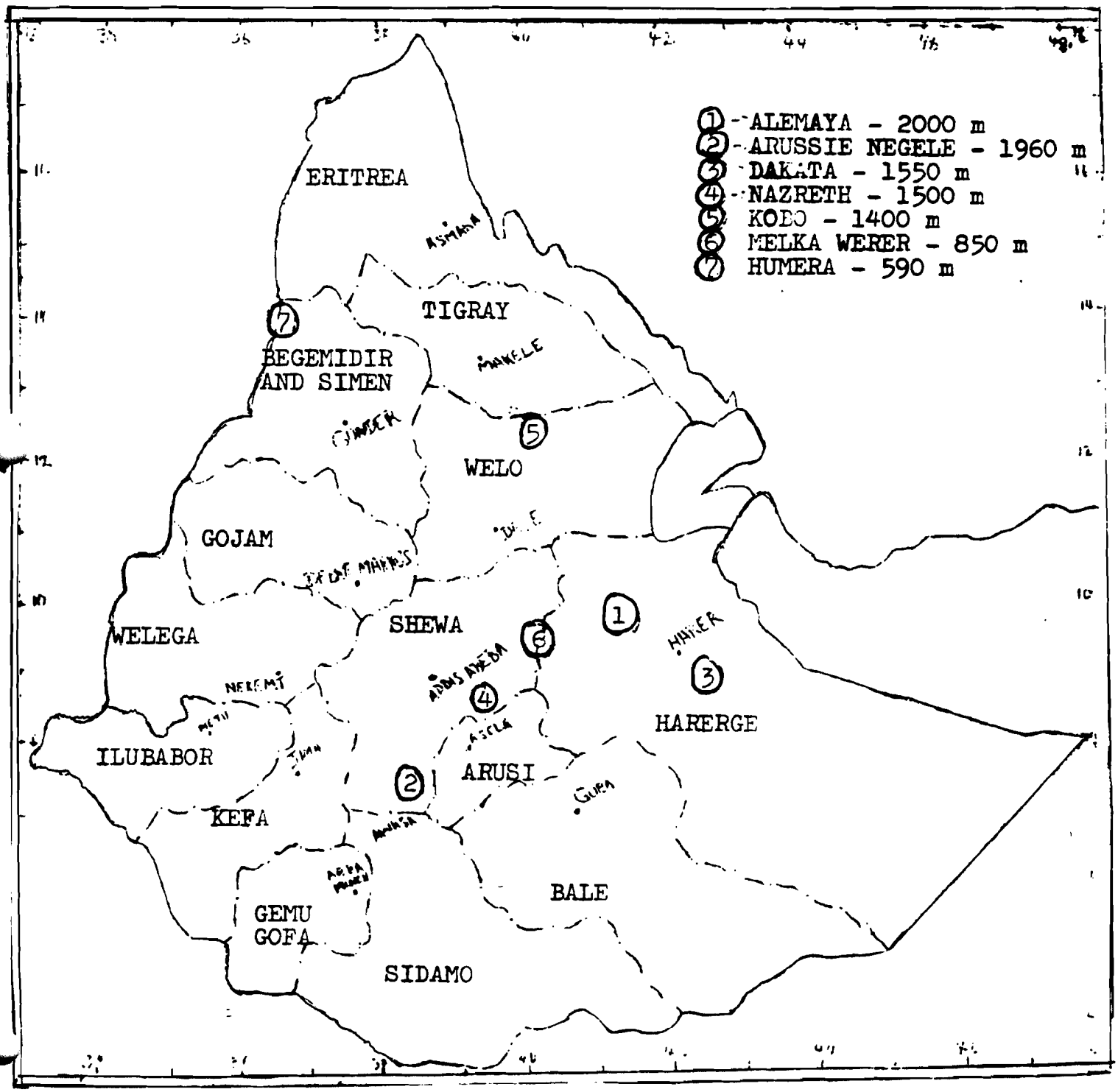
APPENDIX D

Abbreviations Used

(ALAD)	Arid Land Agricultural Development Program
(AAU)	Addis Ababa University
(ENI)	Ethiopian Nutrition Institute
(EPID)	Extension and Project Implementation Department
(ESIP)	Ethiopia Sorghum Improvement Project
(IAR)	Institute of Agricultural Research
(IARC)	International Agricultural Research Centre
(ICARDA)	International Centre for Agricultural Research in the Dry Areas
(ICRISAT)	Institute for Crops Research in the Semi-Arid Tropics
(NCIC)	National Crop Improvement Committee
(NSC)	National Seed Council
(NYT)	National Yield Trials
(SAFGRAD)	Semi-Arid Food Grain Research and Development

APPENDIX E

Map of Ethiopia with ESIP Locations



AQUACULTURE (INDIA):
AN EVALUATION

Phase I - 3-P-73-0065
Phase II - 3-P-77-0077 (Proposed)

RECIPIENT INSTITUTION: Indian Council of Agricultural Research
New Delhi 1, India

DURATION: Phase I - Nov. 1974 to Nov. 1977
Phase II - proposed

IDRC CONTRIBUTION: Phase I - $324,000
Phase II - proposed

October 1978

1. THE RESEARCH PROBLEM

Aquaculture is the practice of farming aquatic plants and animals in water under varying degrees of control. The potential of aquaculture, sometimes called fish farming, for increasing edible protein and the income of rural communities has been emphasized at many scientific meetings including those of the Technical Advisory Committee (TAC) to the Consultative Group on International Agricultural Research (CGIAR). A seminar on aquaculture in Asia was sponsored by IDRC during April 1973 and attended by aquaculturalists from eleven Asian nations who defined several specific problems related to aquaculture as traditionally practised and proposed research projects to improve aquaculture technologies. The productivity of freshwater and brackish (slightly salty) water ponds is considered to be considerably below their potential and there are large bodies of water still unutilized for any food productivity purpose.

1.1 Background

In India there exist about 1.6 million hectares of cultivable fresh water, of which 0.6 million hectares (38 per cent) are currently being utilized for fish culture. Of the remaining 62 per cent, approximately 0.4 million hectares are available for fish farming. In addition, there are 2.0 million hectares of cultivable brackish water areas. In northeastern India, where fish and rice form part of the staple diet, demand for fish has been growing faster than supply. Freshwater fish prices have increased dramatically, and sell for at least 5 rupees ($0.70) per kilogram in urban centres. As a result, the poorer sections of the population can no longer afford to buy fish, and an improvement in their diet will only come about with a rapid increase in fish yield.

In a 1972 study by India's Central Inland Fisheries Research Institute (CIFRI), it was estimated that there existed an annual demand for fish of 8.5 million tonnes but a production of only 1.8 million tonnes. This prompted the Indian Government to place increasing emphasis on the development of fish culture between the fourth and fifth Five-Year Plans. This emphasis was reflected in their submission of a project proposal to IDRC that would involve expansion of basic scientific studies of various fish species and the establishment of composite fish culture (CFC) trials in village ponds.

1.2 Recipient Institution

Officially the recipient is the Indian Council of Agricultural Research (ICAR), which is responsible for all of India's government agricultural research. The actual research has been undertaken by CIFRI which falls under the umbrella of ICAR.

CIFRI was established in 1947, with headquarters in the northeastern Indian state of West Bengal since 1959. CIFRI is one of the

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world's largest freshwater research institutes, comprised of 11 substations and 15 survey centres. The main function of the institution is to study the scientific principles which can be applied to increase the utilization of Indian inland waters to maximize the production of fish for food. The majority of the scientific staff are fishery biologists, with chemists and geneticists involved to a lesser degree.

CIFRI is recognized as one of the leading research institutions in freshwater culture. In 1957, CIFRI was the first institute to succeed in breeding an Indian major carp (rohu) in captivity. CIFRI began a major induced breeding program in 1962 on the major Indian and Chinese carps for large-scale production of seed.

IDRC's willingness to support this project was based on the Institute's record of success in an area where little research competence exists in developing countries and on the exciting potential of the composite fish culture system developed by CIFRI. CIFRI had already done some experimental tests using CFC in which it found that one could obtain up to 9000 kilograms per hectare per year under ideal experimental conditions. This compares to an estimated Indian average of 600 kilograms per hectare per year using traditional methods and species.

An essential precondition for the development of CFC is the supply of a large number of fish seed. Indian scientists were able to perfect techniques of induced breeding of the six needed species to allow large-scale production of fish seed. Broodstock of the desired species are given special care until the breeding age and season are reached, then combinations of one female and two males are injected with a pituitary gonadotrophin preparation that results in the final stages of egg or sperm formation. Either natural spawning is allowed to occur or the eggs and sperm are stripped from the parents and mixed together, then placed in a simple hatchery. When the eggs hatch, they grow to the fry stage and are then stocked in specially prepared nursery ponds. The young fish are now ready for use in the composite culture system.

The CFC system developed by CIFRI was based on the stocking of local and exotic carps with three local Indian carps--catla (Catla catla), rohu (Labeo rohita), and mrigal (Cirrhinus mrigala)--raised in the same pond with three exotic carps--Chinese silver carp (Hypophthalmichthys molitrix), grass carp (Ctenopharyngodon idella), and the Indonesian strain of common carp (Cyprinus Carpio communis). CFC is based on using different but complementary species of fish with different feeding habits and environmental niches to obtain maximum yield. The basic principle of composite fish culture is that when compatible fish of different feeding habits are stocked together they yield a greater amount of fish than if the pond was stocked with an equal number of a single species. In general, each specie does not compete with the others for food or living space and some have beneficial effects on the growth of the others. For example, the grass carp converts plant material into fish flesh and at the same time its excrement fertilizes the pond producing plankton which serves as food for some of the other species.

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The soil and water conditions of the ponds are first determined; then the pond is poisoned by the addition of mahua (Madhuka latifolia) oilcake removing all fish snails and other aquatic creatures. The mahua oilcake--residue after vegetable oil is extracted from a locally available plant--has the additional advantage of fertilizing the pond. Its toxic compound is biodegradable and quickly (12 hours) breaks down into harmless substances. Supplementary fertilization may be achieved by the addition of cow dung or chemical fertilizers (urea or triple superphosphate) to produce the desired plankton production which serves as an initial source of food for the young fish. Depending on the type of pond, its location, and the availability of fish seed (small fingerlings), varying ratios of the six species of fish are stocked at the rate of 5000 per hectare of water area. A supplementary food mixture of oilseed cake and rice bran is broadcast daily on the water surface. Aquatic weeds available from local rivers or ponds banks, together with other vegetable waste, are also added as food for the grass carp.

1.3 Project Development

The States of West Bengal and Orissa were chosen as testing regions because CIFRI headquarters is located in West Bengal, and these two states are part of northeastern India, the main fish-eating area of the country and a place where traditional aquaculture is widely practised.

Originally, the project was to involve five scientists from CIFRI and seven scientists of the State Department of Fisheries seconded to work at CIFRI on the project. This situation has changed, with there now being twelve CIFRI and eight State Department researchers involved.

The project is under the control of a project leader responsible to the Director of CIFRI. One CIFRI fishery scientist operated the program in each state. The two village sites in each state had four senior research assistants responsible for organizing and directing the work at the village level. Two of these scientists were from CIFRI and two from the State Department of Fisheries.

The bulk of the experiments were undertaken in rural areas where farmers, public and private institutions and community associations were approached and persuaded to allow their ponds to be used for experiments. For the first year of pond operation the project provided labour and all inputs free of charge with pond owners receiving all proceeds from the harvest of fish in the first year. Pond owners were expected to use the proceeds from the first year's harvest to pay for all costs of this system in the second year with CIFRI providing only technical assistance. Most inputs required were purchased by CIFRI headquarters and provided to each site rather than purchased in the village.

The demonstrations of CFC were very successful in the original two village sites in West Bengal, so in Year Two, two more sites were

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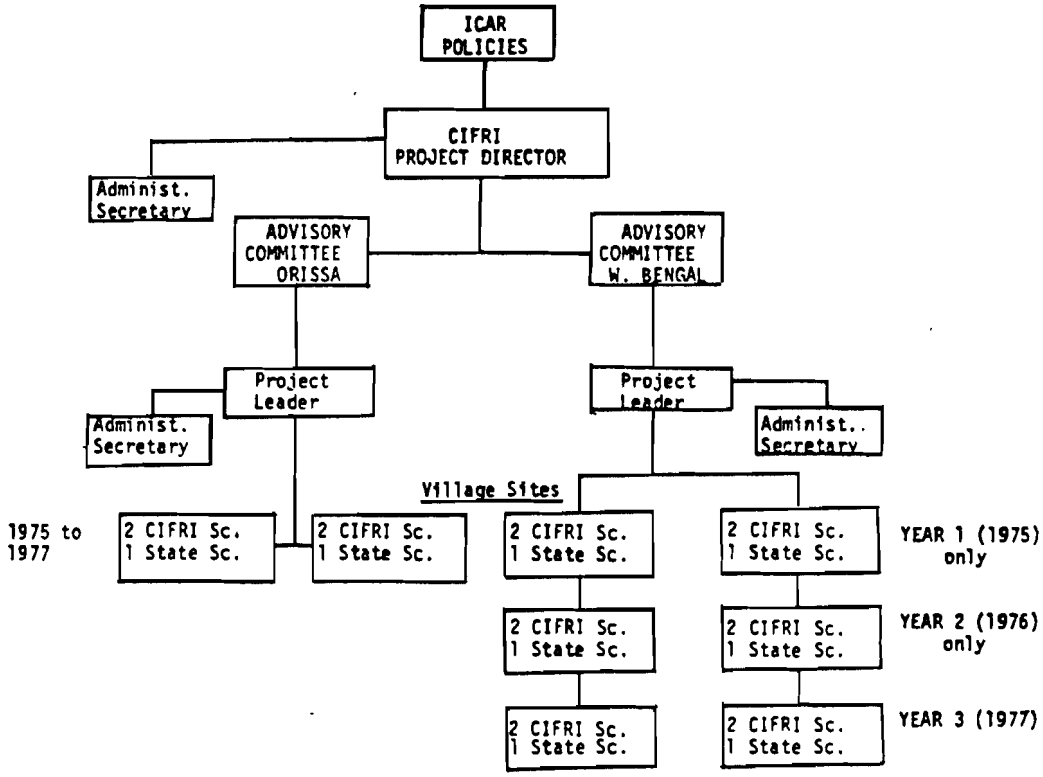
chosen representing different pond conditions, with only technical assistance being provided in the original two villages. Again in Year Three, two more West Bengal villages were chosen. In Orissa, only the original village sites have been involved. In both states, smaller ponds were used as nurseries for rearing fry up to fingerling size prior to stocking in larger ponds.

Figure 1 shows the organizational structure of the project.

Figure 1: Project Organization



1.4 Objectives

The general objective was to support the development of CFC and to increase fish production at the village level through a major program of on-farm testing.

The specific objectives were:

a) To develop highly productive systems of composite fish culture;

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b) To establish and evaluate the most productive experimental systems in village pond conditions at various locations in Orissa and West Bengal; and,

c) To identify and investigate the principal fundamental constraints to improved composite cultures.

2. PROJECT PERFORMANCE

2.1 Technical Achievements

IDRC staff feel the project has made substantial progress towards achieving the first two objectives. However, the Director and staff of CIFRI agreed that progress has been unsatisfactory in the third objective of identifying and investigating principal fundamental constraints. (See section (e) below).

a) In West Bengal, the project was located at Hanspukur-Bishnupur and Harishchandrapur in the year 1975-76. Fish production from ponds at these centres ranged from 3264 kg/ha/11 months to 6033 kg/ha/11½ months (3561 kg/ha/yr to 6295 kg/ha/yr) and 1038 kg/ha/7 months to 2793 kg/ha/8 months (1780 kg/ha/yr to 4190 kg/ha/yr), respectively. In 1976-77, the project was shifted from Harishchandrapur to Gaur. Additional villages were included under the project at Hanspukur-Bishnupur. Fish production ranged from 2588 kg/ha/9 months to 5645 kg/ha/yr at Hanspukur-Bishnupur and 4900 kg/ha/9 months to 7550 kg/ha/10 months at Gaur. Thus CIFRI was able to achieve yields on farmers' ponds in four locations in West Bengal ranging from 1038 kg/ha/7 months to 7550 kg/ha/10 months. For the 1977-78 culture period the project is being run at Sanko (Dist. Burdwan) and Pandapara (Dist. Jalpaiguri).

b) The results also showed that the cost of production, based on total inputs (feed, fertilizer, fingerlings, and casual labour), ranged from Rs 2.34 to Rs 4.89 per kilogram (Can. $0.33 to $0.69). The prices received for the output was a minimum of Rs 5.0 per kilogram (Can. $0.70). These figures provide an indication of all costs incurred by CIFRI except for the supervisory and managerial input by CIFRI staff. The individual pond owners' costs are likely to be higher because locally purchased inputs tend to be higher in price or are not readily available.

In Orissa, the project is located in two village sites where an average fish production of 2589 kg/ha/yr and 3873 kg/ha/yr was obtained. Here the cost of production was estimated to be Rs 2.81 per kilogram with a minimum price also of Rs 5.0 per kilogram. Thus CIFRI, which has been able to achieve yields in excess of 4300 kg/ha/yr in more than 100 trials on CIFRI station ponds, has proved conclusively that with similar management and input levels the production of fish under village pond conditions can be almost as high providing a dramatic increase in yield over that possible from the traditional

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system. The major remaining question is whether the farmer will be able to achieve a major increase in yield over the traditional system without CIFRI assistance and ready access to input requirements. This will depend largely on the farmers' level of management, interest, accessibility to inputs, local marketing structures, and the apparent profitability of CFC.

CIFRI experiments indicate that the optimal size of pond ranges from 0.25 hectares to 2.5 hectares, but small ponds of size 0.045 hectares to 0.09 hectares have been effectively utilized for the production of fry and fingerlings. The techniques of rearing fish seed through induced breeding, hatching, and nursery management were successfully demonstrated in village pond conditions. The project staff produced and distributed several million fry and fingerlings in the areas around the project site, where exotic seed was not available.

As large numbers of the farmers' ponds are of small size, additional work on adapting CFC to smaller pond size is part of a proposed Phase II submitted by CIFRI to IDRC.

c) CIFRI research on nursery techniques has yielded a better data base on the system of induced breeding through to commercial size. The present culture system consists of hatching and seed production during July and August in farmers' ponds with an average of 50 per cent survival. Hatchlings grow to fry in about 20 days again with about 50 per cent survival, then in the next three months up until October-November fry grow to fingerling size again with a survival of about 50 per cent. Following this, culture of the carps in composite form proceeds within the next 7 to 10 months. Survival in this time interval for the species has been shown to range as follows: silver carp, 70 to 97 per cent; catla, 80 to 98 per cent; rohu, 70 to 80 per cent; mrigal, 60 to 80 per cent; grass carp, 30 to 90 per cent; and common carp, 60 to 80 per cent. The reason for the high variability in grass carp survival in the composite culture system is unknown at present and is being investigated.

d) Detailed studies by CIFRI of production costs and returns in 138 case studies of trials on their research stations with yields ranging from 3900 to 6600 kilograms per hectare per year, indicated that average income per hectare from the trials at West Bengal were Rs 27,973 per hectare and exceeded Rs 20,000 per hectare in 14 of the 15 districts. Expenditures averaged Rs 11,445 per hectare with little variation in input costs. The average cost of production per kilogram of fish was 2.62 rupees with a maximum cost of 3.50 rupees. The average sale price achieved was 6.39 rupees per kilogram, indicating that this technology can be extremely profitable.

The data available from project village trials indicates that returns are almost double all input costs. For example, in the village of Aska in the State of Orissa, data showed that the average input costs were Rs 2.88 per kilogram, while the average price was Rs 4.50 per kilogram. However, these results have been achieved with a high level of management control and the ready provision of all inputs

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which in many cases would not be the case for the individual farmer. Further studies on the costs and returns, and other factors such as the level of risk and the profitability of serious shortfalls in yield, will be necessary to determine the profitability and acceptability of this technology to the individual pond owner.

e) Limited nutritional research including feed efficiency has been undertaken to date, partly due to delays in purchase of equipment. At present, groundnut cake (40 per cent protein) and rice bran (10 per cent protein) are fed at a rate of 1:1 during the summer and 2:3 during the winter. However, the high cost of oilseed cake, seasonal variability, and a lack of suitable alternatives would indicate further research is required here before most fish farmers will be able to utilize fully the intensive feeding system recommended by CIFRI. Experiments on the synergistic effect of grass carp and common carp indicated an increase in the weight of common carp fed exclusively on the fecal matter of grass carp by 4 grams per month. The growth rate of fish and their intake of feed is greatly affected by low oxygen levels in the ponds although the utilization rate of feed increases. Experiments on conversion ratios indicate that the growth rate is twice as high when a combination of animal and plant protein, equal to the 30 per cent level in the present oilcake and rice bran combination, is used. The growth rate is also doubled when pond temperatures are raised from 20°C to 30°C. These results are being used by CIFRI to identify the most productive feed ratios and pond environments.

2.2 Institutional and Personnel Development

IDRC staff believe that one of the important results achieved from this project has been the change in attitude of some of the CIFRI scientists. The CIFRI/IDRC project appears to have been an important factor in encouraging research scientists to get out into the field and to test their results in an applied field situation. IDRC staff have accompanied CIFRI personnel on field trips and have noted that CIFRI staff are very familiar with the pond owners in the area and the conditions of the ponds so that they are able to provide detailed advice concerning the initial stocking, management, and harvesting of the ponds.

Formal academic training for CIFRI staff involved in the project was not considered necessary, due to their already high degree of competence and efficiency in conducting fisheries research. However, seven project scientists did take study visits at other fisheries research institutes in the United States and Europe. They judged this to be very useful in identifying certain fields such as diseases and nutritional physiology and where CIFRI could usefully increase its research.

The Advisory Committee established in each of the two states has been concerned primarily with administrative functions and not with program planning or promotion and coordination with other agencies. The CIFRI Project Leader and the Headquarters staff have been responsible for most administrative functions such as purchase of

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equipment and operating supplies, while the Advisory Committees have been responsible for selection of village sites and legal agreements with pond owners. The Advisory Committees have not been given any significant responsibility for evaluation and adjustment of the research program. CIFRI has maintained a policy of providing a 100 per cent subsidization of all costs on pond trials although the Director of CIFRI stated that in many cases this was not necessary and a new policy was outlined in the Phase II proposal. The farmers in West Bengal were provided with full subsidy for only one year as CIFRI moved to new sites, whereas farmers in Orissa were given all inputs for both full years that the project has operated. As already mentioned, CIFRI staff have become familiar with many of the typical problems facing the pond owner, and they have given prompt and practical recommendations on alternatives. However, IDRC staff felt that CIFRI could still improve its responsiveness to field problems as they are identified by undertaking corrective research programs on such problems as variations in pond acidity and netting problems in very deep natural ponds.

CIFRI staff have been much more conscious than most research institutions of the need to demonstrate the economic as well as the technical viability of new technology as indicated by several major CIFRI publications prepared on the economics of the CFC system. The yields and costs of all CIFRI standard inputs other than supervisory costs have been calculated in 138 case studies of on-station trials. CIFRI sought the support of the Agro-Economic Research Centre to undertake some field research as this institute is represented on both State Committees. However, the information they provided was very sketchy and of limited value. As CIFRI has only one junior economist on staff, it does not have the capability at present to undertake any detailed studies of the constraints that limit the adoption of the CFC system or the profitability of each component in the standard system being recommended. It should be possible to provide a stronger feedback during the proposed second phase since CIFRI is planning to provide one economist full-time for the project and discussions have been held with the Indian Institute of Management Studies concerning the use of their Masters degree level students to undertake jointly supervised field studies. It has not been necessary to use the project's Advisory Committees for promotion activities or coordination with other agencies since CIFRI has a regular on-going program of liaison and coordination with other agencies.

2.3 Administrative and Financial Problems

This project has been seriously delayed by a number of administrative problems which IDRC has found to be a common factor in projects supported in India. The project was delayed in starting up due to poor communications between the Indian Council of Agricultural Research (ICAR), the official recipient in Delhi, and the Central Inland Fisheries Research Institute (CIFRI) in Barrackpore. The project agreement was signed in July 1974 but the initial payment was not forwarded until January 1975, due to IDRC's initial payment, thus further delaying the project's initial start-up. In order to obviate further delays of this order on subsequent payment, AFNS now sends

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copies of all official and financial documents addressed to ICAR to the project leader at Barrackpore.

A second problem common to IDRC projects in India concerns the purchase of equipment. At the onset of IDRC's involvement with projects in India, it was decided that the purchase of equipment should be made by the recipient, and not by IDRC. After many months of delay in this project, it was established that this was not a practical course of action in India with the present Government structure, so IDRC undertook to transfer the administration of equipment funds from the recipient-administered portion of the budget to the Centre-administered portion. Most of the equipment has now either been purchased or is on order.

The use of standard budget categories has also created some problems because Indian Government accounting procedures classify expenditures such as some operating expenses under contingencies. IDRC and CIFRI staff have resolved this problem and IDRC has suggested that future budgets be based on Indian accounting categories which project accountants are familiar with. (Appendices A and B summarize planned and actual expenditures in the project).

2.4 National Linkages

One of the most positive developments in this project has been the secondment of staff of the State Department of Fisheries of West Bengal and Orissa to CIFRI. CIFRI staff felt State Fisheries Deparments tended to be poorly organized and motivated relative to CIFRI personnel. By involving state research and extension officers, CIFRI is helping to train the very officials most likely to be sent to the newly established Fish Farmer Development Agency (FFDA) to carry out the long-term extension program of CFC (see section 2.7). As already mentioned, CIFRI unsuccessfully attempted to recruit the cooperation of the Agro-Economic Research Centre of the Government of India, in West Bengal and Orissa.

CIFRI has established some informal links with fish producer associations and Government agencies, such as FFDA and the Fisheries Cooperative Society among others. These linkages result largely from the setting of the terms and conditions with pond owners in using their ponds for research and demonstration.

The collaboration between FFDA and CIFRI has not been as productive as it should be, since FFDA is not represented on the State Advisory Committee, although FFDA is under the responsibility of the Director of Fisheries in each state, who does sit on the Committee. In the Burdwan District in West Bengal, FFDA and CIFRI have separate and unrelated subsidy programs in different villages close to each other. However, the proposed expansion of CIFRI's village testing and demonstration program to six states in a proposed Phase II will parallel the planned rapid expansion of state FFDA agencies. One of the major advantages of this expanding CIFRI village demonstration and testing program is that it will allow CIFRI staff to train more State officials in this new technology. This close working collaboration between CIFRI and FFDA staff will be even more important as the project expands in

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Southern and Western India since the problems of promoting CFC will likely be different and more complex than in Northeast India, and CIFRI officials indicate that fish farming is usually considered a low status occupation in these areas.

During Phase II, an all-India seminar is planned to bring together scientists, fisheries workers, and extension officers from federal and state agencies, development agencies, financial and credit organizations, to demonstrate the technology and discuss what procedures can be implemented to hasten adoption of the technology.

2.5 Regional Linkages

CIFRI is the second institution involved in the planned network of IDRC's agriculture projects in South and Southeast Asia. The first is the Malaysian Agriculture Research and Development Institute (MARDI) in Malaysia.

At the end of the project, a regional seminar is planned to bring together scientists of Southeast Asia, to consider what parts of this technology can be developed in their countries. Many of the countries presently carry out some combination of polyculture using different species combinations, but much more work could be done to increase the yield and make available seed and feed for these farmers. The project also hopes to produce manuals for the use of farmers and extension workers, on how to carry out composite culture and induced breeding. This material will be useful to aquaculture programs in other countries.

2.6 Beneficiary

Fish and rice have traditionally formed part of the staple diet in West Bengal and the surrounding states, but with demand increasing faster than supply, fish prices have increased so dramatically that the poorer sections of the population can no longer afford to buy fish. Freshwater fish were selling for as much as 20 rupees per kilogram in Calcutta in 1977. Given these high prices, most of the benefits to the poorer sector of the population for the foreseeable future will be through increasing incomes and employment generated from CFC production.

While the CFC system can be adopted in ponds ranging in size from 0.1 to 2.5 hectares, optimal production levels require pond sizes from 0.25 to 2.5 hectares. As CIFRI estimates that less than half of the ponds in the northeastern region are more than a quarter hectare in size, there are still a number of small pond owners who will not be able to use this technology for production of adult fish. Small ponds can be used to produce fry and fingerlings for stocking larger ponds. The present shortage of fish seed, particularly of the exotic species, provides a very high income to small pond owners. (Selected CIFRI data indicates that an exceptionally high income of Rs 100 to 160 in 0.01 hectare ponds in a six-week period is possible.)

The results to date from CIFRI village pond trials indicate that the CFC system is attractive to pond owners and fish farmers.

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Most pond owners who were reluctant to provide their ponds at the beginning, are now willingly offering them for further experimental work. In those villages which still demonstrate a reluctance to participate, indications are that they are interested in CFC, but they would rather wait to see more results.

While CIFRI has not measured the number of pond owners adopting this system in the villages they have worked in, a recent visit by IDRC staff to several sites in West Bengal which CIFRI has left confirmed that more than half the ponds selected by CIFRI for demonstration purposes are still employing most of the recommended package. Several other pond owners in the area had started to use some of this system, although problems with availability of fish seed and the increase in oilseed cake prices prevent them from following all CIFRI recommendations.

While most of the individuals who have adopted CFC practices are the wealthier and more educated pond owners, some villages are starting to use their communally owned ponds for CFC production. One of the problems that will hinder the use of village ponds for composite fish culture is that these ponds are used for a number of purposes- domestic water supply, livestock watering and other agricultural and personal needs. Some of the villagers have objected to "enriching" the water through fertilization by cow dung and other additives. However, there is an increasing number of villages with piped water supply and the high returns from CFC have encouraged one of the cooperating villages where CIFRI has worked to lay plans to sink tubewells for drinking water so that the ponds can be used for fish culture. This will have a beneficial effect on general sanitation.

There has been an increase in the number of educated unemployed youth living in the villages, and they have been particularly interested wherever CIFRI has run trials. As CFC production increases, so will the demand for induced breeding which provides, at the moment, an extremely good income without requiring ownership of a lot of property.

Private companies and public institutions practicing CFC have also shown interest, and the State Fish Production Corporation plans to establish 400 hectares of CFC production a year. Tata Corporation, the second largest private company in India, along with some schools and orphanages, is also beginning to utilize CFC methods.

Even where large landowners undertake pond production, there will be some benefits for the rural landless in a region where unemployment is a critical problem. As poaching is a problem in the Bengal Region, CIFRI estimates that one fisherman would need to be employed to provide watch and ward duties for each hectare of water area. A number of pond owners employ fishermen who are usually landless, to undertake the netting and maintenance of their ponds.

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As CFC production increases, the demand for agricultural by-products such as rice bran, mustard seed cake or groundnut cake, mahua oilcake, and other products will increase rapidly, providing a spin-off effect on incomes of agricultural producers.

2.7 The Delivery System

The interest and commitment of the Central Goverment to increasing CFC production is evident from its decision to create the FFDA program. Thirty-five FFDA units, each covering one block (2000 to 4000 ponds per block), are expected in the next five years. Three of these units have already been established in West Bangal and Orissa, and two established elsewhere. The Central Government provides the funds to each state which establishes a state FFDA (staffed with officers from the State Department of Fisheries) responsible for providing financing, inputs, and technical support for the promotion of CFC.

The first unit established in Burdwan, Bengal in 1974-75 has financed less than 100 farmers to date, although they expect to increase this now that the banks agreed to participate in 1977. The banks are expected to provide a 9000 rupee loan and FFDA will provide a 3000 rupee subsidy per one-hectare pond. At present, the Burdwan District has about 40,000 hectares in ponds and FFDA has a target to introduce composite fish culture on an additional 200 hectares per year with a minimum target production level of 2000 kilograms per hectare, as compared to average yields in the state of about 1000 kilograms. This would produce a minimum increase in yield per year, in this block, of 200 tonnes of fish.

FFDA's conservative projections of a minimum production of 2000 kilograms per hectare would provide farmers with an income of roughly 10,000 rupees per year for each hectare of pond, based on a minimum selling price of 5 rupees per kilogram. Input costs are estimated at 7000 rupees per hectare, leaving the farmer about 3000 rupees per hectare. This would not provide a very high return to the majority of pond owners with less than one hectare of pond (less than Can. $375), but the farmers in the FFDA program in Bengal have usually exceeded the 2000-kilogram production target and have been able to sell the fish for 6 to 7 rupees per kilogram.

3. IDRC'S ROLE AND INVOLVEMENT

IDRC supported this project after CIFRI had already developed the CFC system and demonstrated its potential by an extensive series of trials at its research stations throughout India. IDRC felt that the technology was promising and encouraged CIFRI to submit a proposal which would test whether CIFRI's results could be maintained on farmers' ponds, and whether this system was profitable and acceptable to pond owners. IDRC staff felt this project could accelerate the widespread

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adoption of this technology and involve CIFRI in research on problems experienced by the farmer.

While the Central Government had plans to establish FFDA units before the project started, the State Department of Fisheries officials who were seconded to FFDA were unfamiliar with the system. The establishment of these village trials jointly operated by CIFRI and State Fisheries Department employees has allowed this latter group to gain practical experience and to bring CIFRI scientists into close contact with the problems experienced by farmers. Thus, it does seem likely that IDRC funding helped to accelerate the acceptance of the technology to the point where large-scale increases in cultured fish production will be achieved.

The project has been visited by IDRC staff on several occasions to discuss operational and administrative progress. CIFRI staff seemed to be aware of IDRC's role in this project and stated that IDRC's financial support has given them the opportunity to undertake this field testing program. Given the restrictions on expenditures on items, such as travel, equipment, and research expenses outside the main centres, imposed on government research stations in India, they felt they could not readily have carried this out with their own resources.

4. DEVELOPMENT IMPLICATIONS

The lack of government support and commitment to create the right conditions for adoption of new technology is often a critical constraint on the development impact achieved by research institutions. In this case, the Central Government has adequately demonstrated its awareness of the value of this system. Two of the senior CIFRI scientists have been awarded India's most prestigious scientific awards for their work in this area, and the Director of CIFRI has been appointed to the national planning committee for the sixth Five-Year Plan. The Government has provided funds for developing a strong delivery system through FFDA. CIFRI has also received increased recognition with above-average increases in its budget so that CIFRI's relative share of the total ICAR budget for all agricultural research has increased.

While CIFRI, through this project, has undertaken a major field testing program, ICAR has agreed to an expansion of this activity to an additional six states in a proposed second phase. This would allow for the continuation of one of the project's major objectives: encouraging scientists to adjust their CFC recommendations so that they suit the pond owners' needs and constraints.

The Director of CIFRI indicated that there has been some pressure from other ICAR Directors to shift CIFRI's focus back to research and away from what is perceived only as demonstration work in their field trials which should become FFDA's responsibility. However, the state FFDA units have no research capability of their own. IDRC

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staff believe that separation of the research and delivery system in this way seriously reduces at least the immediate impact of any new technology.

The development of this more intensive system of aquaculture is likely to have a number of benefits other than the increased production of fish. There are no significant competing uses for the ponds; the system continues to be very labour-intensive and purchased inputs are largely non-industrial products drawn from the surrounding rural area. The large profits possible from this system could provide a powerful incentive to rural communities to cooperate through their village councils to utilize village ponds with the revenue to be used for improving the general provision of public services such as tubewells.

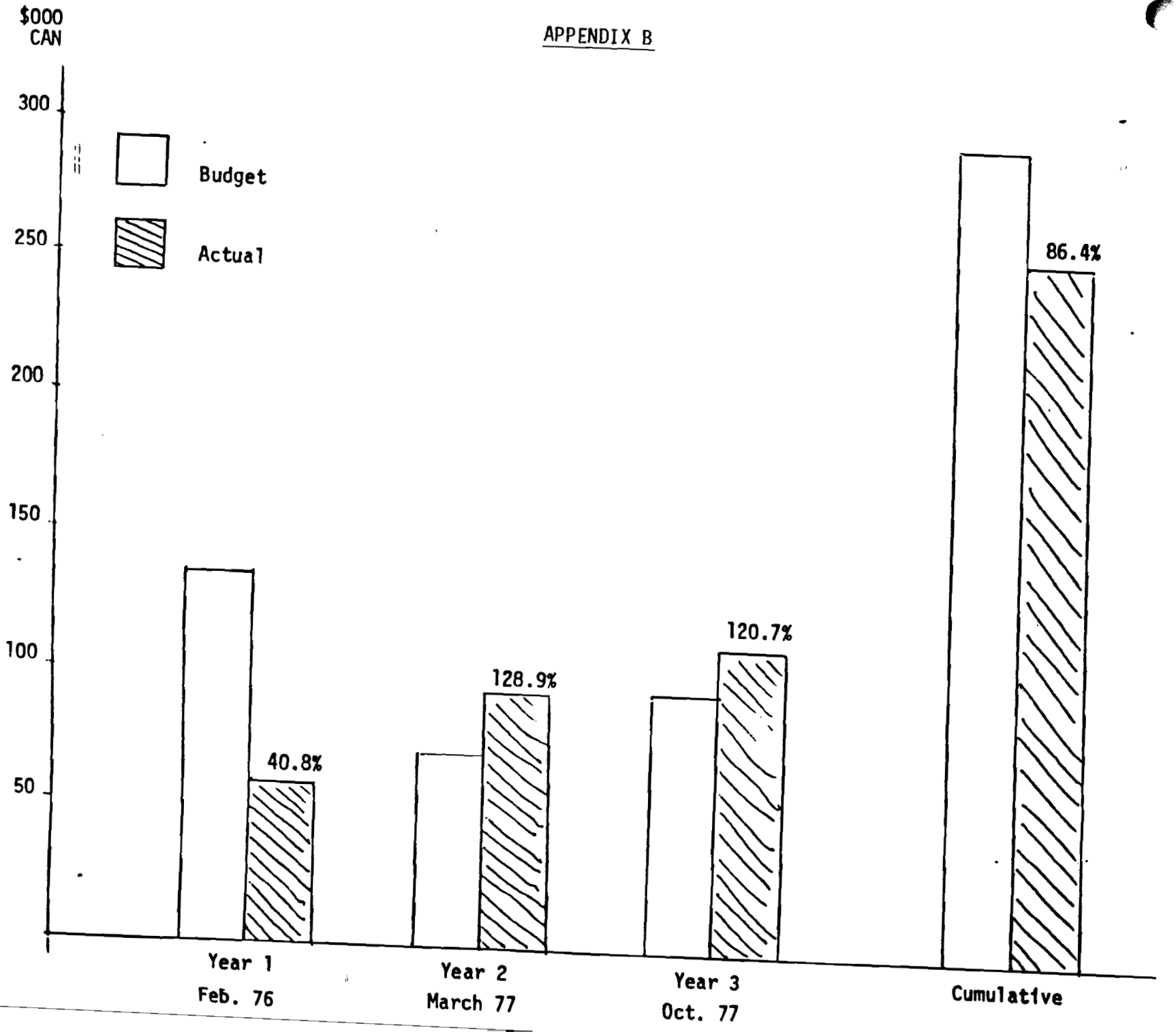
The significance of this applied research could have great potential outside of India, as well as within. With the exception of China, no other country has developed similar composite or polyculture systems. The results in India indicate that polyculture is a very effective way of maximizing the output of a given body of water. The Indian carp occurs naturally throughout Pakistan, India, Bangladesh, and Burma and has previously been introduced in many other Southeast Asian countries as well as some countries of Africa and some Pacific Islands. Increased emphasis on this polyculture approach using locally preferred species (especially those that feed on the wastes of others) makes good ecological sense and could be highly productive.

APPENDIX A

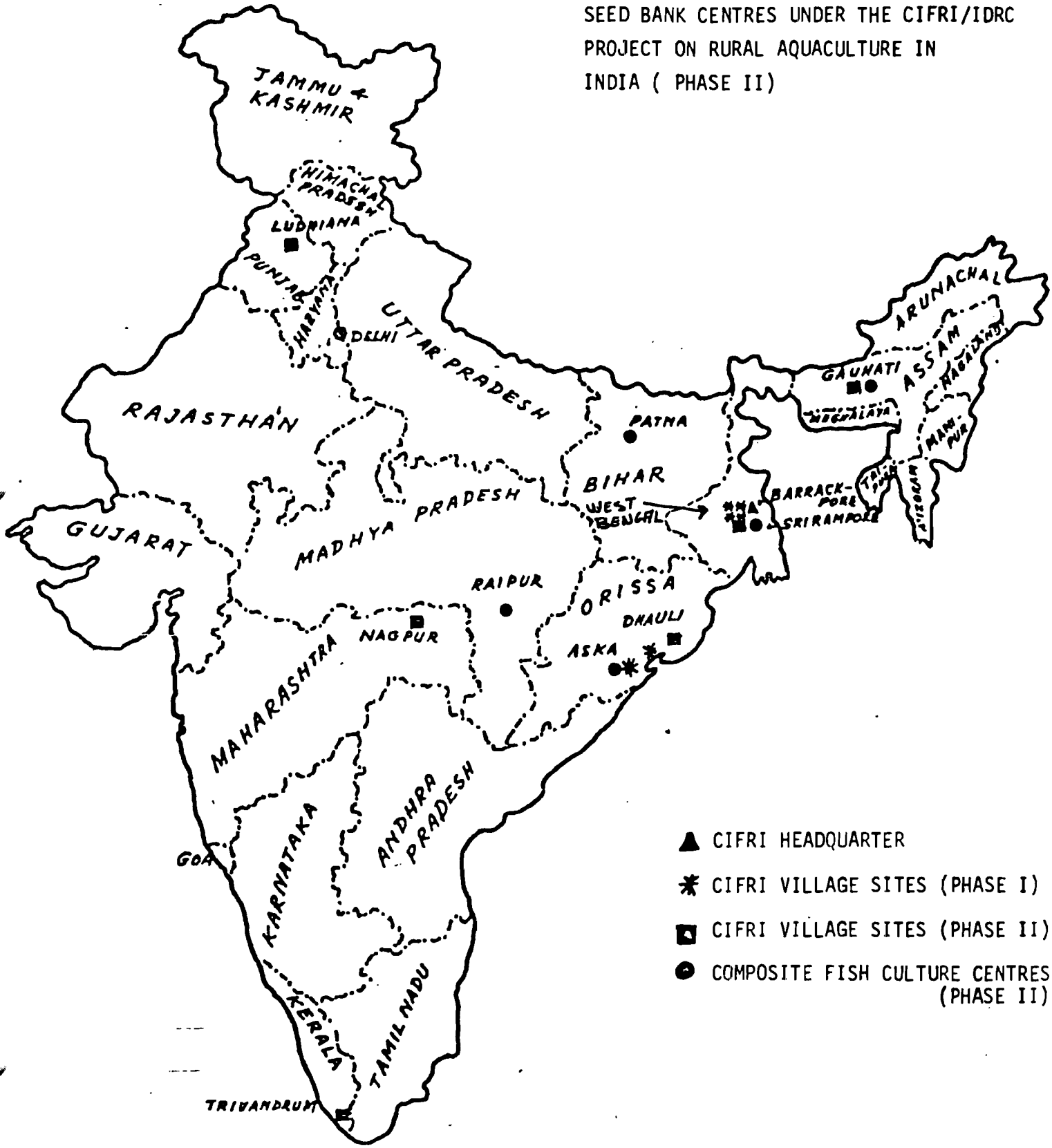
Budget and Actual Expenditures by Major Components

	YEAR 1		YEAR 2		YEAR 3		Cumulative		% Actual Total
	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual	
Training	-	-	-	-	20,000	30,110	20,000	30,110	150.6
Salaries & Allowances	25,399	8,925	26,254	21,846	27,122	15,239	78,775	46,010	58.4
Research Expenses	39,962	19,365	34,836	42,207	34,836	17,453	109,634	79,025	72.1
Capital Expenses	63,000	22,905	3,000	17,700	3,000	42,164	69,000	82,769	120.0
Publications & Meetings	1,000	-	4,000	3	5,000	38	10,000	41	0.4
Travel	3,500	2,311	-	2,720	-	1,664	3,500	6,695	191.3
Service & Supplies	2,500	1,711	2,564	6,629	2,627	5,061	7,691	13,401	174.2
TOTAL	135,361	55,217	70,654	91,105	92,585	111,729	298,600	258,051	86.4

APPENDIX B


$000
CAN
300
250
200
150
100
50
Budget
Actual
40.8%
128.9%
120.7%
86.4%
Year 1
Feb. 76
Year 2
March 77
Year 3
Oct. 77
Cumulative

PRESENT AND PROPOSED SITES FOR COMPOSITE FISH CULTURE AND FISH SEED BANK CENTRES UNDER THE CIFRI/IDRC PROJECT ON RURAL AQUACULTURE IN INDIA (PHASE II)



BY-PRODUCTS (MEXICO)
AN EVALUATION

Phase I - 3-P-73-0139
Phase II - 3-P-76-0064

RECIPIENT INSTITUTION: Consejo Nacional de Ciencia y Tecnologia (CONACYT)
Av. Insurgentes sur 1677
Mexico 20, D.F.

DURATION: Phase I - Nov. 1974 to Dec. 1976
Phase II - Jan. 1977 to Dec. 1978

IDRC CONTRIBUTION: Phase I - $307,650
Phase II - $396,200

October 1978

1. THE RESEARCH PROBLEM

1.1 Background

Mexico has a long history as producer of sugarcane and beef cattle. Thirty million tonnes of sugarcane are grown annually, with 70 per cent of the molasses production being exported and 90 per cent of the bagasse disposed as waste or burned. This is accompanied by a shortage of quality beef, domestic fluid milk, with increasing imports of milk powder.

Much of the sugarcane in Mexico is grown on cooperative farms (ejidos) or on small individually owned farms. The income of these sugarcane producers is reduced by an inefficient processing sector based on outdated technology and inadequate capacity. Similarly, the compesino (small farmer) with a few head of cattle must sell his animals at an early age and for a low price to the larger producer because he has limited resources and depends on the large producer as a non-institutional source of credit.

Mexican beef and milk production depends almost entirely on the quantity and quality of available pastures, with little intensive feeding. The average daily weight gain in cattle is at most 400 to 500 grams per day in the wet season and is often negative in the dry season. Tropical grasses of low nutritive value, a scarcity of cereal grains, and a shortage of pasture in the dry season are the main reasons for these low growth rates.

As early as 1970, Cuban scientists reported live-weight gains of 885 grams per day in commercial fattening systems, using high levels of molasses in combination with urea as feed. In 1973, research in Barbados showed that when derinded cane stalk was supplemented with chopped cane tops, protein, urea, minerals, and vitamins, it was capable of supporting live-weight gains in Holstein steers of up to one kilogram per day. The results of this previous research, combined with dry matter (35 tonnes per hectare), led scientists concerned with animal production in the tropics to recognize the potential of feeding cattle with sugarcane and its by-products.

1.2 Project Development

In 1973, the Director of Research of the Livestock Nutrition Project at the National Sugar Industry Commission (CNIA) and a group of university scientists presented a proposal to IDRC to study the use of sugarcane and cane products as animal feeds. As the original idea developed, the objectives were expanded beyond nutritional biochemistry studies and the encouragement of greater post-graduate training in animal production to comparative economic studies of the introduction of new technologies for the conversion of sugarcane and sugar by-products into animal feeds.

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1.3 Objectives

The specific objectives of the project are:

a) to develop cattle feeding systems which can make the most efficient use of sugarcane and cane products;

b) to develop and test systems by which to diversify the existing sugarcane industry and to determine if low-quality cane and cane being ground in small uneconomic mills can economically be directed into animal feed;

c) to study the biochemical consequences in ruminants of diets based largely upon sugarcane;

d) to determine the relative economic benefits of the alternative uses of sugarcane at different scales and under different conditions of processing and utilization; and,

e) to encourage post-graduate teaching programs in animal sciences.

The objectives of Phase II were similar to those in Phase I with a much stronger emphasis on on-farm testing, and an increase in the levels of milk production.

1.4 Recipient Institutions

Although Mexico has a large agricultural research and training infrastructure relative to other Latin American countries, the various institutions have tended to function in isolation in the past. The Mexican Government, concerned particularly with the independence of university research, set up the National Council of Science and Technology (CONACYT) in December 1970 to act as "advisor to the Federal Government in the establishment, instrumentation, execution, and evaluation of national policies of science and technology".

This project involved the collaboration of six institutions under the overall coordination of CONACYT which was to be the only contracting agency with IDRC. Since this concept of inter-institutional cooperation in research was a novel one in Mexico, a Technical Advisory Committee was established to facilitate coordination, comprising the program leaders in each of the separate project components, the project leader, and representatives from the National Sugar Commission (CNIA) and the Ministry of Hydraulic Resources. It was to be the basic decision-making unit of the project.

The National Autonomous University of Mexico, the leading research university in the country, was linked in this project with the National Institute of Agricultural Research (INIA) and the National Institute for Livestock Research (INIP), the two government research agencies responsible for crop and livestock research in Mexico.

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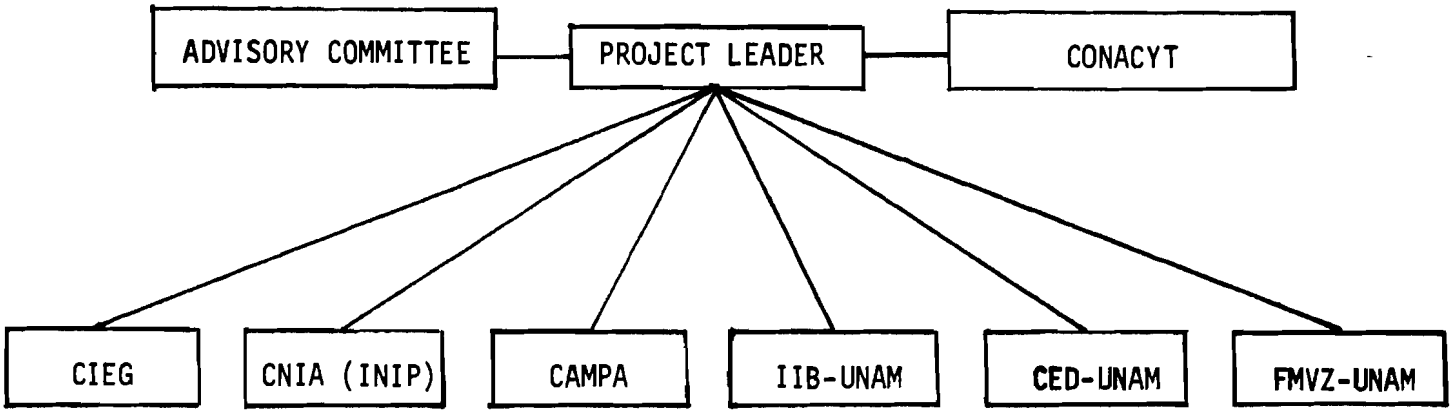
Figure 1



CIEG (Quintana Roo Territorial Government) - the development of feeding systems for production of beef and milk from molasses and derinded cane.

CNIA (National Sugar Commission) - research into the use of molasses, cane tops, bagasse pith and surplus cane for beef and milk production. CNIA was replaced by the National Institute for Livestock Research (INIP) shortly after the project commenced.

CAMPA (Training and Improvement Centre for Animal Production) - research into the use of molasses and sugarcane for beef production.

IIB-UNAM (Biomedical Research Institute of the National University of Mexico) - research into rumen microbiology and biochemistry.

CED-UNAM (Centre for Development Studies at the National University of Mexico) - economic evaluation of the data and feasibility of the alternative proposed technologies.

FMVZ-UNAM (Faculty of Veterinary Medicine of the National University of Mexico) - post-graduate training as a part of all the foregoing projects.

The project is broadly based with professionals drawn from a number of disciplines including veterinary medicine, agronomists, biochemists and agricultural economists with the largest component being veterinary medicine.

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2. PROJECT PERFORMANCE

2.1 Research Program

There are basically four components in this project:

a) basic research on biochemical techniques;

b) applied research dealing with beef and milk production;

c) economic research geared to assist the scientists; and,

d) post-graduate and non-degree training.

The experiments were initiated with some delays due to shortages of staff, research graduates, and lack of some equipment. In spite of the difficulties, the experiments of Phase I were completed on schedule and a five-month extension was granted to finish some training component on ruminants. Phase II is progressing according to plan.

2.2 Technical Achievements

In general, the results from Phase I are both encouraging and interesting in terms of defining the potential of sugarcane and cane by-products as feed for beef and dairy cattle. The results can be summarized as follows.

a) Several trials have demonstrated that there is no advantage in using derinded cane instead of whole chopped cane in terms of live-weight gain and feed conversion in beef cattle. Thus, in the absence of an economic use for the rind, incurring the expense of derinding equipment is not justified. It was also demonstrated that particle size of chopped cane ranging between 3 and 20 millimeters did not affect daily weight gains. In a feeding trial of beef cattle conducted in late 1974, it was shown that a locally made chopping machine (costing US$400) produced chopped cane that was more efficient in terms of average daily weight gain (615 grams per day) than the derinded cane (582 grams per day) produced by a much more expensive derinding machine (US$35,000). If confirmed, these results should be of considerable interest to CIDA which is supporting a major research program on the use of derinded sugarcane for cattle use.

b) Research has shown that the rumen fermentation process is strongly influenced by the amino acid composition of the diet. Sugarcane fermentation, whether spontaneous or as a result of ensiling, can generate various levels of acetic and butyric acids which tend to reduce voluntary intake. Results have shown that spontaneous fermentation is not a major problem in the dry seasons, but sugarcane silage must include ammonia at the time of ensiling or the high levels of

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both acetic and butyric acids will result. Although better than untreated silage, it is still not equal in quality when compared to freshly chopped cane.

Related to the fermentation problem, is the problem of toxicity in animals (often manifested by brain damage) as a result of a high sugar diet, especially one based on molasses. Fortunately, it has been possible to determine the level of toxicity in high molasses diets and now it can be prevented by the addition of dietary glycerine. This statement must be qualified though by stating that the complete understanding of this process and its economics will require further study.

The nutritional biochemistry studies have demonstrated that both the quantity and quality of supplements in high sugar diets are important. Rice polishings have been shown to give a consistent response in terms of voluntary intake, in diminishing the toxicity effects of a high sugar diet and in increasing live-weight gain by using as little as 100 grams per day on 13 kilograms of sugar.

The appropriate mix of supplements is important. Sugarcane supplemented with rice polishings without urea resulted in no significant live-weight gain, but with the addition of 35 grams of urea with every 1000 grams of dry matter, animals grew at almost 700 grams daily. Tests of sugarcane-based rations using native legumes (Leucaena and Ramon) as substitutes for commercial supplements show significant reduction in costs (up to 50 per cent of supplement costs).

c) The IIB has developed a liquid anaerobic fermentation process using a mixture of molasses, manure, urea, and various fibrous crop residues (including sugarcane bagasse). This has gradually been scaled up from the laboratory level to a pilot plant capable of producing 60 tonnes of semi-solid product per month. This product which is called Biofermel, when fed with pasture and a small concentrate supplement, has given daily weight gains of over 2 pounds a day in 450-pound cattle. An economic analysis suggests that under commercial conditions in a feedlot, the use of Biofermel might make it possible to reduce feeding costs by up to 30 per cent. On the basis of these preliminary observations (See Table 1 below), the IIB is collaborating with a commercial feedlot running 500 heads of cattle receiving the Biofermel diet.

In early 1977, an experiment was conducted using 50 per cent Biofermel and 50 per cent concentrate. Preliminary trials indicate that milk yields were 5.5 per cent and butterfat content 6.5 per cent higher than that achieved with a standard corn-based ration.

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TABLE 1

Economic Comparison of Biofermel with Commercial Control Feed[a]

	Average daily feed costs per head (in pesos)	Average daily weight gain (kg)	Costs per kg of live-weight gain (pesos/kg)
Control	8.70	1.168	7.448
Biofermel	6.08	0.989	6.150

[a]These results indicate a savings of 30 per cent in terms of daily feed costs per head and 17 per cent in terms of costs per kilogram of live-weight gain.

Generally, macro-economic analyses of the technological development of this project have been limited. This has been partially the result of the economics group emphasis on macro studies of the sugar and cattle industries in Mexico and partially due to the animal scientists' preference to develop and establish physical parameters of a new technology before making any socio-economic evaluation.

The objectives of Phase II represent a continuation of those in Phase I, but with a much stronger emphasis on testing the application of the technology. Most of the results of experiments performed in Phase II have yet to be received in final form, but what seems to show most promise is the development of an integrated pasture and feeding system in the tropics, with pasture being used in the wet season and cane in the dry season. Furthermore, sugarcane has shown itself to be an important supplement during the rainy season when the muddy condition of the fields does not allow the animals to graze the pastures to satisfy their nutritional requirements.

2.3 Institutional and Personnel Development

In Phase I, twenty-two students were involved in the project, two of these working for their Ph.D's and the majority of the remainder for their M.Sc.'s. In all cases, their thesis work was directly related to some aspect of the project. It is planned in Phase II to have thirty-three students involved, of this six carried over from Phase I. A number of the former trainees in Phase I are still working in the project or are attached to institutions (training, extension, and research) concerned with sugar and livestock production. It should also be noted that non-degree technical training accounts for 40 per cent of the total fellowships awarded.

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Initially, there were problems in the training program because it had not been customary for UNAM to recognize some of the collaborating institutions as approved training centres. Specifically, UNAM would not recognize thesis research work of a student undertaken at one of the other research institutes unless that student was supervised by a professor of UNAM who was also conducting research at the same research institute. An agreement was finally worked out between UNAM, CIEG, and INIP. The training program is now progressing well and is an example of how the project has encouraged inter-institutional cooperation.

2.4 Management and Program Planning

It was realized from the start by both IDRC and the participating agencies that this was an ambitious undertaking. In terms of management and administration, the project's successful operation required the continuous cooperation of eleven full-time researchers operating in six different research institutions in various parts of Mexico.

Due to the strong personalities of the various project components' leaders and the lack of any institutional cooperation in the past, project staff stated there was a tendency for the different research groups to work in isolation, independent of any other sub-project experimental activity. Furthermore, the original project leader, also in charge of one of the sub-projects, was unable to get along with several other sub-project leaders and their staff. This problem was largely solved by having the Advisory Committee select a new project leader from one of the universities who unlike the first project leader was seconded to CONACYT on a full-time basis to coordinate the project.

Subsequent to this appointment, it was decided by the project leader, CONACYT, and IDRC that in the case of a possible Phase II full responsibility for coordination would lie with CONACYT rather than the scientist coordinator. This has occurred in Phase II, and as of April 1977, the project has been fully integrated into the CONACYT structure and an agreement has been reached between IDRC and CONACYT that the objectives of Phase II be more tightly defined and monitored by both.

The organizational structure of the project has remained intact, but there have been changes in terms of the institutions involved. Shortly after the project began, the National Sugar Commission (CNIA) withdrew from active participation in the project but remained on the Advisory Committee in an observer capacity. In place of the Sugar Commission, the Livestock Research Institute (INIP), a branch of the Ministry of Agriculture, entered actively into the project, largely with the use of its own funding.

Since its inception in 1970, CONACYT has been involved in the elaboration of national directives for science and technology, and in

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supporting research and training for industry and the service sectors. Previous to this project, it possessed limited technical capability for selecting and/or monitoring research projects and little, if any, involvement with the agricultural sector. Thus, the project was somewhat alien to CONACYT's structure. The change of administration when the new President of Mexico assumed office in 1976 brought about important repercussions to CONACYT and consequently to the project. The Director of CONACYT was changed as well as all of its top management. The new management misunderstood the original purposes of the project and paralyzed the movement of funds for a period of four months. As of April 1977, the project has been fully integrated into the CONACYT system, by hiring a new project leader responsible to CONACYT and by developing a new coordinating system in which financial and administrative responsibilities are exclusively placed with CONACYT. Both project and CONACYT staff have indicated they felt these changes improved the coordination of the different project components and that CONACYT's capability to monitor and coordinate other research projects has been strengthened, although IDRC project staff believe it still lacks the scientific manpower to adequately initiate, monitor, and control similar research projects of this size.

2.5 Administrative and Financial Problems

While an agreement was reached between IDRC and CONACYT in early December 1974, CONACYT (acting as the sole contracting agency) did not finish signing agreements with the various institutes until July 1975. This was the result of not having the cooperation of CNIA and of their eventual decision not to participate in the project. CNIA felt that it, not CONACYT, should be the sole contracting agency.

Due to some difficulties in obtaining signed agreements from all the institutes involved, there was a delay of six months before all sub-project research was under way. This in turn led to delay in the purchase of equipment, and the recruitment and training of post-graduate students. Also during Phase I, there was a four-month delay in the movement of funds from CONACYT to the institutes. This was a result of the then new administration in CONACYT who wished to have more control over the project, and in doing so, reviewed the accounting procedures of the institutes and made what they felt to be, the necessary changes. It should be mentioned though, that in those cases where funds from IDRC to CONACYT were delayed, CONACYT continued contributing funds to the project to ensure the continuation of research in all of the sub-projects.

2.6 National Linkages

While two to the original participants dropped out of the project by the end of Phase I, it was an encouraging sign to see that this did not lead to the complete breakup of the project and that these vacancies were filled relatively soon by other interested institutions.

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Furthermore, while IDRC staff felt the institutions did not always work together in Phase I as closely as they might have, their willingness to sign an agreement for an additional two years, under a more centralized management system, indicates a sense of inter-institutional cooperation that was not present before the project started. Furthermore, new institutions have expressed an interest in this research area. The University of Chapingo, other departments in UNAM, and the Institute of Electrical Research (IIE)* have indicated their desire to work on or initiate parallel research projects.

Another promising demonstration of the interest shown by other Mexican agencies is the ongoing negotiations with the National Organization of Sugar Mills (ONISA) which has indicated its willingness to provide financial support once the IDRC project terminates.

The importance of continuing support for this kind of major inter-institutional research program is due to the realization by the scientists involved, that the examination and development of the most productive system of sugarcane utilization in animal feeding will take longer than the duration of the project, and will require the cooperation of various disciplines within the scientific community. IDRC staff feel that CONACYT probably provides the best guarantee that this kind of support will be available.

2.7 Regional Linkages

Linkages have been developed between different countries of Latin America, where sugarcane utilization for animal feed could be important. These linkages have been mainly in the areas of animal nutrition and the biochemistry of sugarcane utilization, and with such institutions as the Institute of Animal Science (ICA) of Cuba, the Dominican Centre of Livestock Research with Sugar Cane (CEAGANA), and the Centre for Research and Training in Tropical Agriculture (CATIE) in Costa Rica. Scientists from twelve countries have visited this project and a number of countries were present at the International Conference of Sugar Cane in Animal Production which was sponsored by the project in Mexico on 25-27 April 1978.

2.8 The Beneficiary

The project was intended to benefit the Mexican economy by upgrading the productivity of beef and milk production and to develop new markets for the sugarcane industry.

The methodology employed was not intentionally designed to develop new technologies suited primarily for the campesino or the small marginal sugarcane producer. The idea was to devise new technologies that would turn sugarcane and its products into animal feed.

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*To study the alternative uses of waste gas from biomass fermentation in the production of feeds and fertilizers.

.../D-10

The economic evaluations were used only to determine the relative economic benefits of the alternative uses of sugarcane at different scales and under different conditions of processing and utilization, along with a macro description of the cattle and sugar industry. They were not conducted to highlight a specific technological package suited for a specific category of Mexican beef and sugarcane producers.

The majority of on-farm experiments to date have been carried out on large cattle farms and ejidos, and with at least 100 head of cattle, usually more. Nevertheless, technical and economic studies are now being conducted in marginal areas in order to assess existing technologies and the campesino's reaction to new technologies. Further in this area, IDRC is encouraging the economists involved to evaluate the operations of the smaller (believed to be uneconomic) mills presently grinding cane for the sugar production.

3. IDRC'S ROLE AND INVOLVEMENT

Given the history of institutional isolation in Mexico, IDRC staff were inevitably drawn into a complicated round of initial discussions on the responsibilities and role of each of the participating agencies in this project. CONACYT was selected by the institutions as the umbrella organization which, using the decisions of the steering committee, would monitor and control expenditures. CONACYT's inexperience in coordinating research projects led to certain administrative complications which were eventually straightened out as CONACYT assumed more responsibility for direction of the project.

IDRC staff felt that considerable diplomacy was required to monitor and ensure that each institution stayed within the agreed research program without undercutting the coordinating role that the steering committee and CONACYT were supposed to exercise. Some of the project staff felt that IDRC should have taken a more active role in the project such as helping to jointly organize and sponsor the recent international workshop.

4. BROADER DEVELOPMENT IMPLICATIONS

With the change in administration in 1976, CONACYT is apparently being given an increasing budget and mandate to coordinate university research.

This project was unique in that it was the first research project CONACYT had ever administered. They used this opportunity to develop a more systematic method of monitoring and auditing various other projects of this nature.

Similarly, there may be some important continuing benefits from the cooperation that developed in this project by university and government departments which have had a long history of isolation and competition between each other.

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It may be difficult to eventually develop a process for sugarcane utilization which the small campesino with only a few head of cattle can utilize but the potential benefits justify continuing research in this area. Sugarcane is a widely grown crop in the tropics and produces the greatest amount of energy per unit of land of any widely grown crop.

Low sugar prices have made cane production uneconomic in many areas whereas meat and milk demand is increasing faster than supply, resulting in a continual increase in prices.

APPENDIX A

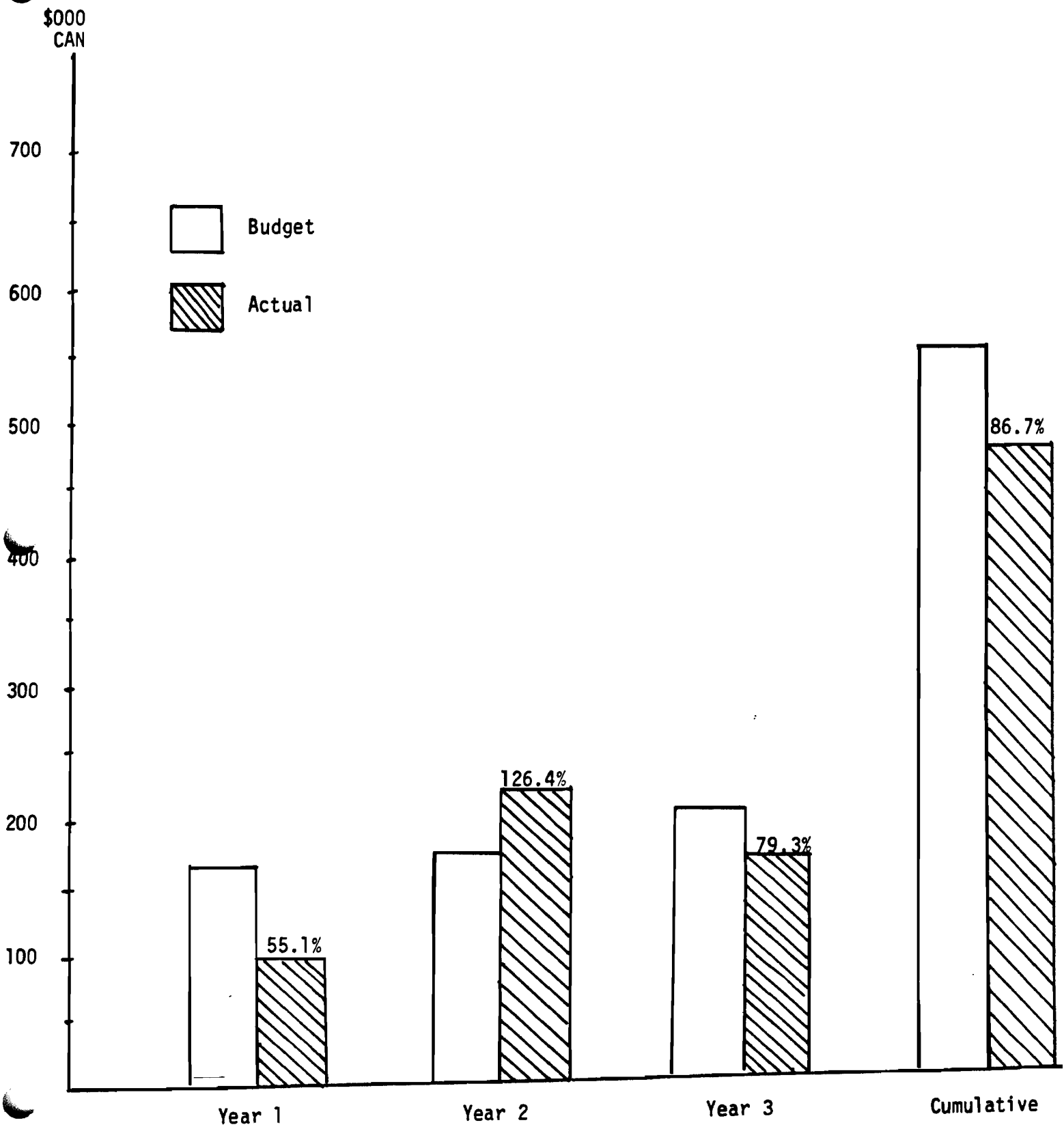
Budget and Actual Expenditures

BY-PRODUCTS (MEXICO)

	PHASE I						PHASE II					
	YEAR 1			YEAR 2			YEAR 3			CUMULATIVE		
	Budget	Actual	% Spent	Budget	Actual	% Spent	Budget	Actual	% Spent	Budget	Actual	% Spent
Training	73,500	45,740	62.2	83,500	121,392	145.4	79,350	53,212	67.1	236,350	220,344	93.2
Research expenses	20,070	7,936	39.5	27,000	22,426	83.1	33,750	29,750	88.2	80,820	60,112	74.4
Travel	11,650	6,316	54.2	12,300	21,162	172.1	23,030	22,030	95.7	46,980	49,508	105.4
Capital expenses	36,200	20,953	57.9	17,000	38,659	227.4	44,540	41,967	94.2	97,740	101,579	103.9
Publication	1,600	-	-	1,600	1,145	71.6	7,450	1,950	26.2	10,650	3,095	29.1
Supplies & Services	13,898	6,409	46.1	16,548	11,783	71.2	17,022	14,877	87.4	47,468	33,069	69.7
Consultancy	9,000	4,000	44.4	13,500	57	0.4	1,500	-	-	15,000	4,057	27.1
TOTAL	165,918	91,354	55.1	171,448	216,626	126.4	206,642	163,786	79.3	544,008	471,766	86.7

APPENDIX B

GRAPH 1: BY-PRODUCTS (MEXICO)



FORESTRY TECHNOLOGY (ANDEAN PACT): AN EVALUATION

Phase I - 3-P-74-0009

RECIPIENT INSTITUTION: Junta del Acuerdo de Cartagena (JUNAC)
Casilla 3237
Lima, Peru

DURATION: Phase I - Nov. 1974 to Dec. 1977

IDRC CONTRIBUTION: Phase I - $1,003,800

October 1978

1. THE RESEARCH PROBLEM

1.1. Background

In comparison with Southeast Asia and Africa, the tropical rain forests of Latin America are the most heterogeneous in that they contain a large number of different species but a relatively low volume of any one species per unit area. There are about 650 species of timber known botanically in the Andean subregion and about 50 species are used commercially, but not more than a half dozen are usually harvested in any particular location. A very small percentage of the standing timber volume is harvested and much of the residual forest is damaged or totally destroyed to clear the land for other uses. This deleterious practice of removing only the choice species, and often utilizing only the best logs of the trees that are cut, leaves a large number of presently unmarketable trees. The most recent assessment indicated that less than 0.1% of the total resource was effectively utilized. If these forests were more completely and more effectively exploited, under sound conservation principles, they could make a far greater contribution to the economic growth of the Andean Pact countries.

A simple case study indicated that one hectare could produce 90 cubic meters of potentially industrially usable timber. At this time 80% of the volume harvested was used as fuel, indicating the large untapped potential of the forest resources for construction of buildings, furniture and other industrial outlets. This potential included apparently 400 species, but was based only on knowledge concerning their volume per hectare. What was not known, and which would provide a much better idea as to their true potential, was information concerning their major wood characteristics and properties as they related to industrial processing.

1.2 Project Development

In 1971, the IDRC granted financial assistance to the Junta del Acuerdo de Cartagena (JUNAC) to undertake a series of studies pertaining to the scientific and technological development of the Andean Pact countries. One study which received high priority because of its importance in the subregion concerned the forestry sector. A specific outcome of this research was the preparation of four interrelated projects pertaining to the technological development of the tropical forest resources. The present proposal reflecting the most important of these projects, aims at developing a technology for utilizing tropical forest species as structural timber for construction purposes.

The research approach and methodology to be followed in this project has been carefully reviewed at a meeting attended by the representatives of

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the participating laboratories and a small group of highly competent forest products experts. Although the project was qualified as ambitious, it was felt to be soundly conceived and justified on the basis of the then present level of scientific knowledge of tropical forests and the availability of qualified scientific personnel.

1.3 Objectives

The project had as its broader aim, the development of technology for better utilization of tropical timber. The specific objectives (each representing a separate sub-project) were to:

a) determine physical and mechanical properties of selected forest species based on criteria for industrial use. Standard methods and techniques will be used;

b) develop standards for visual grading of tropical sawn woods; establish structural values for various grades of timber;

c) test and design wood building elements, design tables and charts for a wide range of structures;

d) develop efficient systems of jointing and uniting timber species in framing construction;

e) develop suitable drying and preservation methods; and,

f) determine woodworking and machining properties of tropical woods.

1.4 Recipient Institution

JUNAC is a regional organization representing the interests of five countries (Bolivia, Colombia, Ecuador, Peru, and Venezuela) and is responsible for initiating and/or administering programs and projects related to their scientific, technical, and economic development. This project represented the first research project JUNAC had ever been responsible for and both IDRC and JUNAC believe that it has been useful in providing JUNAC with the necessary experience to undertake further regional research work on copper, tin, and agricultural commodities, all important to the region.

Since the Forestry Service and some of the five countries were not equipped and did not have the staff to carry out all the research, they had the work performed through contracts to universities possessing forest products research facilities or a laboratory for the testing of materials. The intention was to use existing facilities as much as possible. Most of the Bolivian trials were originally going to be carried out in Peru because Bolivia had no forestry research facilities. But during the project, the government constructed a laboratory enabling researchers in Bolivia to perform the majority of their respective research trials.

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2. PROJECT PERFORMANCE

2.1 Research Program

The research program was carried out entirely by the research workers of the sub-region. In all, more than 60 professional man-years were spent on the execution of the project. The research on timber grading and timber design was an entirely new activity for the laboratories of the sub-region and new staff were recruited specifically for these two sub-projects.

The various institutes involved in the project are:

UNA:	- Universidad Nacional Agraria, La Molina, Peru
Forestry Division	- Ministry of Agriculture, Lima, Peru
PREVI:	- JUNAC's Regional Laboratory, Lima, Peru
UNI:	- Universidad Nacional de Ingeniera, Lima, Peru
CDF:	- Centro de Desarrolo Forestal, La Paz, Santa Cruz, Bolivia
UMASA:	- Universidad Major de San Andres, La Paz, Bolivia
UCQ:	- Universidad Central de Quito, Ecuador
Forestry Service	- Ministry of Agriculture, Quito, Conocoto, Ecuador
LABONAC:	- Forestry Products Laboratories, Ministry of Agriculture, now at the Ministry of Environment, Merida, Venezuela
UNM:	- Universidad Nacional de Medellin, Colombia
UDB:	- Universidad Distrital de Bogota, Colombia
UNB:	- Universidad Nacional de Bogota, Colombia

Due to the complexity of this project both in terms of institutions and personnel involved, and the diversity of topics and activities, the contracting committes organized the project into two main groups:

a) Activities carried out by each country and their selected institutions, under the coordination and advice of JUNAC.

   i) Physical-mechanical properties
   ii) Drying and presentation
   iii) Workability
   iv) Joints

b) Activities centrally carried out by JUNAC with the participation of counterpart members from each country.

   i) Design
   ii) Grading

Figure 1 illustrates the organizational structure of the project.

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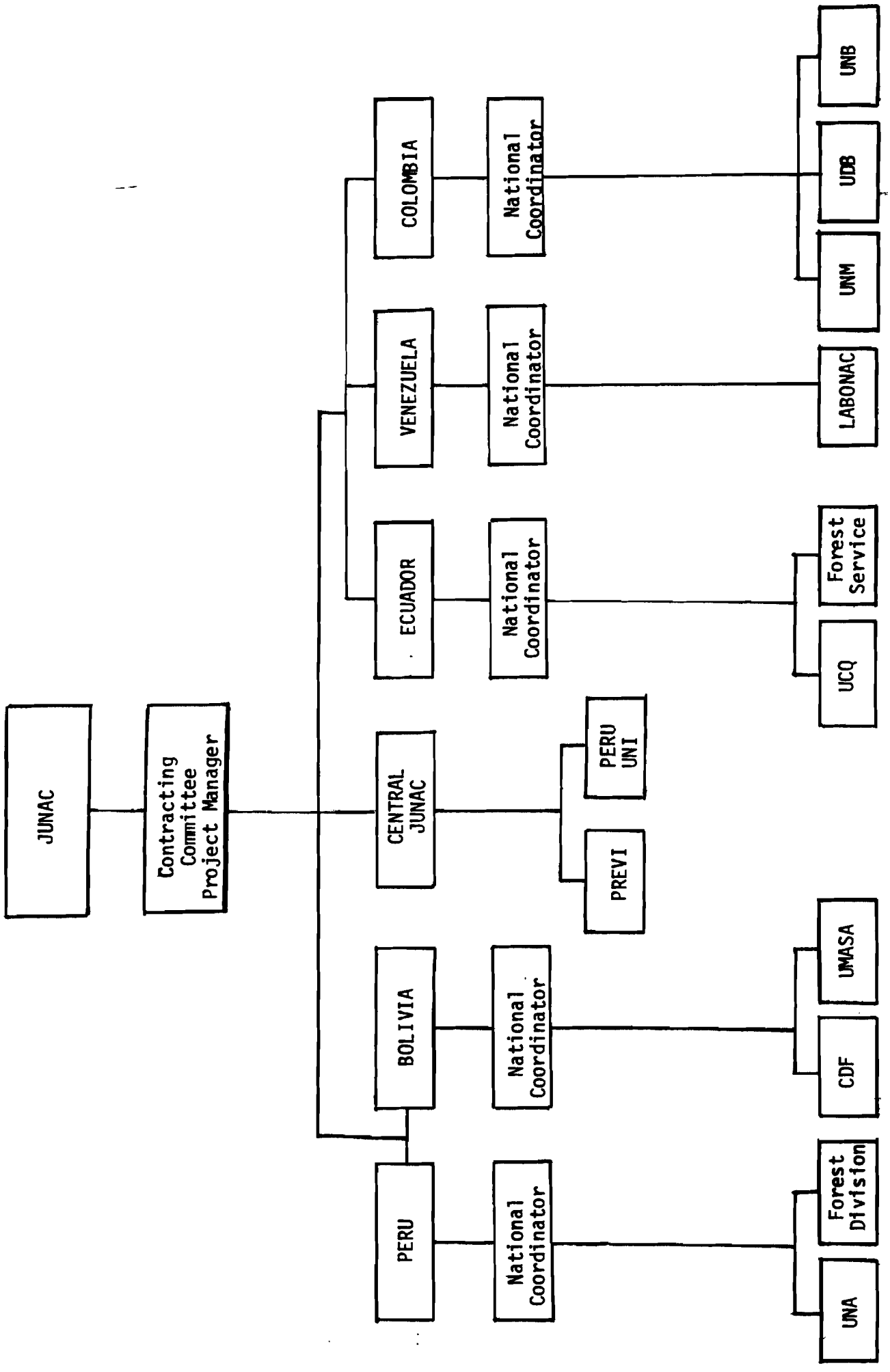
Figure


JUNAC
Contracting Committee Project Manager
CENTRAL JUNAC
PERU UNI
PREVI
BOLIVIA
National Coordinator
CDF
UMASA
PERU
National Coordinator
Forest Division
UNA
ECUADOR
National Coordinator
UCQ
Forest Service
VENEZUELA
National Coordinator
LABONAC
COLOMBIA
National Coordinator
UNM
UDB
UNB

2.2 Technical Achievements

Technical results of the project have been presented in seven major documents along with apparently forty technical papers and notes produced as a result of the various project experiments. All twenty species per country have been tested and all of their industrial properties have been identified. The following is a summary of results from each of the industrial sub-projects.

a) Physical and Mechanical Properties

The results obtained are not entirely comparable, since it was never agreed upon to utilize one specific size of specimen for testing. As a result, certain adjustment ratios had to be employed in order to come up with "standard results."

For certain species it was found that strength values were considerably lower than was hypothesized given their densities. What is of significance though, are the high correlations (often as high as 0.90) between the specific gravity and most mechanical properties for those species whose densities approximate the mean (0.4-0.6). The significance lies in the increased ability to develop a simple grading rule for a much larger number of species than have been utilized in the past. This in turn should result in a more intense clearing of a given forest area in place of the previous system of selecting only a few species within the same given area.

b) Grading

Beam and column testing have taken place in all laboratories, and it appears that the results are sufficient to be reliable for the 70 species tested.

A new and much simpler grading rule of select or reject, known as the "Sistema Andino de Classificacion para Madera Estructural," was developed. This is an exciting development in that it is not a complex system but consultants used in the project believe it is completely satisfactory for construction end use purposes of tropical woods in the Andean Pact countries.

It is important to emphasize that previous to this project, there has never been a standard grading rule for the tropical timbers of the region for use in construction within the region. The only grading rules previously applied to those forest species were those of foreign businesses, the species being graded for use in those foreign countries only.

c) Design

The major effort in this area has been to determine parametric values for industrial species for use in the building of basic wooden structures. The engineering data derived from the project has been incorporated into a written manual along with instructions on how to design

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and build basic wooden structures. A complementary publication called the CARTILLA, includes a glossary which defines a common vocabulary of terms used in wood construction which had previously varied in each of the five Andean Pact countries. This latter publication will be circulated throughout most of Latin America.

d) Joints

Although all testing on joints has now been completed, major delays were experienced in Peru (due to a transport problem) and in Colombia (due to a shortage of funds) and the analysis of the results have not yet been completed.

Test results are being analyzed at JUNAC to determine correlations between different variables; for example, specific gravity and species ability to resist double-shear loads applied to nailed and bolted connections. This work is expected to be completed by mid 1978. Once again, the significance of obtaining reliable correlations is that they are the basis for developing a simple guide in selecting timbers for specific end use purposes, without regards to their species.

e) Drying and Preservation

Natural air-drying tests indicated that a moisture content of 20 per cent (normal for storage) can be achieved in 15 to 20 days for the majority of the 105 species tested. In all cases, the problem of warp was more serious than surface or end checking.

Tests based on kiln drying showed that 110 to 150 hours are generally or always required to achieve a 20 per cent moisture content. This represents a drying time of 4.6-6.3 days, approximately one-third of the time required for air drying but kiln drying is much more expensive than natural air drying. However, it was felt by project personnel that the study on kiln drying was justified since samples were available for testing it was less expensive to conduct them at the time than have to run a completely separate project on this subject matter sometimes in the future. Furthermore for certain non-structural purposes, such as use in furniture manufacturing, kiln drying is preferred and is economically sound given the high prices for the end product.

The process of forced air-drying has not yet been studied. This would be a likely topic for a proposed Phase II of the project since it appears that forced air drying is technologically and economically more suited to mill operators than kiln drying.

In the preservation experiments many of the species tested did not have a distinct heartwood. Some others showed a clear differentiation between sapwood and heartwood. Absorption and penetration classification are being standardized to be applied uniformly throughout the region. The experiments have shown that relatively few species of tropical hardwoods

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have a high natural resistance to damage by insects making it important to know what preservation techniques can be applied before using various species as structural timber.

f) Workability

Results show correlations between specific gravity and workability properties similar to those found between specific gravity and the various mechanical properties. For example, ratings for mechanical stress can be used to grade a sample of timber if its specific gravity is approximately 0.40-0.60, without regard to the actual species, keeping in mind similar qualifications of results of full size species samples as was the case with the mechanical properties.

Given this information it will now be possible to develop or design tools that are suitable for cutting, planing, etc. specific species or group of species (grouped according to a similar characteristic or property) by the mill operators.

Thus in receiving the technical results, IDRC staff feel that the project has made an exceptional accomplishment in managing to identify all the characteristics of an additional 100 tropical species and by using significant correlations to considerably ease classification and hence ease of utilization for different purposes.

However, further research beyond that envisaged in this project will be required to ensure that this information is further analyzed and additional information collected to allow small mill owners to readily use this in their mill operations.

Work of this kind has already begun in that data from all subprojects is being fed into a central computer at JUNAC. Various standard computer programs are being used in order to determine values for the previously mentioned correlations and to come up with more reliable relationships between different variables. Project personnel and consultants hold different opinions as to the significance of the correlations between specific gravity and the mechanical and workability properties. The reason for this is that actual testing on full-size species samples has been minimal and that the correlation values found in the manual are based on (testing a small perfect piece of wood free of all defects) small-size samples only, and when "adjusted", may not be valid for actual structural end uses. Recent work on full size species have resulted in lower value correlations for similar relationships, opposite to what was hypothesized. This, some consultants state, is a further basis for caution in using results in the manual, as grading rules.

2.3 Institutional and Personnel Development

Previous forest products research of the region has usually not been comparable due to a lack of standard testing methodology. Furthermore, most research has been conducted by universities or by institutions closely

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associated with universities, which has resulted in most of the work being of a highly academic matter, little in the area of applied technology. Through this project JUNAC has been able to achieve a uniform methodology amongst research institutions from five countries as well as initiating a basic infrastructure for applied research in forest technology.

In Phase I, JUNAC was not interested with the creation of new forest research institutes for their own sake, but rather with the rationalization of research resources already present in the region. It has incorporated almost all institutes and agencies dealing with forestry research into the project and has attempted to maintain effective coordination. In terms of government participation, JUNAC has focused most of its attention on the Ministries of Agriculture; but it is hoped that it can now effectively involve the various Ministries of Housing in each country in order to extend the project's results to various intended beneficiaries.

There was considerable concern when JUNAC proposed that a new research laboratory for timber grading and design be built in Lima, Peru. The reason for this was due to an on-going strike at the University in Peru where this research was to be conducted and it was felt that the strike and/or related issues would interfere with research operations. It did cost $6000 more to build than rent but there are now permanent facilities for further research. It should be noted also that in certain instances the project staff decided to build special equipment by purchasing separate components and assembling them themselves. They have reduced the cost considerably and have set up three pieces of imaginative and innovative equipment which provide a great deal of versatility for timber engineering research.

IDRC and project staff have been encouraged to see the increased emphasis placed on wood technology as a separate sector within various National Forest Agencies since the start of this project. This is reflected mainly by the budget increase for the execution of this project, and by the fact that Bolivia now has a forest research laboratory where none existed before, and Ecuador which had possessed plans to build forest research facilities have now completed construction as a result of the catalytic effect of this project.

There has been almost no formal training undertaken but a considerable enhancement of scientific capability as a result of having the "weaker" scientists backed up in their research work by the more experienced capable scientists in the region. Approximately 40 scientists and technicians have been trained in this manner, 15 of them participating in an intensive short course on timber classification given in Guyana. The remaining 25 have participated in courses and seminars provided through:

a) forestry experts from participating non-Andean Pact countries;

b) trainees attending short intensive training courses held at the research laboratories; and,

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c) JUNAC sponsored seminars for trainees that introduce them to new topics concerning forestry technology.

2.4 Management and Program Planning

The project was administered at the sub-regional level by a "Contracting Committee" which was to be responsible to the Junta del Acuerdo de Cartagena and would be composed of representatives of each of the participating countries. A national committee was set up in each country in order to keep policy makers and potential users of the research results informed about the progress of the project. These committees were composed of government officials and of representatives of industry, trade, and professional associations.

The Contracting Committee is primarily a political body whose main function was to get initial government financial support, and later to have this support increased. It has been very successful in this task. Representatives from each of the five countries who sit in the Contracting Committee voted an increase in funds from each country to allow the research program to be speeded up when it became evident that the objectives would not be achieved by the original deadline. The member countries have also given JUNAC permission to spend $150,000 from general JUNAC funds to carry on the program now that IDRC funding under the first phase has been used up. The Contracting Committee has already approved member country contributions of $379,000 for continued research and development in a planned second phase, although discussions with IDRC on a possible continuation of IDRC support have not been completed.

This Committee has been active since the initiation of the project, holding meetings every six months to deal with management problems such as staff recruiting, purchase of equipment, organizational tasks, as well as the coordination and planning of technical and administrative activities. The latter function has been very important since every meeting of the Contracting Committee discusses a report on all activities carried out by JUNAC itself and by each participating country.

At the technical coordinating level, a scientist was chosen from one of the participating institutions to act as technical coordinator for each of the sub-projects. As could be expected, a serious management problem stemmed from a lack of established communication channels which hampered some of the coordinating and evaluation activities, especially when one visited the different components of the project. Due to the large and diverse composition of personnel, some personality clashes had to be resolved by the Project Manager and the Contracting Committee.

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2.5 Administration and Financial Problems

There were financial and administrative complications between IDRC and JUNAC and between JUNAC and the national institutions involved.

The most evident operational problem has been the delay of national funding in some countries, due largely to bureaucratic bottlenecks. This has often postponed the contracting of personnel and somewhat limited the time available to conduct experiments. Another major problem, and one which delayed the signing of an agreement between JUNAC and IDRC, was the question of who would hold the patent rights in the event that a new idea or process was developed in this project. JUNAC did not agree with IDRC's policy retaining possession of patent rights. A compromise was arranged whereby JUNAC would hold patent rights in the Andean Pact countries only, notifying IDRC within six months after JUNAC decided to initiate a patent application for any project idea or process.

The purchase of equipment caused considerable delays. The actual cost of equipment was 60 per cent higher than the original estimate, resulting from inflation which occurred during delays in ordering. The changes made to the original equipment reflected more realistically the project needs.

As a result of the complications, IDRC staff have concluded a thought that a project of this size and involving this many participants requires very specific guidelines and a thorough review with the recipient of his rights and obligations before the project becomes operational. This could help to reduce the delays in signing of agreements among all participants and improve coordination of research timetables for all the sub-projects.

2.6 National Linkages

Project staff feel that this project has been most successful in stimulating the interest and commitment of the governments of the region, as demonstrated by increased financial support to the project and by the development of programs to increase the construction of wooden housing in some countries. The Peruvian Government has instructed insurance companies to provide insurance for wood housing, and in Ecuador, the Ministry of Agriculture has joined with the Instituto Ecuatorian and the Banco de Vivienda to provide financing and technical support for the development of wooden houses.

IDRC staff and consultants have been impressed with the success the project has had in stimulating the interest and involvement of the faculties of engineering and architecture in the universities. Seven universities have been directly involved, with several activities undertaken that are complementary to but independent of the project. One example is a one-hour film produced by six students from the Faculty of Agriculture at the Universidad Central in Quito, Ecuador, showing the various activities of the project from cutting of the timber in the forest through to the building of wood houses.

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To date, the project staff have had little involvement with the lumber industry other than responding to requests for information from various sawmills. It was hoped that the employment of two private industry consultants would ensure that the problems and interests of the industry would be taken into account during the project. However, both these project employees proved unsatisfactory because of their apparent lack of competence and conflict of interest with their private businesses and they were dropped from the project. The project objectives did not include any plans for a close involvement or collaboration with the industry, although it was planned to undertake a sawmill survey on the size, production capacity, machinery and personnel of each mill, the species being cut, the characteristics and common defects of each species and the method of species identification used in the sawmills. This survey was to be carried out by each member country but only Peru provided a relatively complete picture. It was difficult for the research staff in other countries to carry out a comprehensive survey on the sawmills which tend to be in isolated areas. Similarly with the construction industry, only a small unpublished survey was carried out in Lima on the cost of housing and availability of lumber products.

The forestry research laboratory in Venezuela brought in a number of mill operators to show them the work undertaken in the project. The mill owners were very interested and wanted the results to be promoted although they felt that the project suggestions were too complicated and they would be able to utilize only 25 per cent to 30 per cent of staff recommendations. The Venezuelan project personnel are continuing these periodic meetings with industry representatives.

2.7 Beneficiary

The project proposal was based on the evidence that only a very small proportion of the forestry resources of the Andean Pact countries were being utilized, while other construction materials were extremely expensive and the supply of housing at all income levels was inadequate and becoming an increasingly serious problem in these countries.

It was assumed that increasing the utilization of these forest resources would provide benefits to both the producers and consumers in terms of increased employment and output, and a reduction in construction material costs. One unpublished study carried out in this project indicates that the net benefit on employment levels, capital requirements and cost of construction would be positive from increasing lumber use in construction at the expense of cement and steel. The forest products industry has a lower capital and a higher employment requirement per dollar of output than either the steel or cement industries so that an increase in the proportion of lumber used in the construction industry by 10 per cent would result in approximately a 20 per cent increase in net employment and wages while there would be a slight decline in the value of output from the construction industry indicating that wood products are cheaper than either cement or steel.

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Another study carried out in 1974 in Lima indicated for those in middle income brackets, wood houses of comparable quality to cement houses had approximately the same cost. However, cement and steel prices have been increasing rapidly while there appears to be considerable potential for reducing unit prices of forest products in the region.

While there has been some increase in the number of large integrated mills producing veneer, plywood, fibreboard or particle board in the region, by far the largest proportion of output (around 60 per cent) comes from the several thousand small sawmills producing less than 15 cubic meters of timber per day. Most of these mills are located in isolated areas close to the forest resources where few alternate employment opportunities exist. While there is no accurate information on the number of these small mills and their efficiency, the information that does exist indicates that they are inefficient in both the utilization of the surrounding forest and wasting much of the potential value of the wood milled. Most mills utilize less than six or seven species so that wood cutting in any one area is very selective and more costly than it would be if the mills could utilize more species in the immediate vicinity of the mills. Forestry officials in the region felt that a change in operating practice towards a more intensive method of clearing would take a major promotional effort and some assistance from the government in order to overcome the resistance of mill owners and operators using the traditional system of forest cutting. Additional machinery would probably be required in many of the mills, but governments of the region are now providing assistance to the saw mills allowing them to purchase new equipment. Individuals in both government forestry departments and industry felt that small sawmills would gradually be forced out of business by large integrated operations which would produce a diversity of products for the construction industry and who would be more responsible than the small sawmills in maintaining forest resources and avoiding wanton destruction of the environment.

While there is a promising market for increasing the use of wood for industrial and commercial purposes such as warehouses, wharves, platforms, etc., the housing market offers by far the greatest potential for increasing the region's utilization of wood. Government estimates by each of the five governments in the Andean Pact, prepared between 1966 and 1970, indicated that the combined shortage of acceptable housing in the region was approximately 4.5 million units. As a result, each of the five Andean Pact governments has assigned high priority to expanding the supply of housing, and housing ministries have been created or expanded with increased government funds.

The use of wood in housing has been extremely limited throughout Central and South America, with the exception of Belize and the Guyanas. Project staff point to these two exceptions to illustrate their belief that the choice of housing material used in the region has been heavily influenced by their different political histories and traditions rather than by any inherent unsuitability of wood for housing. They believe there is a strong consumer resistance to the use

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of wood in housing which must gradually be overcome by government action and by building very attractive model wooden housing which the middle and upper income community will accept. Project personnel believe that the acceptance of wooden housing by upper income groups would eventually encourage low income consumers to accept the use of wood in their housing.

Given the cost of wood, and the ready availability of other materials, it is unrealistic however, to expect that wooden houses could replace present housing materials for the lowest income groups in the rural areas. With a reduction in the cost of wood and an increase in its availability, it may be possible to increase the proportion of wood used in housing for lower income groups but it could not replace the adobe, tile thatched straw or palm leaves and bamboo presently used in the region.

Any increase in the availability in wood products is likely to be of greatest benefit to middle income or lower income government and large company employees, many of whom have inadequate housing. The Government of Venezuela has established minimum housing standards, including a minimum floor space of 56 square meters for new government and commercial housing. The government provides a very large subsidy to allow people to purchase these houses at a minimum cost of $3000. The project staff at the Merida Forestry Institute have produced several prototype wooden houses which they believe can be produced for about $2000 each. Other governments in the region have established ambitious public housing schemes such as the program in Peru to build 60,000 government houses in the next few years. If prototype wooden houses can be produced more cheaply, government contracts would stipulate that a minimum proportion of wood be used in all new public housing as governments are very anxious to reduce their cost.

Wood is also likely to be more useful than other materials in meeting specialized housing requirements such as the present program of the Bolivian Government and private mining companies to build 6000 pre-fabricated units for miners in the Bolivian tin mines.

2.8 Delivery System

This project was designed to provide an improved scientific base on the industrially functional properties of at least 100 unclassified timber species common to the region. It was hoped that the expanded data base would allow the Andean Pact countries to design and implement programs to increase utilization of their forestry resources. The precise way in which this new information would be utilized was therefore not defined in the first phase but the project staff did begin to develop a delivery system for using this new technology during the project and a Phase II proposal was submitted to IDRC proposing a number of activities to strengthen this aspect.

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The project director and senior staff at JUNAC stated that the low level of wood utilization at present was a kind of vicious circle in which lumber was not available in adequate supply or with standard grading and sizes; and the lumber industry would only be prepared to change its operating practices so that it could provide an increased supply of reliable grades and sizes once demand was increased. The demand for and utilization of wood was constrained by the lack of standards, the lack of knowledge and interest of architects and designers in the construction industry, and the inferior status of wooden housing from the consumer's viewpoint, along with the unwillingness of banks and insurance companies to finance or insure wooden houses.

The project staff at JUNAC felt that the first target group that must be reached are professionals, such as architects, designers and engineers who will begin to specify the use of wood in construction once they are aware of its functional properties. Two manuals have been prepared, one on the principles of wood utilization in construction and another on the engineering principles of various wood species, and are regarded as an essential to allow professionals to begin to utilize wood and to stimulate their interest in wooden housing. These manuals are being widely distributed, especially to government departments and university faculties of engineering and architecture. A second phase proposal submitted to IDRC contains provision for a series of wood design courses and seminars to be held throughout the region.

JUNAC has also planned to develop the idea of modular housing and to promote the construction of a number of attractive wooden houses which would be very expensive, but which would help to remove the present stigma attached to wooden housing by all income groups.

JUNAC has developed a parallel project to this one which involved the establishment of a JUNAC Advisory Service to the sawmill industry. CIDA had agreed to provide financing for this program but it has since been dropped partly because the staff to be employed in this were too inexperienced to be able to have any impact on the industry. Several simple publications on the grading rules established during the project are being prepared and it is intended after further analysis of all the data to distribute these to sawmills and the construction industry to enable them to adopt these guidelines. One or two scientists from each of the member countries were sent to a training course for graders, held in Guyana, and it is expected that each government will run courses for graders during a second phase.

2.9 Regional and International Linkages

Before the project started there were only four institutions with forest products research experience in the sub-region; LABONAC at Merida and UNA in Lima had good experience, while the universities of Bogota and Medellin in Colombia possessed somewhat less. IDRC and JUNAC staff felt that the project had produced a much more uniform

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level of research competence within the region as the weakest institutions had made the most progress in developing their capability. However, even Venezuela, which possesses by far the best trained personnel and most elaborate equipment in the area, is willing to remain in the project to benefit from the experience of the other countries.

The project has developed contacts with similar institutions in South America, especially with the Brazilian Institute of Forest Resources, and through short-term consultancies with the Chilean Institute of Natural Resources as well as with the Timber Research and Development Association (TRADA) of England; the Council of Scientific Industrial Research Organization (CSIRO) in Australia; the Forest Products Laboratory, Department of Agriculture, Madison, Wisconsin; and the Centre de Technique du Bois (CIB), France. Finally, there has been a strong interest on the part of several countries concerning the results of the project. IDRC has now received several inquiries for similar projects from other developing countries with an under-exploited forest potential.

3. IDRC'S ROLE AND INVOLVEMENT

National program staff have consistently pointed out that IDRC's willingness to support this project through JUNAC, rather than with each country on an individual basis, was crucial to the operation of this project, since it would have been impossible to mount such a research program in many of the countries without the political support JUNAC was able to generate from the political leadership in each of the countries involved.

In terms of on-going technical assistance, a number of consultants have visited each sub-project on a regular basis. Sub-project coordinators were drawn from the national programs and in some cases they had less contact with other national programs than did the consultants. Advice provided by the consultants to individual scientists in each of the national programs tended to undermine the role of the sub-project coordinator in at least one case. It was pointed out though by many of the national program staff that IDRC staff played a useful role in informing national scientists of the general development of the project, supplementing the coordination function of JUNAC, which they described as the weakest part of this project.

IDRC negotiated and signed this project with JUNAC and not with each of the individual countries. This had certain advantages in that JUNAC was responsible for controlling expenditures and allocating funds to different activities. This meant that IDRC's role was not always clearly understood in the national programs. The primary problem experienced by JUNAC with IDRC was IDRC's refusal to countenance major changes in the direction of the research program after the project was committed. JUNAC staff attempted to increase the involvement of JUNAC beyond its coordinating activities and supporting engineering design research to developing a permanent on-going research capability in

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JUNAC with their own research facilities. This involved the establishment of a very expensive JUNAC Seismic testing laboratory and which appears large enough to test the effects of simulated earthquakes and environmental changes on full-scale houses. As this was a considerable deviation from the approved project and as project funds were already fully committed, IDRC refused to authorize the use of any IDRC funds for these new facilities. JUNAC was able to draw upon other funds to begin the development of its own facilities, an activity which was strongly opposed by a number of the project leaders in the national programs who felt that central laboratory facilities would primarily benefit Peru and would compete with and draw resources from the national programs.

JUNAC leadership subsequently prepared a very large Phase II proposal for submission to IDRC which involved a large house building program throughout the region. As this was purely a demonstration project with no research component, it was completely outside IDRC's mandate. This created some feeling among JUNAC personnel that IDRC was not willing to be very flexible in use of its funds, although IDRC staff had no option in either case.

Senior JUNAC personnel indicated that there was initially some suspicion of IDRC's motives in supporting this research project, the results of which they felt could be very useful to multi-nationals and other firms in the private sector. This was part of the reason for the extensive negotiations which were necessary before JUNAC and IDRC were able to agree upon a patent protection policy. JUNAC staff said this suspicion has now been alleviated and the Director General of JUNAC indicated that while they had strong indications from several European donors that they would be prepared to finance further research and development in this area, JUNAC preferred to deal with an agency like IDRC which had no possible commercial interests.

Another aspect which caused some complications between IDRC and JUNAC was JUNAC's use of its own funds, or other donor funds, to carry on parallel activities which overlapped with this IDRC supported project. Establishment of the JUNAC laboratory is one example. In one case, personnel employed in the project accepted scholarships from a European donor and in another case JUNAC brought in a consultant, using its own funds, to advise on one aspect of this project. The IDRC Associate Director concerned did not object to these activities of the recipient but did insist that IDRC should at least be advised and consulted. It is difficult to determine to what extent IDRC should insist on a recipient institution clearly outlining how broad their total research program will be, including their involvement with other donor agencies, rather than examining the proposed project in isolation. Related to this is the question of what action IDRC should take if the general direction of the institution and research program moves away from achieving IDRC objectives, even if the specific objectives of the IDRC supported research project do not change. If the recipient institution proceeds to subsequently finance all of the activities eliminated during discussions with IDRC program staff, then the ultimate impact of the project may be considerably different from that anticipated.

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4. DEVELOPMENT IMPLICATIONS

The results of this project have important implications for expansion and development of a more efficient forestry industry and for the continuation of a central coordinating agency for regional research and the expansion of forestry research in the region.

It is too early to be able to judge whether the results of the project will be effectively utilized by the saw milling industry and whether the small sawmills will be able to survive the tendency towards development of large integrated milling firms. The rapid growth of the construction industry (12 per cent annual growth rate in this decade) and the interest shown by governments both in increasing financial resources to their forestry research institutions and by the Ministries of Housing, provide some assurance that the forestry industry will develop even more rapidly in the future.

The publications on wood use and design produced in the project provide the first major educational and engineering manuals in Spanish for this region. The lack of familiarity with wood and the historical attitude towards wood use as an inferior construction material indicates that the design and engineering professionals must be educated through the use of such manuals before wood utilization can be increased.

IDRC was the first agency to provide support for a JUNAC designed and coordinated research project. Senior JUNAC personnel have indicated that the experience gained from this project and the enhanced credibility of JUNAC as a regional organization has allowed JUNAC to design and receive international financing for other major research projects. It may be possible to strengthen the ability of regional organizations like JUNAC to resist the strong centrifugal national forces which often pull them apart by developing functions such as coordinated research programs which are based in and benefit all the member countries.

Regardless of whether JUNAC, or the Andean countries, continue to coordinate their forestry research programs, this project will have a long-term impact through the development of a standard nomenclature and hopefully standard grading rules.

Coordinating the research programs of the Andean countries through this JUNAC project has resulted in the strengthening of the weakest national programs and allowed the research institutions of the region to focus on a common research priority and thus greatly increase their total research effort.

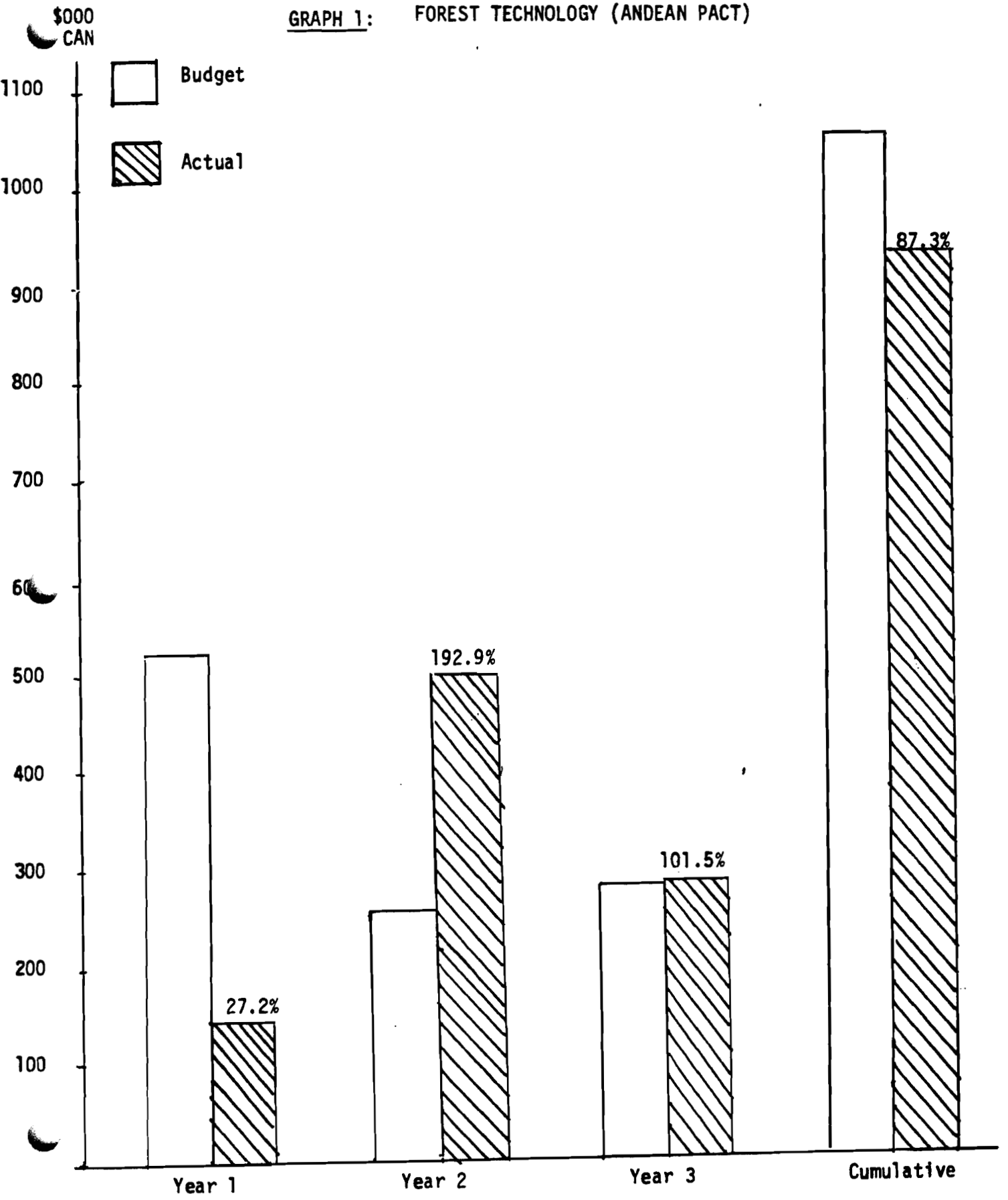
orestry Technology (Andean Pact)
entre File: #3-P-74-0009
In Cdn. $)

APPENDIX A

	YEAR 1 BUDGET	ACTUAL EXPENSES (10/74-9/75)	YEAR 2 BUDGET	ACTUAL EXPENSES (10/75-11/76)	YEAR 3 BUDGET	ACTUAL EXPENSES (12/76-6/77)	ACTUAL EXPENSES (7/77-12/77
ecipient - Administered							
Salaries and Allowances							
Project Leader	16,000.00		19,200.00		42,300.00		
Subproject coordinators	107,600.00		75,600.00		21,000.00		
Research Assistants	80,100.00	100,627.01	45,500.00	241,755.10	44,200.00	129,859.82	
Technicians	11,750.00		5,550.00		29,700.00		
Support Staff	10,500.00		8,400.00		52,100.00		
Research Expenses							
Labour	6,350.00	386.64	550.00	4,695.45	-	5,730.00	
Shipment of Wood Samples	30,000.00	Ø	-	19,893.55	-	9,999.51	
Small Equipment & Spare Parts	10,000.00	Ø	10,000.00	23,491.30	5,000.00	1,138.32	
Laboratory Supplies	7,000.00	273.68	7,000.00	17,495.39	9,000.00	1,953.94	
Computer Services	-	-	-	94.74	5,000.00	2,242.20	
Technical Documentation	1,000.00	647.57	1,000.00	1,776.41	1,500.00	95.80	
Office Supplies	2,000.00	2,110.19	2,000.00	2,464.08	500.00	8,735.58	
Travel (Regional)	46,000.00	24,653.49	15,500.00	31,495.06	22,500.00	24,546.35	
Training							
Short Course	10,000.00	Ø	-	-	2,000.00	Ø	
Practical Training (Region)	26,000.00	5,788.96	-	11,754.10	-	16,552.52	
Practical Training (Abroad)	-	-	20,000.00	7,249.74	-	15,877.37	
Publications and Workshops							
Reports	-	1,879.40	5,000.00	Ø	25,000.00	2,144.57	
Local Seminars	-	3,399.39	-	995.63	5,000.00	(162.88)	
Capital							
Field Equipment	6,900.00	Ø	-	4,314.41	-	3,061.81	
Office Equipment	11,700.00	2,012.39	-	6,440.18	1,300.00	(228.39)	
Laboratory Equipment	107,850.00	Ø	20,000.00	85,616.56	11,650.00	58,998.58	
	490,750.00	141,778.72	235,300.00	459,531.70	277,750.00	280,545.10	
ntre - Administered							
Travel (International)	9,000.00	Ø	-	5,158.90	-	-	-
Consultancies	25,000.00	887.00	25,000.00	37,379.15	5,000.00	6,455.43	5,919.42
Contingency	-	-	-	153.18	11,420.00	Ø	18.30
	34,000.00	887.00	25,000.00	42,691.23	16,420.00	6,455.43	5,937.72
	524,750.00	142,665.72	260,300.00	502,222.93	294,170.00	287,000.53	5,937.72

APPENDIX B

GRAPH 1: FOREST TECHNOLOGY (ANDEAN PACT)



GRAIN MILLING AND UTILIZATION (NIGERIA): AN EVALUATION

Phase I - 3-P-72-0003

Phase II - 3-P-73-0128

RECIPIENT INSTITUTION: Federal Ministry of Agriculture and Rural Development
North Eastern State
Maiduguri, Nigeria

DURATION: Phase I - Feb. 1972 to Dec. 1973

Phase II - Aug. 1974 to June 1978

IDRC CONTRIBUTION: Phase I - $147,250

Phase II - $160,000

October 1978

1. THE RESEARCH PROBLEM

1.1 Background

Economic development in Northern Nigeria in the past ten years has resulted in a rapid increase in the size of its towns and cities, along with accompanying changes in the life style of the urban and semi-urban population. Parallel to this increase in the urban population is an anticipated increase in agricultural output as a result of the Federal Government's ambitious development program for Northern Nigeria.

The North Eastern State was the largest of the northern states, accounting for two-thirds of the land area of Northern Nigeria with a population of approximately 10 million (one-third of the Northern Nigeria population). The main crops are sorghum and millet for food grains; peanuts and cotton for cash export crops; and small amounts of rice, cowpeas and wheat. Wheat is gaining in popularity, costing as much as rice in the market place; the other grains less. There are approximately 1.3 million farmers cropping 9 million acres with holdings ranging from 2 to 50 acres, the average farm size being 5 to 7 acres. There are 3 million acres of sorghum and 2 million acres of millets planted annually. Eighty-five per cent of the output is either consumed at home or traded in the rural areas with the remaining 15 per cent entering market channels or a growing commercial grain industry.

A high percentage of all grains marketed in the urban areas are mechanically ground after they have been manually decorticated, and an increasing percentage of manual dehulling is being performed on a fee for service basis outside the home.

The small, rural plate grinders of Northern Nigeria are frequently overcrowded and an evident need exists for additional and improved capacity. The existing system of manual home decortication and machine grinding is unsanitary, wasteful, and time-consuming. The capacity of a typical plate grinder ranges from 10 to 20 bags of grain (i.e., 0.5 to 1 ton) per day depending upon the condition of the grinding plates, the drive belt, the engine and the general overall technical competence of the operators. Each grinder serves only 10 to 20 customers each day and losses are believed to be very high; consequently, the process is both wasteful and uneconomic. It was visualized that installation of a pilot research mill of improved technical efficiency and increased capacity, which would produce both packaged flour and grits as well as animal feed, would help satisfy the increasing demand for higher quality flours and would improve the efficiency of the rural milling industry and the general economy of the North Eastern State of Nigeria to a significant degree.

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1.2 Project Development

The Permanent Secretary of the Federal Ministry of Agriculture and Natural Resources, Nigeria, approached IDRC with a proposal that it collaborate with the Government in developing an improved rural milling system. It was suggested that an experimental pilot mill be established at Maiduguri in the North Eastern State, with support from both the Federal and North Eastern State Ministries of Natural Resources.

A project was defined in which it was hoped that an improved milling system (based on the addition of a prototype dehuller, which had shown promise when tested at the University of Guelph) could be developed within the context of a total systems study of the grains and grain legumes produced, marketed and distributed within Northern Nigeria. It was recognized that no one institution possessed the capability to carry out such a program, but it was hoped to develop supporting projects at the University of Ife and with the Industrial Research and Development Unit of the Nigerian Ministry of Industry.

The project was established in two phases, the first phase being devoted to the development of a pilot flour mill. Associated activities included consumer grain preference and marketing studies, milled product evaluation, and new product development in a test kitchen. The second phase completed the development, with subsequent monitoring of the pilot flour mill operations, quality control and product development testing. In addition, the setup, operation, and management of a bakery for the preparation of Nigerian-style bread containing sorghum flour is a major activity of this phase.

The Nigerian Federal Ministry of Natural Resources agreed to pay for the initial construction of the mill; the provision of the site and maintenance costs would be the responsibility of the State Ministry of Natural Resources; and the equipment plus any consultancies required would be paid by IDRC. It was further agreed that the Federal Government would provide a revolving fund of $15,000 which, along with the income received from the sale of the milled products, were expected to cover all operational expenses. After a minimum period of five years of mill operation, the mill would then be turned over to the State Ministry to be run on a continuing basis.

The State Ministry of Natural Resources was to take on the responsibility for running the entire project, with the Division of Agriculture responsible for the mechanical operation and maintenance of the mill, and the Cooperative Division (through the Cooperatives Union) responsible for the commercial aspects of the operation such as the purchase of grains and the marketing of the finished products.

It was proposed that the Cooperatives Union would pay to the Government a fee for the milling of the grains and the packaging of the finished products. This milling fee would be determined for each kind of grain during the running-in trials of the mill. However, it

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was decided at the end of the first phase that the Cooperative Division would only supply grain to the mill with the mill management being responsible for marketing the processed grain itself. This was a more realistic procedure since it allowed the development and testing of a marketing and pricing system for the mill.

1.3 Objectives

The objectives were not specifically defined in Phase I, but the problems associated with an inadequate milling system in the semi-arid tropics were well understood. The general objective was to look for ways and means to improve the rural milling system in the North Eastern State through the development of a suitable mill and ancillary equipment producing basic and composite flour for the local market. Since the proposed milling process could mill both cereal grains and grain legumes, leaving a high protein layer with the endosperm, a distinct possibility existed for the production of inexpensive high-protein foods and new simple rural technologies which could eventually be demonstrated and repeated across the entire sub-Sahara zone of Africa and through certain parts of Southeast Asia.

In August 1974, a Phase II of this project was implemented with the following objectives:

a) to investigate the traditional post-harvest grain system in the Northeast region;

b) to develop a suitable system for milling Nigerian grains to produce basic and composite flours for local markets;

c) to adopt and develop methods and technologies for the production of bread, noodles and infant foods to increase the protein content of foodstuffs; and

d) to conduct economic analyses of grain processing and consumer preference studies for new products generated by the project.

2. PROJECT PERFORMANCE

2.1 Personnel and Resource Use

In addition to the resource inputs listed in Section 1.2 above, IDRC granted a $15,000 supplement near the end of Phase I. This was to allow for major modifications to the milling system for the removal of stones and other foreign objects, and to pay for shipment of grains to the University of Saskatchewan, where IDRC subsequently developed a supporting project to this project.

The project personnel have been recruited from the State Ministry of Natural Resources, and at the time of their being

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seconded they had very little experience in the running of test trials or managing commercial operations. The Nigerian input consisted of a manager, accountant, mechanic, casual staff and test kitchen personnel (two home agents). IDRC provided three CUSO advisors, a number of other consultants and a relatively high level of IDRC Program Officers' input as a result of the lack of qualified Nigerian personnel.

2.2 The Research Program

It had been orginally hoped to develop a mill producing a throughput of 3 to 5 tons of finished products per 9-hour working day. Very shortly after the original dehuller was installed, it became apparent that the actual production potential was only one-tenth this desired rate, far too low to warrant this type of investment. Moreover, the mill would only process millet, sorghum and maize, and not cowpeas, the most common legume in Northern Nigeria.

To solve this problem, the Prairies Regional Laboratory (PRL) in Saskatoon modified an existing thresher which appeared to have ten times the capacity of the original dehuller. In a series of tests conducted in Maiduguri, the capacity of the various components was determined, and it was found that no combination of existing equipment produced a sufficiently high percentage of fine flour which a Consumer Preference Study (1973) indicated was required. A series of grinding trials were conducted comparing the percentage of fine flour produced by a hammer and plate grinder. It was found that the hammer mill gave the highest percentage but that it tended to clog. The problem was solved by PRL identifying an existing model hammer mill which produced the quality of fine flour required.

In Phase II, following this success with the mill, a bakery was constructed and installed, producing bread at a higher rate than expected though the percentage of sorghum incorporated into the bread is not as high as originally planned.

2.3 Technical Achievements

The first objective of investigating the traditional post-harvest grain system in the Northeast region led to an economist's survey in April 1972, on food grains production, marketing and consumption. It was this survey that produced the earlier estimate of only 10 to 15 per cent of grains entering the commercial market channels. The survey also showed that most of the grain moved from the orginal market place to secondary and terminal markets for further sale.

The second objective of developing a suitable milling system for Nigerian grains to produce basic and composite flours for local markets has been achieved although this required an additional year in a second phase. During the first nine months of 1975, the average number of kilograms of grain processed per milling day increased

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from 606 kilograms to 944 kilograms (an increase of 56 per cent). By the end of the first nine months of 1976, the average daily weight of grains milled per milling day was 1800 kilograms (an increase of 90 per cent in one year).

The average composition of the milled product is 34 per cent flour, 46 per cent grits and 20 per cent middlings, with an average milled extraction rate of 75 per cent of grain used. Sorghum and maize are being packaged in 2-kilogram plastic bags which are heat sealed. Bran (dussa) is also sold in sacks of 68 kilograms.

Results obtained from the pilot mill during the first nine months of 1976 showed an average production of 1.43 tons per 8 hour milling day (the actual machines run separately for 6 hours per day) and a profit of £ N1.76 per 100 kilograms whole grain, giving a return of 8.62 per cent (see Appendix A).

The significance of the new technology examined in Maiduguri lies in the dry nature of the entire processing cycle, particularly in the decortication stage. This dry process has been able to extend the product shelf life to a minimum of two weeks, from the one to three days maintained by the traditional manual method of wet milling. The problem with the traditional method is that the wet-milled product becomes moldy very quickly. Water added to the grain during the process results in fermentation taking place - the higher the moisture content of flour, the quicker the fermentation.

The present system of manual decortication leads to exceptional losses with only a 65 per cent recovery rate of usable grain. The pilot mill can achieve a recovery rate of up to 80 per cent. With sorghum production estimated at 800,000 tons in North Eastern State the improved mill could result in an increase of usable sorghum grain of 60,000 tons per year assuming half of the sorghum grain is milled in the new milling system.

The third objective of adopting and developing methods and technologies for the production of bread, noodles and infant foods to increase the protein content of foodstuffs has only been partially met.

The bakery originally designed to produce 500 loaves of bread per day is operating at full capacity and producing 700 small loaves or 400 large ones. The population has readily accepted the bread which is produced with a sorghum flour component varying from 5 to 20 per cent. The percentage of sorghum incorporated into the bread is not as high as originally planned due to the additional labour required to develop the sorghum dough.

The bread appears to sell well, but it is difficult to tell whether it is due to consumer preference for the taste of sorghum or because, at present, the private bakeries must often buy their flour on the black market (unlike the government mill) and produce a loaf

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below the government stipulated minimum weights.

A test kitchen was established at the mill with a Nigerian home economist in charge. The work program of the test kitchen involved: milled-product quality control; traditional food-product recipes; development, testing and consumer acceptance of recipes; and demonstration to home agents.

IDRC supported a parallel project for two years at the College of Home Economics at the University of Saskatchewan. The physical and chemical properties of the flours were analysed to determine how the properties affected the preparation and quality of traditional foods. The development of new high-protein products containing sorghum, millet and cowpea flours also received attention. A technique for preparing fried snacks containing various blends of these flours was established. Nutritional evaluation of the product blends confirmed their high-protein composition (approximately 15 per cent). Another important research area was the preparation of Nigerian-style homemade noodles (taliya) with a partial replacement (up to 50 per cent) of wheat flour by various blends of sorghum, millet and cowpea flours. These noodles resembled regular all-wheat noodles with respect to cooking quality and texture, and contained between 12 to 16 per cent protein (14 per cent moisture basis). The techniques developed in this project have been tested and demonstrated through the Maiduguri test kitchen to small processors, including housewives, and have resulted in several modifications to the University of Saskatchewan recommendations.

The fourth objective of conducting economic analyses of grain processing and consumer preference studies for new products generated by the project has also been met. The project has kept careful records on the profitability of the mill, and a major study will be carried out through the National Grains Production Company (NGPC) to determine where and how new mills could be beneficially introduced in Northern Nigeria.

The baseline Consumer Preference Study which was undertaken in 1973 covered 1,100 urban households. This was the first time such a study had been carried out on such a large scale in Northern Nigeria. The study revealed an increase in the use of packaged flours for preparing traditional staple cereal foods and a shift to processed foods. The potential for developing nutritious foods from cereal and legume flours was evident. The survey also indicated that nontraditional foods derived from prepared flours are gaining popularity as part of the Nigerian food pattern with bread becoming a popular breakfast food. At the time of the survey, 64 per cent of the households were purchasing bread, more than half of which was being purchased daily.

The results of this study have been used by FAO and other agencies such as the Group for Assistance of Stored Grains in Africa (GASGA) who are also active in this field in Africa.

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2.4 Institutional and Human Development

IDRC realized during the initial negotiations on this project, that the Nigerian State Ministry of Natural Resources had no research capability, nor were they likely to undertake any major research programs on integrated post-production systems such as an appropriate grain mill design. Therefore, it was anticipated that IDRC would have to provide substantial technical support through the use of consultants. Failure by the University of Ife and the Food Research Institute in Lagos to maintain their initial interest in the project presented a disadvantage in that it greatly increased the amount of support and guidance required by IDRC. In Phase I, IDRC had to hire outside consultants in the form of engineers, economists and one cereal technologist. Again in Phase II, engineers were required for the installation of new equipment and an economist's services were required along with those of a home economist.

The personnel development program was limited to technical training in specific operational activities. Three people have been trained outside of Nigeria: a mill mechanic, one accountant and one home economist.

The turnover of mill managers has been a continuing problem. There have been five to date making an effective training program difficult. The mill managers have been selected from regular Ministry of Agriculture staff, and the present Permanent Secretary and Chief Agricultural Officer have freely admitted that those people generally have no commercial experience and are not capable of managing a mill without outside support.

While the project has not contributed greatly to improving the research and top management capabilities of Northern Nigerians, IDRC project officers feel that the permanent mill and bakery staff have developed considerable experience in operating the technical equipment available. It should also be added that a mill management system with management records, purchasing policy, and other elements have been developed which should allow the Cooperatives' personnel who are experienced in commercial operations to take over and run the operation without having to develop a management and accounting system for the mill.

2.5 Management and Coordination

It was originally planned that a Mill Management Committee would be established with representatives from both the State Divisions of Agriculture and Cooperatives. While a Management Advisory Committee was established, it functioned as an advisory board only, making recommendations to the Permanent Secretary of Agriculture. This resulted in a lack of flexibility in mill policy and operating procedures. One example has been the mill's pricing policy. Selling prices were determined by the Advisory Committee in mid 1977, but market prices for grains and flours have risen

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dramatically since then, due apparently in part to farmers withholding grain from the market. This has significantly reduced the margin between input and output prices for the mill with the wholesalers able to increase their makeup from 8 cents per kilogram to nearly 50 cents.

2.6 Administrative Problems

IDRC staff believe that one of the most serious problems encountered in this project was the continuing lack of Nigerian Government support in terms of providing qualified technical and managerial staff. One of the reasons for this was that the Federal Ministry of Natural Resources which developed the project decided to place the project in Maiduguri with the State Ministry of Natural Resources responsible for providing management, staff and other support to the project. The State Ministry of Natural Resources was not very large and did not have any capable staff. The ability of the State Ministry to provide adequate support to this project was also seriously affected by a number of administrative changes, particularly the transfer of the Cooperative Division out of the Ministry of Natural Resources into its own Ministry. IDRC staff encouraged the Government to transfer the pilot mill to the Cooperative Ministry since Cooperatives had more expertise in running commercial enterprises, but it was decided to leave the mill project with the Division of Agriculture in the Ministry of Natural Resources. IDRC staff felt that the Cooperative Ministry would be able to provide better management to the mill as they operated a number of commercial operations, including large-scale purchasing and sales of grain and a number of consumer cooperative retail stores throughout the State.

In operational terms, the major problem was a lack of close mill supervision after the CUSO advisor left in early 1976. This occasionally resulted in a severe shortage of spare parts with nobody below the level of Permanent Secretary able to accept any responsibility for the mill. This, coupled with the fact that the management wished to have a consistent supply of flour being packaged even during the experimental trials, led to several operational problems in running the trials.

IDRC's financial contribution has been predominantly (70 per cent) Centre administered. The remaining 30 per cent which has been recipient administered has been used for operating costs and minor equipment purchases. IDRC administered a large proportion of its contribution since there were few experienced personnel in either the Government or private sector at the time who could act as a purchasing agent on behalf of the project. It was also due to the nature of the project itself which used milling equipment available in Canada. The earliest and simplest procedure was to have IDRC purchase it in Canada and ship it to Nigeria.

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3. NATIONAL LINKAGES AND DELIVERY SYSTEM

The University of Ife, the Food Research Institute in Lagos, and the Industrial Research and Development Unit of the Nigerian Ministry of Industry had all expressed some interest in undertaking supporting research for this project by using the products of the mill together with starch and flour from cassava and other root crops to make a variety of cereal products. None of these institutions could be encouraged to develop adequate proposals. The Industrial Research and Development Unit was primarily interested in wheat milling and not sorghum and millet, the primary cereal crops of Nigeria. However, Ahmadu Bello University (ABU) and the University of Ibadan both provided some support for this project. ABU was very interested and a number of staff visited the project and provided advice on storage, sanitation and development of the test kitchen to test the acceptability of different mill products. A project to examine the utilization of cowpea flour at the University of Ibadan was subsequently developed.

The Nigerian Federal Government indicated, during the initital development of this project, that as soon as an improved cereal and legumes milling system could be developed they would provide the resources to ensure its widespread utilization throughout Northern Nigeria. However, the Government had no firm policy at that time of how these mills would be developed and whether the private sector, co-ops, or a government agency would be the primary agent for operating these mills. In 1975 the Federal Government established the National Grains Production Company (NGPC), a quasi-government corporation, with a mandate to develop programs on grain production, storage and processing. As a first priority, the NGPC concentrated on the development of storage facilities. With the subsequent creation of a National Grains Board responsible for normal market operations and eventually price stabilization, the NGPC has concentrated on the development of a strategic storage system. The NGPC has now developed its storage program (82,000 tons stored in nine states with an eventual objective of 250,000 tons kept as strategic capacity) and is planning to begin development of commercial production and processing operations.

The NGPC requested IDRC to provide consultants familiar with the Maiduguri project to undertake a major feasibility study on the establishment of commercial mills throughout Northern Nigeria based on the Maiduguri system. The NGPC has committed 42,000 Naira (U.S. $63,000) to cover all Nigerian costs. (NGPC was originally under the impression that IDRC was a commercial consulting firm which NGPC could contract to undertake this study.) This study is a logical follow-up to the work undertaken at Maiduguri since the operational efficiency of the milling system has been clearly established. This study, which is expected to be completed in the fall of 1978, will examine the effect of introducing the Maiduguri mill system on the present production, marketing and processing system, as well as

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undertaking a detailed study on the commercial feasibility of these new mills in different locations with recommendations on the size, equipment and management required for each mill. The study will not be restricted to recommendations only for NGPC's use since the NGPC has indicated it is prepared to cooperate with, or promote, these mills in the private sector or with the Co-ops. NGPC's capability to establish and operate a number of such mills appears to be limited at present and it is expected that the study will recommend a carefully phased expansion of these mills to allow the development of management and operational expertise.

Recently, the Home Economics Division of the State Ministry of Local Government has been actively involved in disseminating some of the tested recipes to the surrounding communities, in developing educational material, and in writing articles for the local magazine. The Home Economics Division is also now engaged in the preparation of a booklet to be used by extension people and in the schools. Most secondary schools in Maiduguri have visited the mill, the bakery and the test kitchen.

4. THE BENEFICIARY

This project was developed on the assumption that an improved milling system could have important benefits both for the consumer in terms of a more assured supply of sanitary, convenient and processed grain products, and for the producer in terms of an increase in effective demand for his cereal and legume crops. The existing mills in the region can only grind and not dehull grain and are regarded as inefficient and unsanitary, and probably unable to handle increasing grain production in the North. The limited information available indicated that while up to 90 per cent of the grain produced in the region was still processed completely in the household, there was an increasing market for mill products in the urban and semi-urban areas due to the rapidly changing social and economic structure in Northern Nigeria.

The main advantage of the new mill is the addition of a mechanically dry decorticated grain. Other advantages are: reducing the real losses from cereal processing; increasing consumer choice and responding more effectively to the changing conditions in traditional consumer markets; and opening new markets for domestic cereal and legume crops. These factors have largely been confirmed by the various studies undertaken during the project.

a) The increased shelf life of mill products, due to dry mechanical decortication, provides an opportunity for cooperatives or other organizations to enter the market since they are unable to handle and distribute the present product with its short shelf life. The entry of co-operatives and other commercial organizations into the distribution system may help to reduce the present monopoly

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situation in processing that exists in many towns in the North and to reduce price fluctuations caused by hoarding and other factors. The first study under this project carried out by a Canadian consultant in 1972 indicated that speculators are active at each step of the post-producing system with resulting instability in prices over the crop year and between markets at the same point in time. Thus, crop prices for the Maiduguri market increased fivefold in 1971, while price differentials between four market centres in the area showed a difference of 30 to 40 per cent at the same point in time.

b) The pilot mill provides a better response than the existing system to the changing market requirements of consumers in the urban population in the region. The Consumer Preference Study, carried out in 1973 as part of the project, showed that the compound household style, with large families and a number of wives able to share the labourious daily job of grain processing, is disappearing and being replaced by single family units. The study indicated that 30 per cent of the urban population now live in rented rooms which are inconvenient for grain processing and grain storage. More women are being employed outside the home and an increasing number of children are going to school, making them less available for household work. At the same time, 40 per cent of the children performed the task of carrying manually dehulled grain to an existing mill for grinding.

Thus, the practice of pounding grain to prepare flour in each household is disappearing and more households are having their grain dehulled as well as ground outside the home. This trend to increased commercialization of grain processing is matched by an increased use of convenience food products and the purchase of packaged flour.

c) The establishment of these mills in Northern Nigeria should increase the utilization of cereal and legume crops produced in the North. The only commercially milled and packaged flour available in the region is wheat or maize flour milled either in Lagos or Kano. The Consumer Preference Study indicated that 50 per cent of the Maiduguri households purchased this kind of packaged flour at least once a month. It is expected that this market will grow rapidly. There is an increase in movement of people from different regions of Nigeria into the cities with food preferences for products not readily available and an increase in high-income consumers who wish to purchase only commercially milled products.

One of the adverse effects of this new milling system could be a reduction in employment opportunities for women processing grain in the home for sale, particularly the dehulling operation since the Consumer Preference Study indicates that the existing grinding mills have already taken over much of the flour milling in Maiduguri. It appears that this improved mill can produce flour and other products as cheaply as the existing system of home dehulling and grinding in the small mills. However, it is expected that these new mills will compete, at least in the initial stages, most directly with the similar products produced by the large automated mills in

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Lagos and Kano which are primarily using imported wheat. There is even some direct importation of wheat flour into Nigeria. The planned NGPC study will provide a better data base on which to assess the markets and competitive impact of the Maiduguri milling system.

5. REGIONAL LINKAGES

The experience gained in this project and the equipment developed have formed the basis for two other projects: one in Senegal and another in Botswana. These are attempting to develop milling systems appropriate to the specific individual requirements of these areas.

While the mill has been able to readily produce a cowpea flour, the Consumer Preference Study indicated that housewives prefer a wet-milled flour. This information led to the development of a cowpea utilization network involving the University of Ibadan, the Food Research Institute in Ghana, the Maiduguri Mill and the University of Saskatchewan Home Economics Department which is analysing cowpeas processed at the mill to examine the differences between dry-milled flour, as produced in the mill, and wet-milled flour as traditionally produced by the housewife. The purpose is to determine the possibilities of substituting the mechanical dry-milled flour for the manual wet-milled type.

6. IDRC'S ROLE AND INVOLVEMENT

As originally conceived, IDRC's role was to oversee machinery installation and provide on-site advisory services on machinery operation, milling system trials and general mill management with consulting experts advising on specific project functions as the need arose. An effort was made from the start to keep a low profile on this advisory function and have the mill managed and run by local staff. Due to the problems experienced by the State Division of Agriculture in providing experienced management personnel, IDRC has had an active role in providing support staff and outside consultants and in administering project funds.

As Nigerian involvement was limited, the Nigerians tended to conceive of the mill as somewhat of a "turnkey" operation, with IDRC responsible for implementation and direction of the project. It was difficult to correct this misconception of IDRC's role because of the frequent change in Ministry structure and senior Ministry personnel. The only real concern expressed by the Nigerians was the lack of spare parts which had occasionally led to the shutdown of mill operations. The lack of efficient spare parts maintenance and purchase system that can be operated by mill staff is still a problem, requiring continued IDRC support.

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While IDRC's staff input appears to be quite heavy, much of it was directed, in whole or part, towards ancillary research.

7. BROADER DEVELOPMENT IMPLICATIONS

The development of this efficient milling system at Maiduguri could have a substantial impact on the economy of Northern Nigeria through reducing post harvest losses, imports and increasing consumer choice, although most of the grain being produced in this region will continue to be processed in the household for some time. The results achieved with the more recent projects in Botswana and Senegal, based on the experience derived from this project and the similarity of crops, processing systems and economic conditions elsewhere in Africa, indicate that this milling system could have a wide regional application. IDRC staff are exploring CIDA's interest in helping to finance the development of a number of these mills in other African countries.

An equally important result of this project was that it served as a model for the development of an integrated approach to a post-production systems program in Africa, providing a practical example of how research on such components as consumer preferences and market research, processing and new product development, can be effectively linked.

The use of this project as a model justified the extensive management input that was required by IDRC staff. IDRC staff have been unable to identify many research institutions which are sufficiently broad based to be able to carry out an integrated systems approach to post-production research or which have the interest or resources to maintain a research program from the initial research through to correcting all the operational problems of a pilot unit tested under typical market conditions.

APPENDIX A

Cost and Returns from Own Operation*

	Total Mill ₤N	Per 100 kg Whole Grain ₤N
Sales		
Flour	18,420.00	
Grits	23,988.90	
Middlings	9,454.50	
Dusa	3,491.16	
Total Value of Production (A)	65,354.56	22.38
Whole Grain Costs		
Sorghum	21,600.00	
Maize	21,027.00	
Total Cost of Grains (B)	42,627.00	14.60
Gross Margin (A-B) = (C)	22,727.56	7.78
Mill Operation Costs		
- Variables -		
Milling labour wages	4,183.18	1.43
Fuel, Oil and Grease	642.60	0.22
Packaging Supplies	2,840.37	0.97
Total Variable Costs (D)	7,666.15	2.62
Margin above Variable Costs (C-D)	15,061.41	5.15
- Overhead Costs -		
Mill Management Salaries	7,556.30	2.58
Guardian Wages	1,272.75	0.43
Depreciation	1,125.00	0.38
Total Overhead (E)	9,954.05	3.40
Total Mill Expenses (D+E) = (F)	17,670.20	6.02
Margin above Total Costs (C-F)	5,107.36	1.76
Profit %		8.62%

* Depreciation charges are excessive by approximately 30 per cent, given the presence of equipment not required in the operation of a commercial mill. Furthermore, both capital and labour charges are higher than need be in comparison to a regular commercial operation.

APPENDIX B

Budget and Actual Expenditures

GRAIN MILLING (NIGERIA)

	PHASE I					PHASE II								
	YEAR 1		YEAR 2			YEAR 3			YEAR 4			CUMULATIVE		
	Budget	Actual	Budget	Actual*	% Spent*	Budget	Actual	% Spent	Budget	Actual	% Spent	Budget	Actual	% Spent
Salaries & Allowances	4,000	-	4,000	8,208	102.6	-	-	-	-	-	-	8,000	8,208	102.6
Research expenses	8,000	-	11,000	19,587	103.1	15,000	14,636	97.6	15,000	10,960	73.1	49,000	45,183	92.2
Capital expenses	23,750	-	15,000	49,961	128.9	51,000	15,242	29.9	5,000	34,044	680.1	94,750	99,247	104.7
Training	3,000	-	-	5,643	188.1	5,000	-	-	5,000	1,388	27.8	13,000	7,031	54.1
Travel	1,500	-	2,010	886	25.3	-	141	-	-	-	-	3,500	1,027	29.3
Publications	-	-	5,000	1,208	24.2	4,000	-	-	4,000	-	-	13,000	1,208	9.3
Consultancy	16,000	-	11,000	51,553	190.9	20,000	9,827	49.1	20,000	20,058	100.3	67,000	81,438	121.5
Contingency Recipient	2,000	-	2,000	1,121	28.0	-	70	-	-	10	-	4,000	1,201	30.0
TOTAL	58,250	-	50,000	138,167	127.6	95,000	39,916	42.0	49,000	66,460	135.6	252,250	244,543	96.9

* Both Years

APPENDIX C

GRAPH 1: GRAIN MILLING (NIGERIA)