PN-ABH-397

70510

THE AGRICULTURAL RESEARCH IMPACT INDICATORS MATRIX

(ARIIM)

USER's GUIDE

January 1991

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PREFACE

Under the Development Fund for Africa (DFA) we have recognized the need for improving our information on final, household level impact of development programs. Such impact information will be integral not only to improving our progress on existing projects and programs but in assessing our progress on overall DFA goals and strategic objectives.

Agricultural research is integral to improvements in technology development and transfer which are necessary for achieving sustainable economic growth in Africa. Considering the importance of this sub-sector, the Africa Bureau Office of Technical Resources (AFR/TR) has commissioned and worked with Management Systems International (MSI) to pre-test and produce an impact assessment tool specifically designed for agricultural research programs and projects.

The Agricultural Research Impact Indicators Matrix User's Guide describes a method for both monitoring and assessing impact at any stage in a project or program. This is a departure from the concept of sending in teams once every five or so years to conduct an impact assessment. The approach described in this guide requires us to re-orient our thinking and data gathering to be more constantly aware of the problems and possibilities for our support to agricultural research.

At the same time, an outside evaluation team could use this approach as a guide to impact assessment. We suggest you consider this approach as an adjunct to traditional cost-benefit analysis rather than a replacement; and as a more practical set of information gathering tools for the decision maker and project manager.

As with all of our endeavors in AFR/TR, we appreciate any feedback or information on utilization of this document which you may care to send to our Agriculture and Natural Resource Division.

Richard Cobb
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ACKNOWLEDGEMENTS

Many people contributed to the development of the Agricultural Research Impact Indicators Matrix (ARIIM). A considerable amount of theoretical and bibliographic background work was done by Dr. Lawrence Busch and Alice Morton of MSI. The original framework, then called the Intermediate Impact Indicators Matrix, was developed at a TPM attended by Mr. Thomas Hobgood, Dr. George Gardner and Dr. Patricia O'Brien-Place of A.I.D, Alice Morton, Larry Cooley, Charles Whyte and Diana McLean of MSI. The framework format had been used for other purposes by Ms. McLean at CIDA, but the content was developed during and following the TPM. The Kenya case study team, (Morton, Gardner and McLean), tested the framework in Kenya. The Cameroon team, which made suggestions for revisions, was lead by Dr. Busch, and also included Dr. Tim Schilling (MSI) and Dr. Paul Anamosa, a AAAS Fellow at A.I.D. The Malawi team, which made further suggestions for changes in the framework, was headed by Dr. Charles Whyte, and included Mr. Richard Newberg of A.I.D., Dr. John Yohe and Dr. Morton from MSI.

The ARIIM User's Guide exercise was carried out by a fourth team. Continuity was provided by Alice Morton and Larry Cooley. Dr. Samuel Taddesse of MSI took over coordination of the effort during Dr. Morton's absence, and did most of the work on data issues, scoring, and updated case studies. He also coordinated preparation of the final report. The other members of the ARIIM team, Dr. Peter Oram and Dr. Edward Rice, worked very hard to refine the matrix and provide discussion sections and user guidance for each level of analysis. Dr. Morton was the overall task manager at MSI for both efforts.

All of us wish to acknowledge the continuing support of Tom Hobgood, Chief of A.I.D.'s Policy Analysis Branch, Agriculture and Natural Resources Office, Technical Resources Division in the Africa Bureau, and that of Cindy Clapp-Wincek and others in the Africa Bureau's Office of Development Planning.

We wish most to thank the staffs of the A.I.D. Missions in Kenya, Cameroon and Malawi, project staff in those countries, and the members of the respective country NARS who patiently worked with us to test and improve the Matrix, provided us with a vast array of information, took us on field trips, and explained their research problems and aspirations. We hope that the results will help them to plan and track their performance in addressing those problems and achieving those aspirations.

ACRONYMS

ADO -	Agricultural Development Officer
AEZ -	Agro-ecological Zone
AFR -	Africa Bureau
ANR -	Office of Agriculture and Natural Resources
ARIIM -	Agricultural Research Impact Indicators Matrix
A.I.D. -	Agency for International Development
CGIARC -	Consultative Groups of International Agricultural Research Centers
CIAT -	International Center for Tropical Agriculture
CIMMYT -	International Centre for the Improvement of Maize and Wheat
DFA -	Development Fund for Africa
DPRA -	Development, Planning and Research Associates
FAO -	United Nations Food & Agricultural Organization
GDP -	Gross Domestic Product
IARCs -	International Agricultural Research Centers
ICAR -	International Centre for Agricultural Research
ICEPE -	International Centre of Insect Physiology and Ecology
ICRAF -	International Centre for Research in Agro-forestary
ICRISAT -	International Crops Research Institute for the Semi-Arid Tropics
IFAD -	International Food & Agriculture Development
IFPRI -	International Food Policy Research Institute
IITA -	International Institute of Tropical Agriculture
IPM -	Integrated Pest Management
IRRI -	International Rice Research Institute
IRA -	Institute of Agronmic Research
ISNAR -	International Services for National Agricultural Research
KARI -	Kenya Agricultural Research Institute
MERS -	Monitoring, Evaluation & Reporting Systems
MOA -	Ministry of Agriculture

MSI -	Management System International
MSU -	Michigan State University
M&E -	Monitoring & Evaluation
NARS -	National Agricultural Research System
NCRE -	National Cereal Research & Extension
NES -	National Extension Services
NRM -	Natural Resource Management
OFCOR -	On-farm Client Oriented Research
OFGSP -	On-Farm Grain Storage Project
PA -	Office of Policy Analysis
PEM -	Planning, Evaluation & Monitoring
PP -	Project Paper
RMFIT -	Research-Managed Farmer-Implemented Trials
ROR -	Rate of Return
SAARFA -	Strengthening African Agricultural Research & Faculties of Agriculture
TA -	Technical Assistance
TLU -	Testing and Liaison Units
TPM -	Team Planning Meeting
TR -	Office of Technical Resources
T&V -	Training & Visits
UNDP -	United Nations Development Program

EXECUTIVE SUMMARY

The Agricultural Research Impact Indicators Matrix

User's Guide

The Agency for International Development's Africa Bureau (A.I.D./AFR) is developing indicators to measure performance in all sectors under the Development Fund for Africa (DFA). One key sub-sector which requires such indicators is agricultural research. To meet this need, AFR/TR/ANR contracted with Management Systems International (MSI) to develop a methodology to examine research programs in African countries, to apply that methodology to discrete cases to generate scenarios of impact, and to develop recommended intermediate impact indicators to determine whether and when impact could have been predicted.

The result is a data gathering and analysis tool presented in the form of a matrix. It generates indicators and associated measures which can be applied by A.I.D field staff. This guide is prepared to aid these field staff in applying the agricultural research impact indicators matrix (ARIIM) to measure the extent and magnitude of impact which is associated with the Agency's agricultural research and extension interventions.

The ARIIM matrix presented here is a refinement of the earlier Intermediate Impact Indicator Matrix (IIIM) developed by MSI. The original matrix has gone through several revisions. One improvement is that all the questions are recast in a normative form so that scores can be developed. Second, the indicators under each level are more explicitly stated and, where appropriate, data tabulation and analysis tables are provided. Thirdly, issues, questions and indicators that are important to know about--but are not directly related to the assessment of impact--are eliminated. This, together with some further effort at analytic coherence, has shortened the matrix, substantially.

As in the original matrix, the agricultural research issues, questions and indicators are organized into four levels. **Level I: Institutional Base** - analyzes the institutional capacity and capabilities of National Agricultural Research Systems (NARS). **Level II: Technology Generation and Transfer** - assesses the number and the quality of technology generated and transferred to farmers and other technology users. **Level III: Intermediate Impact** - measures the rate and extent of adoption of the technology generated by the NARS. And **Level IV: Long-Term Impact** - examines the impact of agricultural research efforts on farm productivity, farm income and employment, food security and health status over an extended period of time.

This guide explains how the ARIIM is used to assess impact at all levels and in particular how Level III impacts can be interpolated or extrapolated to measure long-term impact, depending on whether an **ex ante** or **ex post** approach is taken. The guide explains the data required and the scoring scheme to be used. A detailed discussion of the linkages between and within levels, as well as an explanation of the rationale for issues, questions and indicators, is given. The analysis to be undertaken at Levels I and II is particularly useful in program design.

The Agricultural Research Impact Indicators Matrix

Background

A.I.D's Africa Bureau is developing benchmarks and indicators to measure performance in all sectors under the Development Fund for Africa (DFA). One key sub-sector which requires such indicators is agricultural research. Due to the long duration of most research programs, there is a special need for intermediate impact indicators by which A.I.D. can assess whether continued or additional funding will generate impact over the medium to long term. To meet this need, the Bureau's Office of Technical Resources, Agriculture and Natural Resources Division (AFR/TR/ANR) contracted with Management Systems International (MSI) to develop a methodology to examine research programs in three African countries, to apply that methodology to discrete cases to generate scenarios of impact, and to develop recommended intermediate indicators to determine whether and when impact could have been predicted.

In this report, we presented the resulting set of intermediate impact indicators for agricultural research. The indicators are organized in a matrix which can be used as a data gathering and analysis tool. Next, we discuss the methodology for applying the matrix to research programs and projects.

In the report, we discussed the need the methodology is designed to satisfy, how the methodology was developed, what the matrix contains, key assumptions on which it is based, and the predictive ability of the indicators. We concluded with a discussion of unresolved issues and suggested next steps.

The Problem

Africa Bureau management must be able to show to the Congress that activities funded under the Development Fund for Africa (DFA) are having an impact. Due to the timing of the DFA reporting requirements, the Agency needs to be able to predict medium- and long-term impact in the short term, by applying intermediate indicators.

For some sectors, and very focused interventions, this is relatively simple. In health, for example, there is general agreement that immunization rates and child mortality rates are closely correlated, and that increasing one will decrease the other. At a more complex level, as in population programs, there is general agreement that there is a high correlation between the education of women and contraceptive prevalence, and between increased contraceptive prevalence and decreased fertility. In this example an increased contraceptive prevalence rate is an intermediate indicator of reduced fertility. For agricultural research--as indeed for most kinds of research--the correlation between inputs in the form of trained researchers, operating funds, and genetic materials on the one hand, and increased food production, productivity and security on the other, is not self-evident. Agricultural research as a process attempts to solve a set of interrelated problems and to improve a series of situations which are also likely to be interrelated. Thus, though we speak of agricultural research programs as though they are continuous and uni-directional, they are actually among the most complex interventions funded by A.I.D.

Further, generating technologies and making them available to a target group by some transfer mechanism does not guarantee adoption or the resulting impact that researchers, research managers and donors seek. Once technologies are effectively transferred, and adopted correctly, then the correlation with impact is easier to establish. An example is that using fertilizer in the appropriate amounts and at the right time will increase yields given that there are no countervailing circumstances, such as a drought. Still, increased food security at the household level--the desired impact--is achieved through a series of intervening steps such as increased production, productivity or income. These would be intermediate indicators of impact.

Like other kinds of research, agricultural research often requires considerable up-front investment in capacity building and basic research before any results are achieved. Since it may be a long time before results are available, predicting whether they will be adopted in the medium term is a risky business.

One of the ways in which agricultural research differs from other research is that both the process of doing it, and the results generated by it, are more closely related to the completely exogenous and largely uncontrollable factors of ecology and climate. Agricultural research results (technologies) can be transported, but usually they must be adapted to the local physical and social environment before they are ready for adoption by farmers. This means that capacity building has to take place at more locations--even within the same country--than would be the case for other types of research, and networking among spatially remote research systems or centers may be very important. It also may mean that the elapsed time between initial problem definition, basic research, applied or adaptive research, adoption and impact may legitimately be quite long.

Nevertheless, A.I.D. needs the ability to predict and assess the impact of research funding with some degree of assurance. Some common methodologies have been used over time to assess returns to investment in agricultural research. However, these have more often been used to measure returns achieved after the research program is over than to predict returns. Chief among these are benefit-cost analysis and Rate of Return (ROR) analysis. These have been relatively reliable when applied in Asia and in Latin America. However, they have been applied less often in Africa, and it is not clear that they would be reliably predictive when applied to African cases. Michigan State University (MSU) has been asked to assess their appropriateness for Africa.

Unless or until benefit-cost analysis and ROR analysis are shown to be good methods for predicting the impact of agricultural research in Africa during implementation, there is still a need for some other sort of intermediate impact indicators. This is why MSI was asked to develop an alternative methodology at the same time that MSU is investigating the relevance of more common methods.

A.I.D. has already agreed that for programmatic purposes, intermediate indicators must ideally:

- be simple to apply by A.I.D. staff or consultants;
- require little additional data collection and analysis;

- generate results easy to report in a clear fashion to both A.I.D. managers and the Congress; and

- facilitate ex ante evaluation of final impact during implementation.

The Task

In late 1989, AFR/TR/ANR/PA asked MSI to develop a methodology to identify and apply intermediate impact indicators for agricultural research. The approach suggested was to take three national agricultural research programs--those of Kenya, Cameroon and Malawi--which were regarded as successful. Starting on this basis, and following the scope of work, MSI teams investigated specific projects and, working backward from success, tried to develop scenarios of impact. The next step was to identify indicators that might have predicted impact had they been applied at key stages of the process. The third step was to identify accessible measures for the indicators, based on a realistic assessment of data sources available in each country. Once the indicators and measures were identified, they were applied to real cases, and their reliability as proxies for impact was assessed.

The scope of work was implemented and tested by a team of six consultants from MSI, and three ANR staff. The teams were composed of at least one agronomist, one agricultural economist and a social scientist.

In order to select among alternative approaches to developing a set of intermediate impact indicators, A.I.D. and MSI had to agree on a few basic premises about:

- the salient characteristics of agricultural research;

- the relevant characteristics of the environment into which research results must fit, including differing farming systems;

- what constitutes impact; and

- how reliable the indicators must be.

At an initial Team Planning Meeting (TPM) held in October, 1989, ANR staff and the MSI team agreed that the subject matter for investigation is really the whole technology generation, transfer and utilization process in agriculture.

This is very important to an understanding of both the first and second intermediate impact indicators matrices we developed. Since the objective is to predict impact, and since agricultural research only achieves impact through adoption of its results, maintaining a dichotomy between research and extension is inappropriate. In formulating the first matrix and in applying it to field situations, therefore, we did not stop the clock when the on-station portion of the process was completed.

We also agreed to emphasize research on food crops, rather than cash crops, since the objectives to which these indicators will ultimately relate are food production, productivity and security. We use increases in income as an intermediate impact indicator, but bear in mind that it is not necessarily always a good proxy for improved nutritional status or increased household food consumption.

We start by exploring the institutional base that constitutes a threshold for research activity, then move to what is usually called research, (on- and off-station), then to extension (formal or informal, public or private), and to adoption by farmers. Finally, the intermediate indicators are checked in terms of final impact indicators applied to the post-adoption stage where this is possible and impact is observable at the regional (project area) level, if not yet at the national level.

After presenting the first Intermediate Impact Indicator Matrix (IIIM), at a workshop in April 1990, MSI was asked to do further work on the data collected during the three country case studies, and then further to refine the Matrix. In addition, it was decided then that the user's guide section should be amplified.

A fourth team, made up of two economists, two agricultural research specialists and a social scientist, carried out this task. This document presents the results of that work--an abbreviated and refined version of the IIIM--which we have called the Agricultural Research Impact Indicators Matrix (ARIIM). As will be seen in the following sections, this Matrix contains questions that are cast in a normative manner, so that scores can be developed. A second modification is that the indicators at each level of the Matrix are more explicitly stated and, where appropriate, data tabulation and analysis tables are provided, so that the user will have some guidance as to which type of data to collect, and how to summarize them. Further, a considerable number of questions that were in the original Matrix have been eliminated. These questions dealt primarily with contextual aspects of agricultural research planning and implementation, and the context in which agricultural research institutions operate and evolve. It was decided that while this information is very important for project design, and for project evaluation, it is less critical, perhaps, to assessing impact. These changes, together with some further effort at analytic coherence, have shortened the matrix substantially and we hope, made it more user-friendly.

Uses of the ARIIM Matrix

The Agricultural Research Impact Indicators Matrix is designed to be used both by A.I.D. agriculture development officers (ADOs), and their counterparts in country NARS. We hope that other donor-agencies and some of the agricultural research networks based in International Agricultural Research Centers (IARCs) may also find the ARIIM helpful. The Matrix can be useful both in the design of research institutions and programs and for assessing the performance of programs in impact terms. Table 1 outlines the basic features of the Matrix.

Table 1. Overview of the Agricultural Research Impact Indicator Matrix

LEVEL		INDICATORS(examples)
I.	Institutional Base	Country development plan includes research Long-term research plan
II.	Technology Generation & Transfer	Varieties released % of research on-farm Menu of technologies
III.	Intermediate Impact	Adoption of technology % of farmers adopting technology % of area affected Constraints to adoption - soil problems - climatic variabilities - availability of farm inputs - access to markets - adequacy of processing & storage facilities - price & tax policies
IV.	Long-term Impact	Agricultural Productivity: - Changes in yield - Stability in yield - Change in gross vale of production per farm by farm size - Change in farm investments - Change in cropping patterns & cropping intensity - Changes in farming systems - Change in land use & pressure on land Increase in Net-farm Income: - Farm income by farm size - Change in farm income per farm and by commodity Improvement in Food Security: - Per capita food production - Stability of Agricultural Production Agro-industrial Transformations: - Increases in number of rural-based small businesses Improved Health: - Increases in caloric consumption per capita

Program Design and Formulation

In some instances, the Matrix may be most useful in assessing **ex ante** (in advance), what the impact of a proposed project might be given basic knowledge of the pre-project situation. In this instance, the Matrix, particularly the analysis in Levels I & II, will help the ADO to: 1) organize existing data--including data on the institutional base available on which to build a research project or program--and 2) think through the process which needs to be put in place for impact to be likely by the end of project life. The indicators will then facilitate monitoring throughout implementation to see whether, and to what degree, impact is being achieved. Using the Matrix for assessing impact, to establish the performance or non-performance of research program at given time intervals will allow for mid-course correction during implementation.

Impact Assessment

Benefit/cost (B/C) and Rate of Return (ROR) analysis, often used to measure impact, tell you something about whether or not the funds spent on agricultural research were "better spent" than if they had been put at interest in a bank, or invested in some other program. They say nothing directly about whether the results of the funded research were adopted, by whom, and to what effect.

On the other hand, the ARIIM will assist the ADO to isolate some of the key factors or causes of performance or non-performance in impact terms, and also give him an indication of by whom and to what extent research outputs were adopted by technology users. It should be remembered, however, that a multitude of factors combine to determine success, and it is practically impossible to isolate the impact of individual factors, many of which are exogenous and random. A simplistic use of the Matrix may lead to erroneous conclusions and thus, to inappropriate decisions. The value of the Matrix for impact analysis will be enhanced greatly when reasonably correct data are established both at the project area level and the national level. Resources should be devoted to enhancing the NARS' capability to gather and maintain data deemed critical to measuring the research system's performance. Hopefully, this kind of impact assessment will then be institutionalized.

Monitoring, Evaluation and Reporting

A further use for the ARIIM is in the context of measuring and reporting impact. As Missions design program logframes and related monitoring, evaluation and reporting systems (MERS), the Matrix presents an helpful way to think through the possibility of using increased agricultural production and productivity as a strategic objective, and enhancing or increasing the responsiveness of agricultural research as a target for that objective. It also presents the kinds of indicators that would need to be included in a MER to see whether such agricultural research is achieving results--or is likely to achieve results--that will lead to impact "at the people level".

Caveats

The Agricultural Research Impact Indicators Matrix is designed to be used both for agriculture research impact studies and for the design of A.I.D. funded assistance when the impact of the intervention is to be predicted. However, it should be recognized that there are vast differences in the size, organization, expertise, and capability of both the A.I.D. Missions and the NARS in African countries who may use this Matrix. There is also a vast difference in the degree of support from the donor community. These differences will affect the use of the Matrix for impact analysis. Some of the issues/questions will have less relevance for very small, poor countries because the institutions under study may be virtually non-existent. Not all indicators may be appropriate for program logframes and APIs. Further, there is a broad range of data quality, as we observed during the three country visits and related work on measuring the impact of agriculture development projects in Africa. We have tried to address these data concerns here, as will be seen in the discussion of each level of the Matrix in the material that follows.

Here, we apply the ARIIM analysis, to the Kenya Kitali Maize Program, the Keny On-farm Grain Storage System and the Malawi Maize Commodity Program (See Annexes). Data are drawn from the field visit conducted under the first MSI IIIM study, a subsequent PPA/MER visit to Kenya, and from secondary sources. The main purpose of this synthetic application is to show the potential user what a completed matrix looks like. We picked these cases because they are among the best documented programs in Africa. Even so, some cells of the matrix are empty.

The Structure of the Matrix

AGRICULTURAL RESEARCH IMPACT INDICATORS MATRIX

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base				
A. National Level				
A.1 NARS Institutional Capacity	1.1 Is the NARS adequately coordinated or highly fragmented?	. Presence of apex management organization (i.e., Ag. Research Council) . NARS management and control centralized under few ministries or departments . Regional differences addressed within a coordinated framework . NARS enjoy reasonable autonomy	Score 1 - 5	NARS, MOA MOP, MS&T
	1.2 Does the NARS provide for adequate linkages among MOA research institutions, other relevant ministries, universities, NGOs, farmers, development projects, local agro-business, private sector research organizations?	Linkages with respect to: . Priority setting process . NARS board membership . Training . Technology & seminars in exchange . Contract or collaborative research (in & out) . NARS representation on other boards	Score 1 - 5	NARS, MOA MOP, MS&T NGOs Universities USAID
A.2 Adequacy of NARS Policy & Plan Formulation Process	2.1 Does the country have an effective organization for planning, management, or coordination of the NARS in line with national agricultural policy?	. Research programs support national ag. polices. . Research program priorities set by national planners. . NARS operating budgets reviewed and approved by national planners.	Score 1 - 5	NARS, MOA MOP. MS&T
	2.2 Are existing processes adequate for setting research priorities and for resource allocation?	Process accounts for: . The potential impact of the research thrust on the national economy and society, including the area affected, value of the commodity, changing demand, urgency of problem, constraints, distribution of benefits, political considerations, availability of external technology, extent of NARS staffing including scientists per commodity group, the probability and cost of research success.	Score 1 - 5	NARS, MOA MOP, MS&T

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ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Cont'd.)	2.3 Are the planning and policy formulation linkages between national planners and NARS effective?	Extent of NARS involvement in formulating agricultural policies: . input polices . output polices . foreign exchange polices	Score 1 - 5	NARS, MOA MOP, MS&T
	2.4 Are there adequate facilities for collecting, analyzing, and updating agricultural research related data?	Organization and procedures for: . Collecting baseline and time series data on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc. . Data analysis & reporting	Score 1 - 5	NARS, MOA MOP, NBS
A.3 NARS Financial & Human Resources Strength	3.1 Does NARS receive an adequate level of funding overtime?	. Total budget for research(i.e., salaries & wages, operating expenses plus capital expenditures) . % of actual funding to approved budget . Salaries & Wages as % of total operating budget . Stability of funding overtime and by sector . Research budget as % of Ag. GDP . Total expenditures per researcher . Research budget as % of public investment in agriculture . % of budget from external sources	Score 1 - 5	NARS, MOA, MOF/Treasury, MS&T WORLD BANK FAO USAID
	3.2 Does NARS have adequate control over donor-financed research?	Donor-financed research activities initiated, received and coordinated by: . NARS . the parent ministry . various of other ministries	Score 1 - 5	NARS, MOA MS&T, MOF/Treasury USAID
	3.3 Are adequate accounting procedures and staff in place throughout the system?	. Centralized Financial Management System . Clear and proper accounting procedures Timely reporting of financial transactions	Score 1 - 5	NARS, MOA, MS&T

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Cont'd)	3.4 Is NARS adequately staffed to perform research activities articulated in the national agricultural strategic plan?	. Size of system (number of scientists) . Quality of system (number of postgraduate to BS) . Ratio of trained technicians to scientists . Distribution of researchers by commodity and/or disciplines	Score 1 - 5	NARS, MOA MS&T WORLD BANK FAO
A.4 Effectiveness of Monitoring & Evaluation Process	4.1 Are monitoring and evaluation processes adequate?	. Active annual process . #of projects revised or canceled . Provisions for external reviews . Peer or expert review . # of projects redesigned	Score 1 - 5	NARS, MOA MS&T
A.5 Soundness of NARS External Linkages	5.1 Does the NARS have satisfactory linkages with IARCs, developed countries, international private sector research institutions (e.g., agro-business)?	Linkages with respect to: . technology exchange . training . networking . consultation	Score 1 - 5	NARS, MOA MS&T, MOE Universities
B. Institute/Program Level				
B.1 Appropriateness of the Program Planning and Management Process	1.1 Do programs have a soundly conceived research plan?	. Program plan incorporates: - farmer organizations feedback - agro-ecological, provincial, and cultural differences . Plan articulates priorities and allocates resources . Plan includes program budget with projections for salaries & wages, capital expenditures and operating expenses . Plan is properly documented	Score 1 - 5	NARS, MOA MS&T, MOP
	1.2 Is program adequately funded?	. Proportion of funding to requested budget . Expenditures directly controlled by program/station . Funds are received on a timely manner	Score 1 - 5	NARS, MOA MS&T,MOF USAID

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ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Cont'd)	1.3 Are programs adequately staffed?	. Size of program (# of scientists per programs) . Quality of program (# of postgraduates to BS) . Ratio of technicians to scientists	Score 1 - 5	NARS, MOA MS&T WORLD BANK FAO
B.2 Soundness of Institute/Program Linkages	2.1 Within programs are linkages among disciplines adequate?	. Programs designed and worked on by a multi-disciplinary team . Program results reviewed by a multi-disciplinary team . Institute and programs have both formal and informal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agro-business organizations for problem identification, program formulation and execution.	Score 1 - 5	NARS, MOA MS&T Universities
B.3 Effectiveness of Program Monitoring & Evaluation Process	3.1 Are program level monitoring and evaluation systems adequate?	. Active annual process . #of projects revised or canceled . Provisions for external reviews . Peer or expert review . # of projects redesigned	Score 1 - 5	NARS, MOA MS&T
C. Sufficiency of the Institutional Capacity of Extension Services	1.1 Is there an adequate institutional base for extension?	. Presence of APEX management (i.e. Extension Services Consul) . Extensions management & control centralized under few ministries and departments . Extensions enjoy reasonable autonomy	Score 1 - 5	NARS, MOA MS&T
	1.2 Are extension services receiving an adequate level of funding overtime?	. Total budget for extension (i.e., salaries & wages, operating expenses plus capital expenditures) . % of actual funding to approved budget . Salaries & Wages as % of total operating budget . Stability of funding overtime and by sector . Extension budget as % of Ag. GDP . Total expenditures per extension officer . Extension budget as % of public investment in agriculture . % of budget from external sources	Score 1 - 5	NARS, MOA MS&T MOF/Treasury WORLD BANK FAO USAID

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ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Cont'd)	1.3 Do extension services have adequate control over donor-financed extension programs?	Donor-financed extension activities initiated, received and coordinated by: . Extension Service . the parent Ministry . various of other ministries	Score 1 - 5	NARS, MOA MS&T MOF/Treasury WORLD BANK USAID
	1.4 Is the extension service adequately staffed?	. Total number of extension workers (i.e., extension officers) . Distribution of extension workers by gender . Farmers per extension agent	Score 1 - 5	MOA
	1.5 How suitable are the methods developed to monitor and evaluate technology transfer and adoption?	. Accuracy of adoption reports	Score 1 - 5	NARS, MOA
	1.6 How appropriate are the extension-farmer linkages?	. Frequency of visits . Demonstration plots . Number of scheduled farmer meetings with subject matter specialists	Score 1 - 5	NARS, MOA Sample Survey

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer				
A. Research System Output				
A.1 Rate of Technology Generation	1.1 Have new varieties and technologies been developed and released?	. Number of technologies generated . Number of technologies released . Number of scientific, technical and farmer level publications	Score 1 - 5	NARS, MOA
	1.2 Does the "Menu" of technological choices developed and offered to farmers accommodate different systems and situations?	. % of released varieties responding to low and high input systems . Proportion of technologies responding to specific NRM issues . Divisibility of package	Score 1 - 5	NARS, MOA
A.2 Suitability of Training Programs	2.1 Is sufficient training planned and given to collaborators and clients?	. Number trained by category (ST & LT Training) . Training aligned to goals of program . Adequate funding ear-marked for training	Score 1 - 5	NARS, MOA
B. Interaction between Research & Extension				
B.1 Effectiveness of the Collaboration between Research & Extension	1.1 Is the collaboration between research and extension effective?	. Frequency of interaction . Liaison officer . Baseline survey participation . Program-level or center-level planning meetings . Regularly scheduled field days . Publications . Regularly scheduled workshop . OFR or other trials . Tracking system exists.	Score 1 - 5	NARS, MOA
	1.2 Is there a satisfactory feedback mechanism to researchers?	. Number of programs changed based on feedback from extension.	Score 1 - 5	NARS, MOA MS&T
	1.3 Is there a suitable feedback mechanism to policy makers?	. Regularly scheduled meetings of research & extension staff with policy makers	Score 1 - 5	NARS, MOA MS&T, MOP

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact				
A. Technology Adoption & Utilization				
A.1 Level of Technology Adoption	1.1 Have new technologies been adopted by farmers?	. Number of technologies adopted - New seed varieties - Other technologies (specify) . Completeness of adoption (for each technology)	Score 1 - 5	NARS, MOA Sample Survey
	1.2 How beneficial was each technology as viewed by farmers?	. Shorter maturity . Increased yield . Improved quality . Improved Taste . Higher price . Resistance to biological stress . Better storage life etc:	Score 1 - 5	NARS Sample Survey
	1.3 How widely has each new technology been adopted?	. % of total arable area affected by the new technology . % of total crop adopting the new technology . % of total program area affected by new technology . % of farmers adopting new technology - in crop area - in program area - by farm size - by gender	Score 1 - 5	MOA NBS Sample Survey District Commissioners
A.2 Restrictiveness of the Constraints to Adoption	2.1 How severe are the major ecological factors limiting adoption?	. Soil Problems (fertility, salinity, alkalinity, impeded drainage etc.) . Climatic variability (temperature, variability and distribution of rainfall) . Slope . Pests	Score 1 - 5	NARS, MOA

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ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. **Intermediate Impact** (cont'd)	2.2 Is the availability and supply of key agricultural inputs limiting adoption?	. Sufficient supply of farm inputs . Appropriate choice of input (packaging size/quantity, toxicity, application difficulty, and storability) . Timing of input purchase . Accessibility to farmers (conditions of rural roads and availability of nearby input distribution outlets) . Availability of credit . Prices of inputs	Score 1 - 5	NARS, MOA Sample Survey Central Bank USAID
	2.3 How formidable are market constraints?	. Farm to market transportation: - average distance farm to market - proportion of transport cost to total cost . Farmgate vs market price . Required marketing channels . Nature & availability of market information . Onerous marketing standards	Score 1 - 5	MOA, MOPW NBS Sample Survey Marketing Boards
	2.4 How adequate are processing and storage facilities?	. Losses & deterioration of quality: - On-farm - Off-farm . Sufficient capacity	Score 1 - 5	MOA, NBS Sample Survey Commodity Boards Cooperatives
	2.5 How significant are the producer disincentives created by restrictive government policies?	. Price & Tax policies . Subsidies . Overvalued exchange rate	Score 1- 5	Special Studies USAID WORLD BANK
	2.6 How has the technological change influenced government policy?	. Price and/or subsidy policy . Input policy . Marketing policy . Tax policy . Exchange rate policy . Land reform . Public investment in irrigation, infrastructure, and institutional support to research & extension	Score 1 - 5	Special Studies USAID WORLD BANK

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact				
A. Impact on Agricultural Productivity	1.1 By how much has the technology increased agricultural productivity?	For relevant crops: . Change in yield . Stability of yield . Change in aggregate production . Change in gross value of production per farm by farm size	Score 1 - 5	NBS MOA WORLD BANK FAO Sample Survey
	1.2 Has the technology caused a significant increase in agricultural investment in the program area?	. Investment in farm improvement (e.g., drainage, liming, soil conservation, fencing water supply, buildings, machinery, livestock, trees, roads); . Electrification	Score 1 - 5	NBS MOA, MOPW Sample Survey
	1.3 Has the new technology affected farmers cropping intensity?	. Soil cultivation . Weed control . Planting date . Population . Irrigation . Mechanization	Score 1 - 5	Sample Survey
	1.4 Has the new technology increased expenditures on agricultural inputs?	. Fertilizer . Seed . Pesticides . Labor . Tools . Power	Score 1 - 5	NBS Sample Survey
	1.5 Has there been a technology related shift in farming systems?	. Inter-cropping . Alley cropping . Crop substitution . Introduction of livestock into system	Score 1 - 5	Sample Survey
B. Effect on the Natural Resource Base	1.1 How sustainable is the technology adopted?	Changes in: . land use . farm size . forest cover . erosion . sedimentation . desertification . salination . pollution	Score 1 - 5	Sample Survey

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact (Cont'd)				
C. Influence on Net Farm Income	1.1 Has there been an increase in net farm income?	. Change in net farm income (distribution & by commodity composition) at national aggregate level in rea l terms. . Change in net farm income per farm in real terms disaggregated by farm size, male per female household heads, by commodity	Score 1 - 5	NBS, MOA USAID WORLD BANK Sample Survey
D. Consequences on Food Security	1.1 Has agricultural research improved food security?	. Change in per capita food production by major commodities . Reduced variability in agricultural production. . Change in per capita food imports by value by major commodities . Change in food exports by value . Adequate carryover stocks of basic food stufis	Score 1 - 5	NBS, MOA WORLD BANK FAO
E. Effect on Rural Agro-Industrial Transformation	1.1 To what degree has agro-industrial transformation occurred?	. Increased rural employment . Increased number of rural-based small enterprises by regions (female vs male-owned) . Increased rural savings	Score 1 - 5	NBS, MOA WORLD BANK FAO
F. Impact on Nutritional Improvement	1.1 Has agricultural research improved health?	. Reduction in number of people in poverty . Increased caloric consumption per capita . Improved weight to age ratio in children . Increased longevity	Score 1 - 5	NBS, MOA MOH WORLD BANK FAO

Levels of Analysis and Linkages

The Matrix groups issues, questions and agricultural research impact indicators into four levels. There are linkages both within each level of the Agricultural Research Impact Indicators Matrix (ARIIM) and among levels. Some indicators in the Matrix are clearly more important than others, but a lesson of the various evaluations which have been made of the impact of research and development projects is that there are often many factors which combine to determine success, and it is their interaction as much as their individual contribution which is crucial to the outcome.

Moreover, their weights may vary with varying circumstances. For example, the constraint imposed by poor transportation and access to markets on the production and price of roots and tubers, which are bulky and perishable, is often much greater than is the case with cereals. If this cannot be overcome, the incentive to adopt technology which increases production of starchy products beyond subsistence needs is likely to be small. Similarly, as was the case in Malawi, seed companies may simply not produce bean seed since there is a very thin market, although beans are central to the diet of each household. People save their own seed, and have bred seed for a variety of characteristics without the help of researchers.

Level I: Institutional Base - At this level the over-arching objective is to assess the overall institutional capability and capacity of the National Agricultural Research System (NARS) in generating and transferring new technology to technology users. All facets of the NARS are evaluated including its management structure; human, capital and financial resources; research program monitoring, evaluation and planning processes; and linkages to technology transfer agents and users and linkages with international and other national research institutions.

Level II: Technology Generation and Transfer - questions and indicators at this level assess the rate and the quality of technology generated and transferred to farmers, seed companies and other clients. This includes extension as a transfer agent. In looking at technology generation, i.e. research output, it is essential to consider not merely the availability of new technology, but also its **appropriateness** to the needs of potential clients of the research generally--but not always--the farmers. There are many examples from Africa of research systems having produced innovations which were suited to the needs of estates or large farmers, but were either too cash-intensive (risky), or too labor-intensive to be acceptable to smallholder farmers. To understand the diverse requirements of technology users, research systems must develop mechanisms for assessing client needs and must test their products under user conditions. They must also forge strong linkages with the extension services and private sector agents such as seed and fertilizer distributors, which can normally cover a much wider spectrum of client situations than the research system. If this linkage is poor, or the extension service contacts with farmers are inadequate, the research outputs are likely to be irrelevant to meeting farmers needs or to solving farmers problems.

Level III: Intermediate Impact - measures the progress made by the NARS and technology transfer agents in disseminating the technology (for adoption) to the target clients and assesses the severity of the constraints limiting adoption of the new technology by clients.

Level IV: Long-Term Impact - examines to what extent the NARS and technology transfer agents have achieved the DFA stated objectives and the host country's objectives as articulated in its five to ten year economic development plans. Consideration is given to impact on productivity, the natural resource base, farm income, food security, and agro-industrial changes. Impact is assessed over a given time interval so that the issues of sustainability of the benefits, degradation or improvement of the environment, and food security can be addressed.

The multiplicity of linkages and their variability with ecological, institutional, social, and political circumstances make the choice of indicators for impact evaluation complex. Sometimes the impact of a soundly-managed and well coordinated research system is nullified by political or economic circumstances beyond its control. For example, there is clear evidence of low levels of adoption of new technology in several African countries which have experienced serious political unrest. Similarly, changes in exchange rate valuation or in world market prices can either depress or stimulate changes in land use and use of technology. Adoption of improved maize seed in Malawi is an example where producer price changes had a negative impact on adoption of improved seed, when linked with the lowering of fertilizer subsidies.

For these reasons, it is difficult to short-circuit the pursuit of a logical series of indicators in attempting to evaluate the effectiveness of a NARS, or the impact of new technology, whether at the national level or the program/project level. However, there has been a considerable effort over the last decade, especially since the establishment of the International Service for International Agricultural Research (ISNAR), to identify the factors which determine the effectiveness of agricultural research systems and component institutions. Consequently, it is not an insuperable task to postulate what needs to be corrected or strengthened in reviewing the performance of a research institution **ex post**, although it may not always be easy to persuade the government concerned to institute the necessary reforms. Where a new investment in research is being considered, the experience of NARS accumulated by ISNAR, FAO, the World Bank, A.I.D., and other development assistance agencies provides a sound basis for preparation of a project which has a good chance of success in terms of research productivity.

From Intervention to Impact

Analysis **ex ante** will mainly be directed to evaluating the likelihood of the system or its components being productive at various levels of output--depending on its goals and resource endowments. In some cases, the products might be intermediate (e.g., some genetic outputs from biotechnology), requiring further change and refinement to develop a stable variety and adapt it to local needs before being released to users. A successful outcome could then depend on the adequacy of the research system's arrangements for screening genetic material and for testing its finished products at the user level, as well as its links to the agencies responsible for technology transfer, diagnosis of user needs and constraints, and feedback of such vital information to the researchers.

In an **ex ante** assessment where the main issue is the likelihood of future success it may have to be decided whether to proceed with an institution-building investment or a commodity-or resource-based

research project which has the **internal** basis for success even if there are external factors which might constrain the impact of the project if they are not improved. Should a research project be rejected or postponed because a road has not been built? Or should it be rejected because current price relationships are not favorable to a given commodity? Difficult decisions may be involved, but given the long-term nature of research one assumption might be that such impediments to adoption would disappear over time.

As one passes from Level I to succeeding levels in the ARIIM matrix, the attribution of impact becomes more complex because the number of variables involved increases rapidly and their interactions are often harder to identify. A relatively simple example is sales of inputs--seed, fertilizer, pesticides, etc.. Is an increase in their sales due to some technological innovation or to the removal of constraints to their use with **existing** technology? For example, improved access due to a better distribution system, easier credit, lower input prices or higher product prices, subsidies, etc.? Or are both technological change and external factors leading to improved input availability involved?

Thus, it becomes extremely important to try and simplify the process of evaluation by identifying the crucial linkages and eliminating indicators of only marginal value to impact assessment both within and among levels in the matrix--particularly the latter. Otherwise it may be impossible to see the woods for the trees.

Apart from this crucial linkage, it is reasonable to treat evaluation of the potential of a research establishment as a relatively self-contained exercise. However, it is easier to postulate a set of indicators to guide new investment in research **ex ante,** than it is to establish the causality of impact or lack of it **ex post,** where many factors besides research are involved.

Therefore, when the ARIIM matrix is used for program design purposes, it should be of benefit in attempting to predict the ability of the NARS to produce appropriate technology. When used for this purpose, the matrix user begins at Level I and moves to subsequent levels in the order in which they are presented.

From Impact to Intervention

The ARIIM matrix contains many questions needed to evaluate the potential of the NARS systems, especially for design purposes, but which are not valid predictors of impact nor useful in impact analysis unless they are used to determine cause of failure of the system to produce technologies farmers are willing to adopt. Here, for example, the problem of adoption of dent versus flint varieties of maize in Malawi is a case in point.

The user who is conducting an **ex post** impact analysis exercise, whether of intermediate or long-term impact should determine the degree of adoption first (Levels III and IV), then determine whether the reasons for adoption/non-adoption are related to a technical strength or weakness of the technology or are caused by other factors (Level II). It will be necessary to look for institutional

weaknesses only in the case where poor or mediocre technologies were in question (Level I). In reality, with research strengthening, commodity improvement, and natural resources management (NRM) programs, the institutional base of the NARS will have been studied and the deficiencies known before project paper (PP) approval.

A more difficult problem arises when assessing the chances of a research investment being **sustainable,** since this depends both on the government's current and its future attitude to support for research, as well as on consistency in relevant donor policy. Experience shows that neither of these commitments can be regarded as a constant over the long term. Thus, the linkages between the research system and its financial backers have to be assessed, whether the objective is to analyze the reasons for its success or failure **ex post,** or to try to predict the probability of any future investment being sustainable.

A further important issue involving linkages is the extent to which the success or failure of the NARS or of an individual research institution is the result of the quality of its products or of other factors affecting the general ambience into which those products are being released. **Ex post** evaluation of research impact suggests that other factors are often crucial to the adoption of technology, although their weight may be different in different situations or with different commodities. In the case of roots and tubers, market access and keeping quality are likely to be crucial. With cereals the key determinant of impact is likely to be yield response and the price and availability of yield-increasing inputs, including labor.

Scoring and Interpreting Results

The ARIIM contains normative questions. Indicators to these questions are to be scored on a scale of 1 to 5, where a score of 1 implies weakness (negative) and a score of 5 indicates strength (positive). Scoring constraints or any other negatively-worded questions will remain on a 1 to 5 basis with 5 being the least constrained. Much of the scoring must be based on qualitative judgements by subject matter specialists. At Levels I and II (Institutional Base and Technology Generation & Transfer), scoring is not based on a comparison with any other NARS but rather on <u>the potential of the subject NARS to produce usable technology</u>.

A low composite score at **Level I** should flag the low potential of the existing research system to produce technology of value and the need to upgrade the NARS before implementing any commodity improvement program. A.I.D.'s current project with Kenya's KARI attempts to do both at the same time, focussing on overall system strengthening and two commodity programs.

A low score at **Level II** should alert the user that there is either a problem with the quality and appropriateness of the technology developed, or with the effectiveness of the linkages between researchers and technology users (e.g, farmers) and researchers and technology transfer agents (e.g., extension workers). Feedback from extension workers alone, although important, is not sufficient. As documented by ISNAR, extension workers are not the main source of researchable ideas in many countries. Researcher-to-farmer linkage, on the other hand, is vital for successful technology

development and delivery. Linkage to farmers ensures the relevance of research by prioritizing and focussing research on farmers' felt and perceived needs and constraints.

A low score at **Level III** (Intermediate Impact) given a reasonably high score at levels I & II should assist the user in isolating the key constraints to adoption. The constraints include those that are associated with the availability of farm inputs including labor, ecological conditions, infrastructure, and policy.

A low score at **Level IV** (Long-run Impact) does raise several questions. The user will need at this point to investigate the reasons for weak impact either at the NARS or program level. Was the project designed with the DFA objectives in mind? Was linkage between researchers and the technology users appropriate? etc?

There was no obvious way to weight the scoring to differentiate between that which could be critical and that which is (merely) important. Every discipline has its critical list. Therefore, scoring can only be indicative of weaknesses and strengths of the various elements. The earlier version of the Matrix attempted to include all necessary elements, but it was not possible to determine which of these were sufficient, even after field-testing on mini cases.

The ARIIM has been written to be scored either by a multi-disciplinary panel of specialists who have knowledge of the NARS organizations in the African countries of interest, who also have expertise in A.I.D. development assistance, and who have access to expertise in agricultural research management, or by a single A.I.D. agriculture officer (ADO) with assistance of local counterparts.

Predictive Capability of the Matrix

There are no successful impact prediction models now used in agricultural research programming. There are efforts being made to predict yield by the use of crop models but only after the incorporation of a great deal of accurate agro-ecological data. The major problem is the vast difference in quality of technology generated, it's adaptation to site-specific situations, the multitude of constraints such as input availability or marketing problems, to say nothing of political stability, and food taste preferences.

In spite of the pitfalls listed above, there are a series of predictions that can be made step-wise in progressing through the proposed Agricultural Research Impact Indicator Matrix. The further up the levels one goes (i.e., from Level I to Level IV) the greater the likelihood that the user can predict the rate, extent and the nature of impact.

When Level I has been completely analyzed it will be possible to predict the capacity of the NARS to produce useful technology. In the event that Level I scores very low, it can be assumed that no impact will be possible without investment in the NARS' infrastructure and management.

After determining that the NARS has produced technology of a high quality, as it relates to farmers' needs, at Level II, one can also see if it has wide general adaptability and whether there is a system in place to make farmers aware of a "menu" of choices. At this point, the potential productive capacity of the technology under various input levels can be calculated, and a prediction made on "yield potential" on farms in the target area and other potential areas.

To predict long-term impact of any technology intervention one will need Level III and Level IV data. Given our assessment at levels I and II, however, it is possible to extrapolate the Level III impacts to make judgments on Level IV impacts by extending the adoption of specific technologies to all potential areas over the planning period, at a given rate.

Applying the Matrix

This chapter is divided into four sections, one for each level of the matrix. Each section includes the matrix, a discussion keyed to the numbering of the issues and questions in the matrix, and information on using and scoring the matrix. Each section contains proposed data analysis tables to facilitate the recording and assessing of the quantitative information associated with key indicators.

Level I: Institutional Base

AGRICULTURAL RESEARCH IMPACT INDICATORS MATRIX

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base				
A. National Level				
A.1 NARS Institutional Capacity	1.1 Is the NARS adequately coordinated or highly fragmented?	. Presence of apex management organization (i.e., Ag. Research Council) . NARS management and control centralized under few ministries or departments . Regional differences addressed within a coordinated framework . NARS enjoy reasonable autonomy	Score 1 - 5	NARS, MOA MOP, MS&T
	1.2 Does the NARS provide for adequate linkages among MOA research institutions, other relevant ministries, universities, NGOs, farmers, development projects, local agro-business, private sector research organizations?	Linkages with respect to: . Priority setting process . NARS board membership . Training . Technology & seminars in exchange . Contract or collaborative research (in & out) . NARS representation on other boards	Score 1 - 5	NARS, MOA MOP, MS&T NGOs Universities USAID
A.2 Adequacy of NARS Policy & Plan Formulation Process	2.1 Does the country have an effective organization for planning, management, or coordination of the NARS in line with national agricultural policy?	. Research programs support national ag. polices. . Research program priorities set by national planners. . NARS operating budgets reviewed and approved by national planners.	Score 1 - 5	NARS, MOA MOP, MS&T
	2.2 Are existing processes adequate for setting research priorities and for resource allocation?	Process accounts for: . The potential impact of the research thrust on the national economy and society, including the area affected, value of the commodity, changing demand, urgency of problem, constraints, distribution of benefits, political considerations, availability of external technology, extent of NARS staffing including scientists per commodity group, the probability and cost of research success.	Score 1 - 5	NARS, MOA MOP, MS&T

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ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (Cont'd.)	2.3 Are the planning and policy formulation linkages between national planners and NARS effective?	Extent of NARS involvement in formulating agricultural policies: . input polices . output polices . foreign exchange polices	Score 1 - 5	NARS, MOA MOP, MS&T
	2.4 Are there adequate facilities for collecting, analyzing, and updating agricultural research related data?	Organization and procedures for: . Collecting baseline and time series data on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc. . Data analysis & reporting	Score 1 - 5	NARS, MOA MOP, NBS
A.3 NARS Financial & Human Resources Strength	3.1 Does NARS receive an adequate level of funding overtime?	. Total budget for research(i.e., salaries & wages, operating expenses plus capital expenditures) . % of actual funding to approved budget . Salaries & Wages as % of total operating budget . Stability of funding overtime and by sector . Research budget as % of Ag. GDP . Total expenditures per researcher . Research budget as % of public investment in agriculture . % of budget from external sources	Score 1 - 5	NARS, MOA, MOF/Treasury, MS&T WORLD BANK FAO USAID
	3.2 Does NARS have adequate control over donor-financed research?	Donor-financed research activities initiated, received and coordinated by: . NARS . the parent ministry . various of other ministries	Score 1 - 5	NARS, MOA MS&T, MOF/Treasury USAID
	3.3 Are adequate accounting procedures and staff in place throughout the system?	. Centralized Financial Management System . Clear and proper accounting procedures . Timely reporting of financial transactions	Score 1 - 5	NARS, MOA, MS&T

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Cont'd)	3.4 Is NARS adequately staffed to perform research activities articulated in the national agricultural strategic plan?	. Size of system (number of scientists) . Quality of system (number of postgraduate to BS) . Ratio of trained technicians to scientists . Distribution of researchers by commodity and/or disciplines	Score 1 - 5	NARS, MOA MS&T WORLD BANK FAO
A.4 Effectiveness of Monitoring & Evaluation Process	4.1 Are monitoring and evaluation processes adequate?	. Active annual process . #of projects revised or canceled . Provisions for external reviews . Peer or expert review . # of projects redesigned	Score 1 - 5	NARS, MOA MS&T
A.5 Soundness of NARS External Linkages	5.1 Does the NARS have satisfactory linkages with IARCs, developed countries, international private sector research institutions (e.g., agro-business)?	Linkages with respect to: . technology exchange . training . networking . consultation	Score 1 - 5	NARS, MOA MS&T, MOE Universities
B. Institute/Program Level				
B.1 Appropriateness of the Program Planning and Management Process	1.1 Do programs have a soundly conceived research plan?	. Program plan incorporates: - farmer organizations feedback - agro-ecological, provincial, and cultural differences . Plan articulates priorities and allocates resources . Plan includes program budget with projections for salaries & wages, capital expenditures and operating expenses . Plan is properly documented	Score 1 - 5	NARS, MOA MS&T, MOP
	1.2 Is program adequately funded?	. Proportion of funding to requested budget . Expenditures directly controlled by program/station . Funds are received on a timely manner	Score 1 - 5	NARS, MOA MS&T,MOF USAID

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Cont'd)	1.3 Are programs adequately staffed?	. Size of program (# of scientists per programs) . Quality of program (# of postgraduates to BS) . Ratio of technicians to scientists	Score 1 - 5	NARS, MOA MS&T WORLD BANK FAO
B.2 Soundness of Institute/Program Linkages	2.1 Within programs are linkages among disciplines adequate?	. Programs designed and worked on by a multi-disciplinary team . Program results reviewed by a multi-disciplinary team . Institute and programs have both formal and informal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agro-business organizations for problem identification, program formulation and execution.	Score 1 - 5	NARS, MOA MS&T Universities
B.3 Effectiveness of Program Monitoring & Evaluation Process	3.1 Are program level monitoring and evaluation systems adequate?	. Active annual process . #of projects revised or canceled . Provisions for external reviews . Peer or expert review . # of projects redesigned	Score 1 - 5	NARS, MOA MS&T
C. Sufficiency of the Institutional Capacity of Extension Services	1.1 Is there an adequate institutional base for extension?	. Presence of APEX management (i.e. Extension Services Consul) . Extensions management & control centralized under few ministries and departments . Extensions enjoy reasonable autonomy	Score 1 - 5	NARS, MOA MS&T
	1.2 Are extension services receiving an adequate level of funding overtime?	. Total budget for extension (i.e., salaries & wages, operating expenses plus capital expenditures) . % of actual funding to approved budget . Salaries & Wages as % of total operating budget . Stability of funding overtime and by sector . Extension budget as % of Ag. GDP . Total expenditures per extension officer . Extension budget as % of public investment in agriculture, . % of budget from external sources	Score 1 - 5	NARS, MOA MS&T MOF/Treasury WORLD BANK FAO USAID

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ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Cont'd)	1.3 Do extension services have adequate control over donor-financed extension programs?	Donor-financed extension activities initiated, received and coordinated by: . Extension Service . the parent Ministry . various of other ministries	Score 1 - 5	NARS, MOA MS&T MOF/Treasury WORLD BANK USAID
	1.4 Is the extension service adequately staffed?	. Total number of extension workers (i.e., extension officers) . Distribution of extension workers by gender . Farmers per extension agent	Score 1 - 5	MOA
	1.5 How suitable are the methods developed to monitor and evaluate technology transfer and adoption?	. Accuracy of adoption reports	Score 1 - 5	NARS, MOA
	1.6 How appropriate are the extension-farmer linkages?	. Frequency of visits . Demonstration plots . Number of scheduled farmer meetings with subject matter specialists	Score 1 - 5	NARS, MOA Sample Survey

Discussion

National Level - Research

Ideally, a national research system should be well-structured, well-integrated, well-managed, well-funded, and well-staffed. It should have internal linkages upstream to policy, downstream to farmers, and externally to other scientists. While few if any countries would achieve a perfect score for all of these goals, a serious weakness in any of them would compromise the integrity of the system as a whole.

A well-managed NARS will in general have a clearly-stated mission. Its goals focus on meeting the needs of its clients and it sets realistic and attainable objectives to meet that goal. It periodically reviews its operation and achievements and restructures its functions and management as appropriate to the changes in its clients' needs and constraints. Ideally, all of its research programs will be evaluated in terms of the extent to which they demonstratibly satisfy clients' perceived needs.

The main criteria which need to be scrutinized in evaluating a NARS are, therefore, those most closely related to these goals; others, while desirable, are not so essential. The crucial issues requiring answers at the national level are enumerated below. The questions are discussed and number exactly as they appear in the matrix.

Structure & Management Capacity of the NARS

A.1. Does the structure of the NARS provide a good environment for productive research?

The key questions which need to be answered here are:

A.1.1 Is the NARS well-structured and coordinated or highly fragmented?

A.1.2 Does the NARS provide for adequate linkages among its component parts within the country?

Many national systems are both seriously fragmented administratively (involving several ministries, parastatals, and other agencies--as has been the case in Kenya until very recently--and excessively dispersed physically) with numerous "regional" stations and sub-stations, commodity stations etc.. While adequate coverage of agro-ecological zones (AEZs) and social and cultural variability is essential, regional dispersion must be carefully planned to avoid wasteful duplication on the one hand and gaps in research coverage of important local problems on the other. The uncoordinated participation of numerous government organizations in regional research is a common cause of waste and inefficiency in NARS, while their different and sometimes conflicting vested interests make it difficult to develop an effective central research planning and management structure.

A NARS which is loosely structured centrally and excessively dispersed regionally is unlikely to be well-targeted and highly productive **unless** it has satisfactory provisions for integrating and coordinating the efforts of its different components. Even a tightly structured NARS--for example, where 80 percent of the institutes are under the control of one Ministry--is more likely to be effective when its components are closely linked within the framework of an embracing national strategy for agricultural research.

A.2/2.1 Does the country have an effective organization for planning, management, and coordination of the NARS in line with national policy? (Questions 2.2, 2.3, 2.4, 2.5 are subsumed under 2.1.)

NARS vary considerably in their provisions for integrating and coordinating their disparate elements. In general, the mechanisms are more elaborate in larger systems, where planning and coordination of all or a substantial part of the system's activities and the allocation of resources to those activities is often the task of a Scientific or Agricultural Research Council. Bangladesh, India, Japan, Kenya, Nigeria, Pakistan, the Philippines, Sri Lanka, Taiwan, the United Kingdom, and Zimbabwe are examples of countries with this type of management organization, although its powers vary among countries from management of a major part of the system to a financial or coordinating role. Other countries, such as Brazil, Indonesia, the Sudan, and Malaysia have established an autonomous research organization, independent of a particular Ministry, to plan, coordinate, and manage agricultural research.

Essential objectives of all such apex bodies are to develop effective **linkages** among component institutions of the system, to establish a planning mechanism so as to integrate their efforts in pursuit of agreed national goals, and to allocate financial and human resources efficiently to those efforts. They should not become involved in "micro-management" of the institutions under their control e.g. interfering in their internal organization and in the day-to-day implementation of their research program (although they sometimes do). Their primary role lies in the governance of the system and in ensuring its coherence.

Where NARS do not have an apex organization of the type outlined above, their headquarters is usually located in the Ministry of Agriculture, very often in a Directorate or Department of Agricultural Research. This may offer an adequate mechanism for managing and coordinating research within the parent Ministry, although it often lacks the authority of an apex management agency for establishing satisfactory linkages with other Ministries (especially Planning and Finance Ministries), or with universities.

A worst-case scenario is where research **within** the parent ministry is fragmented among several directorates e.g. crops, livestock, forestry, and fisheries. Where such a situation exists it needs to be eliminated; in cases where only one directorate has the main responsibility for inter-disciplinary coordination, planning, and resource allocation it must be given adequate managerial staff and scientific support to fulfill this role effectively.

Ideally, the core management unit of a NARS ought to be seen as an important source of knowledge and policy advice not only to the Minister of Agriculture, but to the Planning Commission or its equivalent (see A.2.3). In NARS where this situation exists and the managers of the NARS act as **de facto** consultants to the national planners, the chances of the NARS receiving adequate support from the government are good. However, to build the necessary confidence requires the establishment of good linkages from the NARS to the field (A.2.4) so as to collect baseline data and keep up with farmers' needs and reactions, as well as the development of a good analytical capability. Unfortunately, many NARS are very weak in this respect, due mainly to a lack of staff trained in economics and policy analysis. Hence research managers are at a disadvantage in dealing with national planners as well as in formulating research policy and priorities, a situation reflected in poor allocation of research resources among commodities and problem areas. The exception to this generalization among the three countries studied--Kenya, Cameroon and Malawi, is Malawi--which has such an entity but is still resource poor for agricultural research.

Human & Financial Resources Capability of the NARS

A.3 Does the NARS receive adequate resources to play an effective role in national development, and are those resources efficiently managed?

This issue needs to be addressed by answering two main questions:

3.1 Is the NARS adequately funded and are the funds efficiently managed? Questions 3.2 and 3.3 are subsumed under this heading.

3.4 Is the NARS appropriately staffed to perform research activities articulated in the national agricultural strategic plan?

The linkages to national policy-makers are critical to both of these questions, since if the NARS has poor contacts with national planners, whether directly or through the parent ministry, or if the planners feel that the NARS is unproductive or badly-managed, it will not receive adequate funds and will be unable to attract or support enough well-trained staff. This is particularly the case where much of the research budget comes from external sources, since in most cases the donor funds are channeled through the Ministry of Finance or the Ministry of Agriculture rather than directly to the NARS from the donors, as is the case in Kenya.

The adequacy of funding is determined not only by the total amount received from all sources, but by the nature of the sources, their reliability, the efficiency with which funds are channeled to the NARS, the timing of those disbursements in relation to seasonal needs, and the use of the funds within the NARS itself.

There is a perception among the donor community, fostered by normative targets suggested by development assistance agencies--in particular the World Bank--that an expenditure on agricultural

research equivalent to 2.0% of agricultural GDP is a desirable goal. It may appear heretical to question the validity of such pronouncements, but although there is evidence of high rates of return to agricultural research--which suggest that there is often considerable under-investment--links between a productive research system and a given expenditure/GDP ratio have not been established empirically. Not many developed countries spend 2% of their agricultural product on research, and only about 20 developing countries have exceeded 1% of agricultural GDP (a goal suggested earlier by FAO). Nearly all of these are small countries in terms of the size of both their agricultural sector and their population. While several have well-qualified research staff, their ability to meet all the demands placed on them is limited by their small size.

On the other hand, many of the larger research systems in the developing countries with over a thousand scientists spend no more than 0.5% of their agricultural GDP on research--including China, India, Pakistan, Bangladesh, Indonesia, the Philippines, Thailand, South Korea, Egypt, the Sudan, and Turkey. A number, although not all, of these have good records of productivity. Research expenditure is often low relative to the value of GDP in countries with a large agricultural sector but there is no evidence of a linear relationship to productivity which could justify a proportionately large research expenditure; in fact, very large research institutions tend to suffer from management problems leading to diseconomies of scale.

Some of the other norms cited in the literature such as research expenditure or number of scientists employed per hectare or per capita of population appear irrational. Research productivity--unlike that of extension--is not directly related to the size of the population, or of the cropped area; a small research team may make a historic break-through in productivity affecting millions of people or hectares. Eicher, for example, has observed that the seminal work in the domestication of the African oil palm, which has produced benefits throughout the humid tropics, was done by a team of only four scientists.

Expenditure per scientist is often determined largely by scarcity factors affecting supply and demand for qualified scientists, and by local salaries and costs of living, as well as by manufacturing costs for buildings, vehicles and equipment. Thus, costs in Asian countries with little scarcity of graduates, low costs of living, and adequate industrial capacity are generally much lower than those in Africa.

A more positive approach to judging the adequacy of a government's financial support to a NARS may be to look at what it is actually spending on agricultural research as a proportion of the total national investment in agricultural development. Here, there are more direct comparables, e.g. expenditure on extension, agricultural education, farm subsidies, etc., although again there is little empirical evidence to support normative targets such as that suggested by FAO, of 10% of national agricultural investment being devoted to research.

Financial instability is inimical to effective research, thus it is extremely important to study the allocation of funds over time both to the NARS and within the NARS. Idachaba has shown how

greatly and irrationally research funding has varied in Nigeria, both in total and in its distribution among sub-sectors of agriculture such as food crops, estate crops, forestry, and livestock.

A meaningful indicator of efficiency in the use of funds is the distribution of the agricultural research budget between capital expenditure, salaries and emoluments, and operating expenses for the conduct of research. Capital expenditure is "lumpy," for example, it may be high when new buildings are involved and low at other times; but over a run of years the salary component of a research budget should not exceed 70 percent of recurrent expenditure; otherwise, the productivity of the system is likely to decline.

Unfortunately, in recent years, there has been a declining trend of operational funding in many national systems. This can be attributed largely to a rapid increase in the size of their scientific cadres as training programmed at home and abroad bears fruit. In Africa, for example, the growth of scientist numbers was 4% p.a. during 1980-85, whereas that of research expenditures was only 3% in real terms. In Kenya, the 11 donors contributing funding to KARI in 1989 were all interested in funding participant training abroad. In Malawi, over 100 scientists were abroad on training in 1989, but in that instance, training mobilization was coordinated with help from expatriate Technical Assistance (TA) provided by A.I.D.

In some instances, there seems to have been a decoupling of staff development from financial planning, possibly because of inadequate linkages between research managers who plan and implement training programmed at the level of the NARS, and financial planners at Ministerial level who allocate funds to research. Once this happens, the operational rather than the salary component of the budget is generally the one which suffers, not only because a larger research establishment tends to confer more status on its managers and is to some extent donor-driven, but also because there is an understandable reluctance to fire newly-trained staff. Nevertheless, such a policy may be self-defeating, leading to an unsustainable system.

The question of the optimum size of a NARS raises difficult issues. A large system has advantages of scale, and as long as it is well-structured, and has considerable flexibility to form multi-disciplinary teams or task forces to deal with special problems or to meet new challenges. Both staff and funds are more fungible in a large system than in a small one. It is easier to provide a critical mass of staff to cover the different agro-ecological regions and farming systems of a country when the scientists are not entirely preoccupied with work on a single commodity or disciplinary problem as they often are in smaller systems--for example in the South Pacific, the Caribbean, and in most of Sub-Saharan Africa (where 18 countries had under 50 scientists in 1986). In reviewing African needs, Valleys, et al have suggested a goal of at least 100 scientists for a NARS to be effective.

Nevertheless, any research system is only as good as the quality of its personnel, its management, and the adequacy of its funding, and in many countries the NARS have expanded numerically at the expense of quality and managerial ability.

The proportion of scientists with a post graduate degree of any kind remains low, they represent on average only about a third of the total research staff for NARS in developing countries as a whole. Staff turnover is high, because shortages of operational funds frustrate keen scientists, and personnel policies are archaic. Research management in many NARS is the prerogative of promoted scientists, and professionally trained managers are rare. In one large national system in Asia every managerial post in the research council (including planning, finance, and personnel) is filled by a super-annuated biological scientists with no training and little hands-on experience of management.

Not only is it important to improve academic standards by upgrading the competence of staff filling existing posts, but most NARS have serious gaps in scientific capability with respect to policy analysis, economics and social science disciplines related to natural resources management, post-harvest technology, animal and pasture management (as opposed to veterinary medicine), social and agro-forestry, and farming systems research. Many of these disciplines have an important bearing on environmental sustainability. Study of the staff composition of a NARS by commodity and discipline is, therefore, essential in assessing the reasons for its performance **ex post**, as well as its probability of success **ex ante**.

The role of the universities in both agricultural education and in research is crucial in building national scientific and administrative capability. But university linkages are not always evaluated in sufficient depth by external review missions. A number of developing countries still have no university courses in agriculture and must rely on external facilities for their research staff. In many countries the general universities and even the agricultural universities are affiliated to another ministry than agriculture (usually education), and their contribution to the NARS, particularly with respect to research, is limited and sometimes irrelevant.

Managerial competence is at a premium in most NARS, yet agricultural universities and faculties rarely offer professional management training. The ICAR Staff College in India is an outstanding exception. The nature and strength of the linkages between the public sector research system and the university system should receive close attention.

Thus, in evaluating a NARS, it is extremely important to look at the patterns of growth of its staff and expenditures, to study their distribution over time, and to scrutinize the policies for the development of human resources with particular emphasis on quality and managerial competence. Donors should be cautious in providing funds leading mainly to growth in numbers rather than to growth in competence.

Adequacy of the NARS Monitoring & Evaluation Procedures and Policies

A.4.1 Does the NARS have a satisfactory procedure for monitoring and evaluation?

Many NARS, probably a majority, have no formal mechanism for monitoring research in progress or for evaluation of its impact **ex post**. This may be due partly to methodological problems related to evaluation, as well as to the scarcity of staff trained in impact analysis (referred to under A.3.4).

Nevertheless, difficulties of this nature should be no excuse for the absence of any effort to monitor progress in the conduct of research or to follow upon its adoption and utilization.

Moreover, it is not in the best interest of the NARS to avoid the monitoring, evaluation and reporting (MER) of research activities, since governments and donors are increasingly demanding evidence of tangible benefits accruing to their investments in research. Lists of numbers of varieties developed, or even released, are not sufficient to provide such evidence: a more comprehensive evaluation of their impact on production, price, balance of payments, employment, income and nutritional status of the population, may be required to satisfy funding agencies--and the parent government that they are getting value for money. This has proved to be the case not only with respect to national systems, but also in international agricultural research, where the donors to the Consultative Groups of International Agricultural Centres (CGIARC) require quinquennial external reviews of each institute in the system and a periodic evaluation of the impact of the system as a whole.

The building blocks for analysis of the impact of a system are the results of monitoring and evaluation of its individual components, primarily research institutes and their programs. Monitoring and evaluation (M&E) should be an active and continuing process, so that mid-term corrections can be introduced where unexpected problems arise, when circumstances make changes of course necessary (e.g. a major shift in price or market relationships) or when new goals are identified. Thus, costly mistakes may be avoided before it is too late. Evaluation of **impact** may require periodic rather than continuous assessments, guided partly by past experience of farmers' attitudes to change and the time lags between release of an innovation and its adoption, and partly by current information from extension staff and other knowledgeable sources in the field.

Good linkages between researchers and extension are not only essential to satisfactory evaluation of research **output**, but can be enhanced by cooperation with respect to identification of **impact.** Linkages between research managers, national policy makers, and donor agencies are likely to be strengthened as a result of better feedback of information from the NARS on the impact of expenditure on research. Even where results are disappointing, a frank analysis of the reasons is less likely to cause negative reactions than keeping policy makers in the dark until they receive bad news from other sources.

Thus, it is vital for NARS to build linked procedures for impact monitoring and evaluation throughout the system as an integral component of all major programs and institutes, as well as at the apex. Resources needed to maintain M & E system should be allocated on a full-time basis, and should be regarded as an essential contribution to the system's planning, management, research operations, and sustainability.

External Linkages

A.5.1. Does the NARS have sound external linkages?

International scientific linkages

All NARS are part of a global agricultural research community, which is in turn are part of a larger and rapidly evolving scientific community. No country can afford to remain isolated from these larger associations of scientists, not only because of the difficulty of keeping up with developments in scientific fields if contacts are not established and maintained, but because good linkages to other scientists can confer positive benefits which may save that country time or money or both.

With respect to research those benefits may be confined to the acquisition of new knowledge, techniques, and methodology; or they may take the more tangible form of exchange of genetic material, equipment, or other technology. Recent studies have shown that major gains in value of agricultural production and value-added post-harvest have accrued to the "spill-over" of research initiated in one country or region to other developed and developing countries where it has been modified and adapted to local needs and conditions. Rice, wheat, maize, oilseeds, potatoes, coffee, bananas, coconuts, rubber, fodder/pasture crops, fruit and multi-purpose trees are some of the commodities which have benefitted. Pest and weed control techniques, both chemical and biological, have been widely transferred among countries. So have improvements in mechanical and post-harvest technology.

International and regional agricultural research centers have played an important role in this process of diffusion, both directly, through their own research products and genetic resource pools, and indirectly through the dissemination of information and through training. The interchange of knowledge, ideas, and materials has also been fostered by national research institutions and universities in developed and developing countries, and by international development assistance organizations such as the World Bank, Regional Banks, FAO, UNDP, IFAD, and by bilateral donor agencies.

NARS in developing countries have been able to profit from this process at different levels according to their scientific strengths and financial resources. Larger systems have been able to draw on a wide range of direct linkages, involving collaboration in strategic and applied research, including biotechnology, as well as tapping the global pool of genetic material and technology for adaptive as well applied purposes.

The ability of small national systems to take individual advantage of these linkages is generally less, but this limitation may be partially offset by linking into research networks on commodities or problems in which they have special interests. (See MSI's recent report on the M&E System for A.I.D.'s SAARFA Project, which funds many of these networks in Africa.)

Research networking is a relatively new approach to achieving critical mass and economies of scale, and works best where there is at least one well-equipped and staffed "Lead Institution" to give focus and conceptual support to the other members. Networks are relatively flexible and lend themselves well to inter-disciplinary research in pursuit of a common goal. They are not necessarily confined to research, but may include exchange of knowledge and information, materials, techniques, and training arrangements.

Networks have proved popular with donors, since they tend to have modest overheads and to be operationally oriented. However, experience of evaluating their impact is relatively limited, as most networks are of fairly recent origin. Research needs to be devoted to determining the approaches and criteria best suited to this purpose.

A recent CGIARC publication (Plucknett, et al, 1990) lists about 70 international networks related to agricultural research not including collaborative research, networks on a national scale. Oram (1988) identified over 50 networks operating in Africa alone, although some of these involved the same crop, e.g., maize in different regions of the continent. Existing networks vary widely in scope, size, geographical coverage, and objectives. Some, such as the Sorghum Breeding Networks managed by ICRISAT involves 40 countries in Africa and Asia; by contrast the Great Lakes Regional Bean Project in Central Africa has only 3 member countries. This does not necessarily mean that it has low value to those countries.

Private Sector Linkages

In general, NARS in developing countries are almost entirely composed of publicly-funded institutions. The private sector has a limited involvement in research, and even where private organizations are involved it is tenuous. Often there are faults on both sides. The public sector, and the private organizations are sometimes reluctant to give away information which might give them a market advantage if they can patent it or develop a sales edge over their competitors. In some countries, e.g., Bangladesh and Niger, non-governmental organizations undertake research, usually of a grass-roots nature, sometimes with a measurable impact.

Commercial private research tends to be focused mainly on breeding high-value crops (hybrid maize, tobacco, cotton, vegetables and tree crops) where plant breeders' rights can be enforced; and on field testing agricultural chemicals and machinery. Linkages tend to be strongest where farmer organizations develop commercial arrangements with private companies, as in Latin America; or where private organizations develop vertically integrated operations, including research, production, processing, and marketing--usually for export.

At the Institute/Program Level

The ARIIM shows clearly that a majority of the linkages which are crucial to determining the success of a NARS are also of vital importance to the success of its component institutions and of their

research programs. These include items B.1.1, 1.2, and 1.3, dealing respectively with the planning process, with the adequacy of funding of programs, and with their staffing and its quality.

Stress is also placed under item B.2.1 on the importance of good linkages among disciplines **within** individual institutes and programs; and on external linkages from those units to the clients of their research (universities, extension services, farmers, private sector research, agro-business organizations, and provincial-level policy makers).

There is no need to repeat the earlier discussion, under A above, of the nature and significance of these linkages, since their application to the institute and program levels is essentially the same. However, it must be emphasized that they should not be merely passive. They may involve collaborative or contract research with the universities or the private commercial sector, on-farm trials in close association with extension staff or NGOs; and special studies related to farmer needs and conditions or to impact analysis, involving survey or other forms of data gathering in cooperation with farmers' organizations, extension staff, or rural social services. Here, a good example is embodied in the approach to extension and monitoring of adoption in Cameroon's National Cereals Research and Extension Project (NCRE).

The effectiveness of these linkages may be crucial not only to the institutes or programs concerned, but in a wider sense to the analysis of the returns to research of the NARS as a whole, and the assessment of the impact of the national policy on the farmers. They also guide scientists as to the appropriateness of their products to clients needs. Hence, as indicated under A.5.1, it is essential to develop satisfactory monitoring and evaluation procedures **at the program and institute level**, since these provide the building blocks for assessment of the impact of the NARS as a whole, as well as facilitating the diagnosis of weak points in the system.

Research-based field programs or projects are generally shorter in duration and, therefore, are more vulnerable to external constraints than investment projects involving support to an institute or to the NARS as a whole. Thus, it would be unwise for donors to assume that weaknesses in infrastructure, deficiencies in input supply, or government policies which disfavor agriculture will be corrected. Motivations of farmers in the target area is also essential to success. A recent World Bank review of Technology for Small-scale Farmers in Africa is replete with examples of lack of adoption due to failure to appreciate labor constraints, consumer preferences, risk aversions, local differences in population pressures, etc.. This implies a high risk of low impact to research in situations where research-liaison linkages are poor or extension services are incompetent. In order to minimize this risk it may be necessary to mount pre-investment surveys to attempt to characterize the target area and population and identify possible impediments to success. (See, inter alia Kaimowitz et al, 1990.)

Extension Institutions

Most of the questions posed with respect to the extension services closely resemble those related to the NARS, i.e.:

- How well is extension structured and coordinated?
- How adequate is its financial support ?
- Is its staff numerically sufficient and is its quality adequate in relation to the functions it is expected to perform?
- How appropriate are the research-extension-farmer linkages?
- How suitable are the methods developed to monitor and evaluate technology transfer and adoption?

There are, nevertheless, important differences between national research and extension systems which need to be borne in mind when attempting to evaluate the impact of either separately, or of the technology transfer system as a whole. These are:

i. Extension does not normally generate new technology **by itself.** Instead it is the main, although not the only, vector to the farmer of technology derived from the NARS. It is a go-between; it **depends** heavily on the NARS for its continuing productivity.

ii. Consequently, its structure and disposition is radically different from that of research. Extension does not maintain large fixed institutions, it is geographically dispersed, it works mainly "downstream" at the farm end and the composition of its staff reflects this.

iii. Extension staffs in developing countries are usually larger than research services, but the ratio of graduates to non-graduates is normally much lower. Extension tends to substitute numbers for quality, since a tenet of extension is that close contact between extension workers and farmers is essential, and the deployment of a large number of people to the field is considered necessary to ensure such contacts. **One extension worker to a thousand farmers in rain-fed areas or one to five hundred farmers on irrigated land is a commonly-cited normative goal.**

iv. Extension service structures tend to be more hierarchical than those of research, with a rigid chain of command from the center to the field, usually related to the administrative structure. It is not unusual to find some fragmentation of extension services in a country; veterinary/livestock, forestry, and irrigation organizations often maintain their own services, as do certain industrial crops (sugar, tobacco, cotton). However, commonly there is one principal extension organization based in the Ministry of Agriculture, primarily responsible for contacts with farmers, at least for the majority of crops. External development assistance agencies have helped many governments to reorganize their advisory services, and this has often led to a reduction in the type of fragmentation described above.

v. Except at the national level through managerial linkages their parent Ministries, the NARS, and policy makers, the extension staff are principally linked internally downstream to their clients, and external linkages (except to donors) are relatively unimportant. In some countries, e.g., India and Morocco the universities play a significant role in extension education derived from US Land Grant College model.

vi. However, the crucial linkage at the client level is with the research staff; and following widespread criticism of its inadequacy by external review and evaluation teams, both research and extension staffs in many countries have been adopting a range of measures designed to strengthen this vital bond.

These include the adoption of the **Training and Visit System (T&V)** being actively propagated by the World Bank. Key components are: the establishment of Extension-Liaison units with specialist staff located usually in the NARS; the development of agro-ecological zone research stations which function as the main foci of multi-disciplinary applied research; the establishment of coordinating centers for on-farm trials in the zone, as well as the regional headquarters of the extension service and the base for its subject-matter specialists. So far it appears that these various measures have resulted in enhanced research-extension interactions, and improved joint linkages to the farmers and the rural community.

vii. A continuing point of weakness in many countries is the inability of the extension service to overcome the constraints to the adoption of new technology imposed by externalities such as limitations on the access of farmers to seed, fertilizer, pesticides, and other inputs, as well as credit for their purchase. Some countries have attempted to put extension workers in charge of the distribution of seed, fertilizer or other inputs; generally without success because of lack of administrative experience, poor storage facilities, and corruption. More commonly, developing countries have established parastatal monopolies for this purpose. These agencies generally reflect the absence of a strong commercial sales and distribution system, although vested state interests in some countries have actively discouraged private investment in the input business. To a certain degree, A.I.D. is encouraging private sales and distribution, e.g., through linkages to food aid programs, as in Senegal and Tunisia.

Evaluation of the adequacy of arrangements for technology transfer must take these constraints into account when looking at the impact of research and extension efforts, especially if the output of research seems appropriate to client needs and the research-extension linkages are adequate.

It is also important in designing new technology to note that the educational level and technical competence of the average field-level extension worker is not high. The T&V system aims to offset this by providing programmed messages from above at regular intervals. These are generally simple and narrowly focused. It is questionable whether this approach is adequate to training farmers in the adoption of more complex techniques such as Integrated Pest Management (IPM), organic farming, alley cropping etc., which may be beyond the technical competence of the field extension staff.

In order to overcome this problem some countries have raised the proportion of graduates in their extension services, and reduced the number of low-level field staff. This may be feasible without affecting the frequency of contacts with farmers if the extension staff are mobile and well-equipped with modern communications equipment--as well as well-trained in techniques of communication. A better-quality extension staff may also be able to communicate more effectively on a peer basis with researchers, and may command more attention from farmers. More needs to be learned about the circumstances (farmer density, type of farming, infrastructure, education levels of farmers, etc.) under which graduate extension services might be most effective in developing countries, as well as about their cost compared to more conventional T&V type systems.

Using and Scoring the Matrix

The over-arching objective of the assessment at Level I, is to determine whether there is an institutional base with the capability to produce technology, both at the national and institutional levels. Does the NARS have the capacity to plan and set research priorities, to conduct research and generate technology, and the coordination capacity to work with external research organizations and internal extension systems.

The evaluation of necessity is static in nature in so far as being effected by the production of technology. In the case of impact analysis, it need not be evaluated over time. To assist the evaluators some of the issues and questions are explained below. Those questions and issues that are self-evident from the matrix are labelled as self-explanatory.

A 1.1 Recognizing that there are differences among African countries in size, organization, and capacity, these indicators are designed to determine whether the NARS has national coordination, is it fragmented among many ministries, and does it have any freedom from the politics of the Ministry of Agriculture (MOA). In general, less fragmented and autonomous institutions perform better than fragmented research institutions.

A 1.2 All linkages are considered positive. Where central control excludes institute involvement, a lower score is needed.

A 2.1 The first question is whether there is a National Agricultural policy. Do the indicators support an effective policy?

A 2.2 The indicator list for existing research priority setting processes is extensive and other indicators could be added. Requires a value judgement from subject matter specialist.

A 2.3 Self-explanatory

A 2.4 Self-explanatory

A 3.1 Total budget for research: as a general rule, the salary and wage component of the total annual national budget for Agricultural Research should not exceed 70% of total recurrent budget of the NARS.

Expenditure per researcher: in many cases Africa countries have a higher expenditure than Asian countries. This may indicate too few researchers for the size of the system.

Research budget as a percent of Agriculture gross domestic product (GDP): the World Bank recommends 2% but very few countries reach this level. A low figure (e.g, 0.2%) would be indicative of probable funding constraint.

Research budget as a percent of public investment in Agriculture: FAO recommends 10% as a general guideline knowing the figure could swing widely depending on a multitude of variables.

Stability of funding: is very important, especially for salaries and recurrent costs.

Percent of external funding: can be positive in the short-term and negative in the long-term. A high percentage of external funding can threaten stability and flexibility at the institute level.

Table 2 and **Table 3** can be used for summarizing the relevant data for analyzing the operating budget of the NARS in total and distributed by commodity.

A 3.2 Various other ministries: refers to control (often restrictive) by other ministries; Finance, Economic Planning, etc..

A 3.3 Self-explanatory

A 3.4 Staffing adequacy: after determining the size and quality of the total NARS staff, determine how many competent scientists work in the commodity and disciplines of concern. **A two to one ratio of technician/scientist is considered a minimum.**

Table 4 and **Table 5** can be used to summarize the total number of the research staff by level of skill and discipline.

A 4.1 Self-explanatory

A 5.1 These external linkages are of vital importance for all African countries, especially with the International Agricultural Research Centers (IARCs). Attempt to score the apparent impact of the linkage.

B 1.1 The questions under B. are termed institute/program level but it may be more helpful to limit these questions to those elements which directly impact on the program under study.

B 1.2 Self-explanatory.

B 1.3 This set of indicators refers to staff in subject program only. Use **Table 6** and **Table 7** can be used to summarize the number of research staff assigned to a program/project by skill and discipline.

B 2.1 Self-explanatory.

B 3.1 Self-explanatory.

Table 2. NARS Total Operating Budget Analysis

	19xx	19xx	19xx	19xx	19xx
Personnel Costs					
Operating Expenses					
Total Operating Budget					
Capital Budget					
Total NARS Budget					
Personnel Costs as % of Total Operating Budget					
Budget per Researcher					
Change in Operating Budget					
Government Funding:					
Operating Budget					
Capital Budget					
Total Gov. Funding					
Donor Funding:					
Operating Budget					
Capital Budget					
Total Donor Funding					
% of Operating Budget Funded by Donors					
% of Capital Budget Funded by Donors					
Change in total Donor Funding					
Total Ag. GDP					
Total Public Investment in Agriculture					
Research Budget as % of Total Ag. GDP					
Research Budget as % Public Ag. Investment					

Table 3. NARS Total Research Budget by Commodity

	19xx	19xx	19xx	19xx	19xx
Maize					
Wheat					
Beans					
Sorghum					
Other					
Total Operating Budget					

Table 4. NARS Total Research Staff Analysis

	19xx	19xx	19xx	19xx	19xx
Research Scientists:					
BSc					
MS					
PhD					
Total Number of Research Scientists					
Postgraduate as % of Total Research Scientists					
Technicians:					
Trained					
All Other					
Total Number of Technicians					
Administrative & Support Staff					
Total NARS Staff					
Ratio of Technicians to Scientists					

Table 5. NARS Distribution of Scientific Staff by Discipline

	19xx	19xx	19xx	19xx	19xx
Plant Science:					
Breeding					
Pathology					
Entomology					
Soil Science:					
Agronomy					
Chemistry					
Taxonomy					
Animal Science:					
Breeding					
Husbandry					
Veterinary					
Social Sciences:					
Agro-business					
Economics					
Sociology					
Marketing					
Engineering:					
Mechanics					
Irrigation					

Table 6. Distribution of Research Staff by Program
Program:_____

	19xx	19xx	19xx	19xx	19xx
Research Scientists:					
BSc					
MS					
PhD					
Total Number of Research Scientists					
Postgraduate as % of Total Research Scientists					
Technicians:					
Trained					
All Other					
Total Number of Technicians					
Administrative & Support Staff					
Total Research Staff					
Ratio of Technicians to Scientists					

Table 7. Distribution of Program Scientific Staff by Discipline
Program: _____

	19xx	19xx	19xx	19xx	19xx
Plant Science:					
Breeding					
Pathology					
Entomology					
Soil Science:					
Agronomy					
Chemistry					
Taxonomy					
Animal Science:					
Breeding					
Husbandry					
Veterinary					
Social Sciences:					
Agro-business					
Economics					
Sociology					
Marketing					
Engineering:					
Mechanics					
Irrigation					

C 1.1 All questions under C. relate to linkages of research to extension, and the capability of the extension services to transfer technology to farmers. The extension service per se is not being evaluated, the indicators are used to determine efficiency of the system.

C 1.2 Self-explanatory. Use **Table 8** to summarize and analyze national extension (NES) services operating budgets.

C 1.3 Self-explanatory.

C 1.4 Self-explanatory. Use **Table 9** to tabulate and analyze the staff level of the NES.

C 1.5 The timeliness and accuracy of adoption reports are used to judge the adequacy and appropriateness of the monitoring and evaluation processes that are in place.

C 1.6 Self-explanatory.

Table 8. NES Total Operating Budget Analysis

	19xx	19xx	19xx	19xx	19xx
Salaries & Wages					
Operating Expense					
Total Operating Budget					
Capital Budget					
Total Extension Budget					
Salary & Wages as % of Total Operating Budget					
Budget per Ext. Officer					
Change in Operating Budget					
Government Funding:					
Operating Budget					
Capital Budget					
Total Gov. Funding					
Donor Funding:					
Operating Budget					
Capital Budget					
Total Donor Funding					
% of Operating Budget Funded by Donors					
% of Capital Budget Funded by Donors					
Change in Total Donor Funding					
Extension Budget as % of Total Ag. GDP					
Extension Budget as % Public Ag. Investment					

Table 9. Distribution of NES Staff by Gender

	19xx	19xx	19xx	19xx	19xx
Extension Officers					
Male					
Female					
Administrative & Support Staff					
Total Extension Workers					
Number of Farmers:					
Male					
Female					
Total Number of Farmers					
Farmers per Extension Officers:					
Male Farmers per Male Extension Officer					
Female Farmers per Female Extension Worker					
All Farmers to All Extension Officers					

Level II: Technology Generation & Transfer

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer				
A. Research System Output				
A.1 Rate of Technology Generation	1.1 Have new varieties and technologies been developed and released?	. Number of technologies generated . Number of technologies released . Number of scientific, technical and farmer level publications	Score 1 - 5	NARS, MOA
	1.2 Does the "Menu" of technological choices developed and offered to farmers accommodate different systems and situations?	. % of released varieties responding to low and high input systems . Proportion of technologies responding to specific NRM issues . Divisibility of package	Score 1 - 5	NARS, MOA
A.2 Suitability of Training Programs	2.1 Is sufficient training planned and given to collaborators and clients?	. Number trained by category (ST & LT Training) . Training aligned to goals of program . Adequate funding ear-marked for training	Score 1 - 5	NARS, MOA
B. Interaction between Research & Extension				
B.1 Effectiveness of the Collaboration between Research & Extension	1.1 Is the collaboration between research and extension effective?	. Frequency of interaction . Liaison officer . Baseline survey participation . Program-level or center-level planning meetings . Regularly scheduled field days . Publications . Regularly scheduled workshops . OFR or other trials . Tracking system exists.	Score 1 - 5	NARS, MOA
	1.2 Is there a satisfactory feedback mechanism to researchers?	. Number of programs changed based on feedback from extension.	Score 1 - 5	NARS, MOA MS&T
	1.3 Is there a suitable feedback mechanism to policy makers?	. Regularly scheduled meetings of research & extension staff with policy makers	Score 1 - 5	NARS, MOA MS&T, MOP

Discussion

Research System Output

A.1 Have an adequate number of technologies been developed and released?

This section is meant to identify and describe the technologies generated by the NARS and made publicly available to users. It is indicative of the productivity of research, and the expectations of the researchers in terms of the advantages of the new technologies and their potential benefits to target clients.

It does not record the extent of adoption of the technologies, which is covered in Level III. But the comparison of their actual use in Level III with the statement of expectations in Level II should provide valuable insights into the soundness of the researchers judgements concerning the needs and attitudes of their clients, and the appropriateness of the technology in meeting those needs.

A further product of this analysis should be to determine how far research output is aligned to national goals with respect to the development of technologies suited to the needs of small farmers and of women; to the alleviation of poverty and to the prevention of environmental degradation through better management of natural resources.

A.2 Suitability of training programs

Except at Universities, most researchers do not regard, training as an integral part of their duties. Yet, carefully planned courses for extension specialists, field level workers and farmers can be very valuable both in sensitizing researchers concerning the problems impeding the adoption of their technologies, and in alerting and educating extension staffs and clients concerning the potential benefits of new technologies and the optimum requirements for their utilization.

Interactions Between Research & Extension

Information on the nature, goals, frequency, and results of training linkages between researchers and users of technology can provide further valuable insights into reasons for the success or failure of research output.

B.1 How effective is the interaction between research and extension?

All of the questions in this section refer to the adequacy of the linkages between the extension service and the NARS, and of the feedback mechanisms from extension to researchers and policy-makers. Most of these issues have been dealt with under Level I and need not be repeated here. **Suffice it to say that this is a two-way relationship and effective linkages are essential to the success of both research and extension.** Neither service is doing the other a favor by not contributing its best efforts to making this a fruitful marriage. While there have been some instances of technologies

taking off without much initial involvement of extension, as in the early days of the "Green Revolution" in Asia, there have also been numerous ghastly failures when technologies were developed without adequate liaison between researchers and extension advisors.

Both services also need to collaborate at the level of their top management in providing impartial feedback to policy-makers on the progress and potential of the agricultural sector, and ideas on the measures, resources, and incentives required to realize that potential. There should be a tripartite policy linkage, either at the level of the parent Ministry or in a broader planning forum. In addition, the two services should collaborate in developing similar linkages with local government staff at the level of administrative districts or agro-ecological zones.

These linkages should not be self-serving in the sense of always pushing for more resources to research or extension, but if clear evidence can be provided to policy makers by those services of obstacles to the adoption of technology or to better use of natural resources which can be removed by timely government action, the chances of success in their efforts will be enhanced.

Using and Scoring the Matrix

Level II is concerned exclusively with technology developed for the program under study. It may refer to more than one institute if more than one is involved. The scoring is 1 to 5 as in the case of Level I. If the NARS is producing appropriate technologies, with high potential adoptability by clients, it receives a high score. Emphasis should be placed on quality rather than on quantity of research output.

A 1.1 How productive is the system? Is the NARS turning out new technology? The term "released" can be interpreted as officially transferred from NARS to the extension system. Publications are a source of information on technology generation. A format similar to **Table 10** can be used to list the specific technologies generated and released for adoption.

A 1.2 All biological technologies are affected by the environment in which they are applied. Researchers must take this into consideration when developing a product to accommodate different situations. The low and high input systems refers to levels of inputs based on a knowledge of anticipated farming intensity or environmental response.

A 2.1 This training does not refer to research strengthening but rather training to promote long-term impact of the program.

B 1.1 Self-explanatory

B 1.2 Feedback is necessary to ensure that the problems facing the farmers are being resolved by NARS rather than by an insular agenda. Feedback is important by whatever the method.

B 1.3 The feedback from farmers to policy-makers can be through the extension service. The pathway is less important than the response of the policy makers.

Table 10: New Technologies Generated & Transferred

Commodity:_____

	Variety 1	Variety 2	Variety 3	etc.
Name of variety				
Date Released				
Agro-ecological Zone: Altitude Rainfall Soil-type				
Days to Maturity				
Recommended Farming System				
Expected Yield				
Input Use: Seed (Ton/Hec) Fertilizer (Kg/Hec) Pesticides (Kg/Hec)				
Storing Quality (1=poor, 5=Excellent)				
Taste (1=poor, 5=Excellent)				
Relative Price Index				
Number of Collaborator & Client Trained: Short Term Long Term Degree Non-degree				
% of Arable Land to be affected				

Level III: Intermediate Impact

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact				
A. Technology Adoption & Utilization				
A.1 Level of Technology Adoption	1.1 Have new technologies been adopted by farmers?	. Number of technologies adopted - New seed varieties - Other technologies (specify) . Completeness of adoption (for each technology)	Score 1 - 5	NARS, MOA Sample Survey
	1.2 How beneficial was each technology as viewed by farmers?	. Shorter maturity . Increased yield . Improved quality . Improved Taste . Higher price . Resistance to biological stress . Better storage life etc:	Score 1 - 5	NARS Sample Survey
	1.3 How widely has each new technology been adopted?	. % of total arable area affected by the new technology . % of total crop adopting the new technology . % of total program area affected by new technology . % of farmers adopting new technology - in crop area - in program area - by farm size - by gender	Score 1 - 5	MOA NBS Sample Survey District Commissioners
A.2 Restrictiveness of the Constraints to Adoption	2.1 How severe are the major ecological factors limiting adoption?	. Soil Problems (fertility, salinity, alkalinity, impeded drainage etc.) . Climatic variability (temperature, variability and distribution of rainfall) . Slope . Pests	Score 1 - 5	NARS, MOA

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. **Intermediate Impact** (cont'd)	2.2 Is the availability and supply of key agricultural inputs limiting adoption?	. Sufficient supply of farm inputs . Appropriate choice of input (packaging size/quantity, toxicity, application difficulty, and storability) . Timing of input purchase . Accessibility to farmers (conditions of rural roads and availability of nearby input distribution outlets) . Availability of credit . Prices of inputs	Score 1 - 5	NARS, MOA Sample Survey Central Bank USAID
	2.3 How formidable are market constraints?	. Farm to market transportation: - average distance farm to market - proportion of transport cost to total cost . Farmgate vs market price . Required marketing channels . Nature & availability of market information . Onerous marketing standards	Score 1 - 5	MOA, MOPW NBS Sample Survey Marketing Boards
	2.4 How adequate are processing and storage facilities?	. Losses & deterioration of quality: - On-farm - Off-farm . Sufficient capacity	Score 1 - 5	MOA, NBS Sample Survey Commodity Boards Cooperatives
	2.5 How significant are the producer disincentives created by restrictive government policies?	. Price & Tax policies . Subsidies . Overvalued exchange rate	Score 1- 5	Special Studies USAID WORLD BANK
	2.6 How has the technological change influenced government policy?	. Price and/or subsidy policy . Input policy . Marketing policy . Tax policy . Exchange rate policy . Land reform . Public investment in irrigation, infrastructure, and institutional support to research & extension	Score 1 - 5	Special Studies USAID WORLD BANK

Discussion

Technology Adoption and Utilization

This important section asks two main questions which take the analysis of the productivity of research a stage further toward the quantification of the impact of technological change. These questions are:

A.1 What new technologies have been adopted (A.1.1); how widely (A.1.2); and why, and in what respects was each technology seen as beneficial by the farmers (A.1.3)?, and

A.2 What are the major constraints limiting adoption in terms of ecological factors (A.2.1), input supply (A.2.2), markets (A.2.3), processing and storage facilities (A.2.4), and government policies (A.2.5 and A.2.6)?

A.1 Level of Technology Adoption

The rate and extent of adoption of the new technology by farmers is measured as an intermediate impact indicator.

A.1.1 This question seeks specific information on the nature and number of new technologies which have actually been adopted by clients, and the extent of their adoption in terms of the proportion of the area affected by each new technology at the level of the program being evaluated, the total area of the commodity concerned, and the total arable and permanent crop area of the country. The latter takes account of the fact that the successful adoption of a new technology may lead to shifts in land use in favor of the commodity or commodities which benefit from it. This shift could be at the expense of other commodities (as occurred in India following the introduction of high-yielding varieties of wheat, when wheat area expanded at the expense of pulses.) Or it could be from the extension of production of a commodity into new land not previously cultivated.

A.1.2 This information is complemented by an indicator of the completeness of adoption expressed in terms of the percentage of the farmers at each of the above levels who have adopted the technology concerned over time. It is important to be able to evaluate both the speed of adoption and the level of adoption in assessing the benefits of a new technology. There are instances of very rapid early adoption on a relatively small proportion of the total area, followed by slower growth for several more years or even a decline in the area covered. In other cases, initial adoption is slower, but the level of adoption continues to expand for a lengthy period, and may accelerate as its benefits become more widely known, before tailing off. Evaluation at different points in time is necessary in order to capture these lagged effects. They are particularly valuable in calculating rates of return to research investment, and need to be assessed in value as well as area terms for this purpose.

In evaluating impact it may be possible to show how the rate and level of adoption would have changed had the research program not been in place, and to calculate how this would have affected the rates of return in financial terms. An interesting exercise along these lines was undertaken by the NARS in Panama.

A.1.3 From the point of view of the researchers, analysis of their clients' perceptions of the advantages of new technologies released to them is crucial. On-farm trials are a first step in this process, allowing adjustments to be made before final release. But sampling of farmers reactions to the finished product should be undertaken with the help of extension staff at intervals after release, so that further refinement can take place over time. It may be necessary to supplement this process by sampling reactions of processors or other end-users, especially for crops of commercial importance. This information will probably be mainly qualitative and judgmental but is nonetheless extremely important in setting future goals for research.

Constraints to Adoption

Various types of constraints to adoption are identified as intermediate impact indicators under Level III A.2. They include:

2.1 The ecological situation (climate, soil, slope, water supply, pests and diseases (human, animal, crop).

2.2 Limited availability, high price, unsuitability or unreliable supply of key inputs.

2.3 Constraints imposed by markets or their absence.

2.4 Inadequate or poorly located processing and storage facilities.

2.5 Disincentives created by government policies.

It is not possible to discuss all of these limiting factors in detail, but certain considerations relating to their importance merit emphasis. These are:

i. While the majority are outside the control of individual farmers, in some cases the farmer may be able to mitigate their impact by changes in his/her traditional practices. These may range from shifts in variety (to increase resistance to disease, pest, or stress or to shorten maturity); shifts in agronomic practices (planting date, spacing, inter-cropping) to avoid pest or weed problems, reduce labor peaks, or stagger harvesting and maturity; reduction in the area cultivated by a particular crop (to mitigate labor constraints); changes in the composition and levels of inputs use (to reduce costs, or overcome shortages of certain inputs); increased

investment in on-farm storage or a change to varieties which store better; or restructuring of the farming system.

ii. Producers perceptions of the benefits of a new technology may not coincide with those of processors or consumers, and may therefore be reported by farmers as constraints to adoption. New disease-resistant cassava varieties in Africa have disadvantages compared to traditional cultivars in terms of their root quality and storage life in the soil. White maize is preferred to yellow maize for domestic consumption in much of East Africa, but yellow maize is required for export sales. Existing maize hybrids in East Africa are soft and harder to dehull than flint types. They tend to be rejected where farmers are accustomed to eating dehulled maize for home consumption.

However, if researchers are alert to these preferences they may be able to develop varieties which offer a wider menu of choice to the farmers, allowing them to allocate land and resources to varieties which better match their own needs and those of the commercial market according to their goals. Under those circumstances market constraints may be reduced.

iii. **Thus the analysis of intermediate impact under A.1 and A.2 must be seen as complementary, with benefits and constraints being viewed in many respects as two sides of the same coin.**

iv. The analysis of the ecological situation should be part of the strategic planning process both for the NARS as a whole, and for each major component of the system. Unlike most of the other constraints the natural resource base cannot easily be modified to favor a technology, except in some cases over the long-term, for example, by irrigation. Rather the reverse has to be the case. The concept of definition of agro-ecological zones (AEZ) characterized by the length of their growing season on the basis of temperature, moisture availability, potential evapo-transpiration, soil characteristics, and slope is now widely recognized, and is a valuable tool for applied and adaptive research strategy, including determining the suitability of technologies developed in one country to introduction to a given environment elsewhere.

The use of the AEZ methodology should help to reduce errors resulting from poor definition of growing conditions for a given commodity or target area, thus giving precision to research goals. It should **precede** the establishment of research programs wherever possible, thus allowing quantitative targets and resource requirements to be assessed **ex ante**, which can also provide baseline data for evaluation of impact **ex post**.

v. The remaining constraints identified under A 2.2 through A 2.5 are less inflexible than those listed under A 2.1, and more amenable to government intervention. They are also closely inter-linked. For example, a well-developed infrastructure is important not only for providing producers with access to knowledge about new technologies and to the inputs and credit which may be required for their successful adoption, but also to giving them access to

markets and processing industries. Adoption studies by CIMMYT, IRRI, and IFPRI clearly identify infrastructure as a crucial factor in adoption.

But government policy towards investment in infrastructure may be the ultimate determinant, and this may be based on policy-makers' perceptions of the importance of the area concerned--economically or politically, the actual costs and expected returns of the infra-structural development, and the opportunity costs versus alternative uses of the money.

Techniques such as Domestic Resource Cost Analysis may be helpful in reaching a decision, but this is more likely to be undertaken at the level of national planning than by the NARS because of the various other interests concerned.

vi. The role of government is also pervasive with respect to other components of the adoption process. Its decisions may impact directly on producer incentives through prices, exchange rate policy, taxation (especially with respect to agricultural exports), interest rates or subsidy policies; or indirectly through investment in irrigation, infrastructure, research or extension, marketing institutions, or agricultural industries.

The importance of having a good analytical capability with respect to policy in the NARS therefore cannot be over-emphasized. Unfortunately this is often not the case, and even where it exists it is generally located in a central unit, and is not well developed at the level of individual institutes and programs. Consequently, feedback to policy makers of the problems and constraints created by national policy at the local level is inadequate. This is generally one of the weakest linkages within and from the NARS, and a serious constraint both on the formulation of sound research policy and on the evaluation of the impact of research.

vii. Although constraints on adoption related to input use are closely linked to government policy, including investment in infrastructure, timely delivery, attitudes to the private sector, foreign exchange availability, and prices, and subsidies; research also has a major role to play in providing options to farmers which mitigate those constraints. These include development of varieties which use inputs most efficiently or which reduce input requirements (tolerance of pests, diseases, or weeds); advice on options in the choice of inputs, especially different combinations and levels of fertilizer use; agronomic practices and combination enterprises in farming systems which make effective use of inputs through synergistic effects, residual benefits, etc.; improvement of storage methods to reduce post-harvest losses; and so on.

Establishing quantitative Level III relationships between these constraints and the adoption of new technology is not easy. It is difficult to identify how much higher the levels of adoption might have been had a given constraint not existed. Moreover, if that constraint had been eliminated another might have proved equally limiting (as with Liebig's Law concerning plant nutrients). The complex interactions and linkages among the various constraints listed in Level III often over-ride the direct effects of any one individually; for example, although a low-level of adoption of Nitrogenous

fertilizer may appear as the first-order constraint there may be second-order constraints (lack of foreign exchange, inadequate infrastructure, etc.) which have to be overcome before the real solution to the fertilizer application issue can be found.

Thus, the measurement of impact has to be dealt with in more direct terms related to tangible benefits of a given technology or set of technologies; the problem then being to attribute those benefits to specific aspects of adoption and to attempt to assess whether those benefits might have been even larger had some of the constraints identified by the Level III analysis been removed. The link between this analysis and the quantitative assessment in Level IV of the effects of adoption of research output is, therefore, extremely crucial.

Using and Scoring the Matrix

In Level III, the questions are commodity/technology specific. There may be more than one technology and each technology may be divisible into a " menu " of recommendations.

A 1.1 Here, the technologies are to be identified and disaggregated and are to be presented in this manner throughout Level III. It must be possible to know specifically what the farmers are adopting. Data for this section can only be collected at the farm level. Trends can be established when data are collected over time. Refer to Table 10 for the list of specific technologies under question.

A 1.2 The list presented is not all inclusive. Develop a list of all reasons given for adoption and non-adoption.

A 1.3 The percent of area adopting and the percent of farmers adopting refers to the program area, the area in which the new technology was presented. When the technology is adopted on farms previously growing other crops, so state. To measure change over time, take adoption rates as a percent of program area, of total crop area in the country, and of total farm land in the country. Potential impact predictions can be made from the trends produced from data taken over time. Use **Table 11** to organize the data for analysis.

A 2.1 -
A 2.6 Question A 2.1 through A 2.6 address the issue of constraints to adoption. These include input availability, market restrictions, storage problems, restrictive government polices, and ecological factors. The list could be expanded to include all constraints that may have a significant impact on adoption. **The whole purpose of determining constraints to adoption, is to find ways to redirect the program and to solve as many of the critical problems as possible in order to increase impact. Table 12** is offered to assist in organizing constraint factors. Adoption studies are necessary to collect these data.

Table 11. Level of Technology Adoption
Program/Commodity:_____

	19xx	19xx	19xx	19xx	19xx
Total Arable Area					
Total Crop Area					
Total Program Area					
Affected Area as % Of:					
Total Arable Area					
Total Crop Area					
Total Program Area					
Total Production:					
Arable Area					
Crop Area					
Program Area					
Change in Yield:					
Arable Area					
Crop Area					
Program Area					
% of Farmers Adopting New Technology in:					
Arable Area					
Crop Area					
Program Area					
By Farm Size					
By Gender					

Table 12. Factors Limiting Technology Adoption
Program/Commodity: _____

	19xx	19xx	19xx	19xx	19xx
Farm-To-Market Roads (in Kilometers)					
Change in Farm-to-Market Roads (in Kilometers)					
Average Distance to the Nearest Seed Outlet					
Average Distance to the Nearest Fertilizer Outlet					
Average Distance to the Nearest Pesticide Outlet					
Farm Credit Available:					
Total					
By Farm Size					
Change in Avail. Farm Credit:					
Total					
By Farm Size					
Value of Production					
Value of Farm Input					
Ratio of Value of Production to Value of Farm Inputs					

Level IV: Long-Term Impact

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact				
A. Impact on Agricultural Productivity	1.1 By how much has the technology increased agricultural productivity?	For relevant crops: . Change in yield . Stability of yield . Change in aggregate production . Change in gross value of production per farm by farm size	Score 1 - 5	NBS MOA WORLD BANK FAO Sample Survey
	1.2 Has the technology caused a significant increase in agricultural investment in the program area?	. Investment in farm improvement (e.g., drainage, liming, soil conservation, fencing water supply, buildings, machinery, livestock, trees, roads); . Electrification	Score 1 - 5	NBS MOA, MOPW Sample Survey
	1.3 Has the new technology affected farmers cropping intensity?	. Soil cultivation . Weed control . Planting date . Population . Irrigation . Mechanization	Score 1 - 5	Sample Survey
	1.4 Has the new technology increased expenditures on agricultural inputs?	. Fertilizer . Seed . Pesticides . Labor . Tools . Power	Score 1 - 5	NBS Sample Survey
	1.5 Has there been a technology related shift in farming systems?	. Inter-cropping . Alley cropping . Crop substitution . Introduction of livestock into system	Score 1 - 5	Sample Survey
B. Effect on the Natural Resource Base	1.1 How sustainable is the technology adopted?	Changes in: . land use . farm size . forest cover . erosion . sedimentation . desertification . salination . pollution	Score 1 - 5	Sample Survey

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact (Cont'd)				
C. Influence on Net Farm Income	1.1 Has there been an increase in net farm income?	. Change in net farm income (distribution & by commodity composition) at national aggregate level in real terms. . Change in net farm income per farm in real terms disaggregated by farm size, male per female household heads, by commodity	Score 1 - 5	NBS, MOA USAID WORLD BANK Sample Survey
D. Consequences on Food Security	1.1 Has agricultural research improved food security?	. Change in per capita food production by major commodities . Reduced variability in agricultural production. . Change in per capita food imports by value by major commodities . Change in food exports by value . Adequate carryover stocks of basic food stuffs	Score 1 - 5	NBS, MOA WORLD BANK FAO
E. Effect on Rural Agro-Industrial Transformation	1.1 To what degree has agro-industrial transformation occurred?	. Increased rural employment . Increased number of rural-based small enterprises by regions (female vs male-owned) . Increased rural savings	Score 1 - 5	NBS, MOA WORLD BANK FAO
F. Impact on Nutritional Improvement	1.1 Has agricultural research improved health?	. Reduction in number of people in poverty . Increased caloric consumption per capita . Improved weight to age ratio in children . Increased longevity	Score 1 - 5	NBS, MOA MOH WORLD BANK FAO

Discussion

As in the case of the Level III indicators, there are several categories of direct impact of agricultural research. The main difference between the Level III and Level IV Indicators is that the latter can all be expressed in quantitative terms, although the units of measurement are not the same for every category.

Nor can all of the indicators listed in the matrix be quantified with equal case either within each question or between them. Some, such as the impact of a piece of research on the yield or value of a given crop over time may be adduced from the national statistics, especially if that research was of a distinctive nature, such as the development of high-yielding varieties to replace others markedly inferior in yield. The fact that a variety owes part of its impact to additional fertilizer, water, or other inputs made remunerative by its higher yield potential need not detract from its value as the main carrier of those inputs, since without that potential they would probably not have been used. The evaluation should be expressed in terms of the benefits to the yield-increasing technology, net of the additional costs of seed, inputs, field operations, and labor.

However, evaluating the impact of the same variety on farm income at the level of individual farms, disaggregated by farm size or the gender of the head of household, has to be tackled either at the research program or project level, or in terms of a target population, by an appropriate sampling procedure.

Although several of the indicators can be measured in aggregate at the national level this is only possible in individual cases after a lengthy period and when the effects of a given technological change has been very large--the impact of the Mexican wheat derivatives in India and Pakistan, and of the IRRI rice varieties in S.E. Asia are two such examples. Another is Kitali Maize in Kenya (see Karanja, 1990, and MSI, 1990 a.)

Another form of impact evaluation which requires national-level data is where the productivity of the NARS as a whole is at issue. This is difficult and complex because of the interactions among components of the system, and the fact that an increase in the output of one commodity due to technological change may reduce the area of another. Increases in productivity may shift the supply curve upwards leading to reductions in prices. Some components of a NARS may generate indirect or qualitative benefits which will have multiplier effects in the long term but which cannot easily be measured or valued, such as increased knowledge and skills. These have largely been ignored in the past. The social returns to a technological change may be negative, or the distribution of benefits may be different from those expected. Both costs and benefits must be known or derived in order to calculate rates of return. It may not be possible to net out the adverse effects of inept government policies or inconsistent donor support. Different types of research undertaken in the country concerned or "borrowed" from elsewhere need to be taken into account in assessing the total stock of knowledge, the determinant of productivity change and how its benefits are distributed. An analytical framework has to be developed with appropriate criteria, and data relevant to those criteria have to be collected over time.

When technological change is largely confined to a project area, its impact on marginal productivity at the national level will be difficult to detect unless the area concerned is a substantial proportion of the total for that commodity. Yield data can be collected at the local level by crop cutting, sampling at harvest, or rapid appraisal methods. Other measures of impact such as increased real income per farm by farm size or the gender of the farm manager or improvement in family nutrition and health are difficult to assess except by farm survey techniques, including anthropometric measurements in the case of some aspects of nutrition.

What we are in fact attempting to evaluate at the level of impact is not simply a research system or program, but an agricultural technology management system. Koppel (1990) suggests that such a system must develop a baseline understanding of:

1. Who the primary end-use clients are?
2. What characterizes their farming enterprises and household economies?
3. What their existing problems are?
4. What strategies they currently choose to address these problems?

and, for impact assessment,

5. Is the output of the system addressing the correct problems and reaching the farmers who actually have these problems?

In order to provide this knowledge it is necessary to describe the project area, describe the problems and how people currently address them, and identify and describe potential beneficiary groups.

Koppel argues that an important goal of the evaluative procedure is to understand the linkages between activities (inputs) and accomplishments (outputs and their effects) an objective also stressed by ISNAR (Murphy 1985). The key questions are "did we produce the outputs we wanted" and "did the outputs have the effects we expected". A further stage is to evaluate the decision-making process--how the outputs and effects were achieved; who made the decisions, who benefitted from the program, and who paid for it. Were there consequences and benefits which were significantly different from those planned? This involves tracking the chain of effects and the linkages between outputs and inputs, and trying to measure their impact through various indicators over time.

As will be seen from the lengthy list of indicators specified under Level IV of the matrix, this process can be very demanding of quantitative information. A number of approaches have been developed in recent years which provide information of the type required for impact evaluation both **ex ante** and **ex post**. These include:

i. On-farm studies of constraints to increased yields and consequences of the adoption (or non-adoption) of new technology on yield, cropping intensity, labor use, and the distribution of income among and within households. Studies of this nature have been undertaken ex post by several of the International Agricultural Research Centers, including IRRI, CIMMYT,

ICRISAT, and IFPRI. They have been directed to improving the understanding of the factors which affect or contribute to adoption or impact under different sets of circumstances for their priority commodities and the farming systems in which they are cultivated. In some cases they have been undertaken to shed light on a controversial issue: for example, IFPRI's analysis of the effects of shifting from a predominantly subsistence food-based economy to growing certain crops for cash, on the income and welfare of farmers. Another example is ICRISAT's yield gap analysis work in India, designed to detect and understand the reasons for gaps between potential and actual farm yields. ICRISAT has also looked at patterns of income and consumption in West Africa, and found that a much larger proportion of income was earned from non-farm sources in the drier Sahelian zone than in the more favorable Sudanian climatic zone. This study highlights the importance of disaggregation by region, household wealth, and season in studying food consumption.

ii. **On-farm Client-Oriented Research** (OFCOR), which aims to complement experiment-station research with a series of operational activities at the farm level (ISNAR 1989). These include diagnosis and ranking of problems; design, development, adaptation and evaluation of appropriate technological solutions, with direct involvement of researchers and farmers at several stages of the process as well as extension and development agencies.

Such activities form part of the general field of research with a farming systems perspective and now represent an integral part of the regional or ecological zone research component of many NARS. They provide essential inputs both to the Level III analysis of intermediate impacts, especially those related to the what, why, and how of adoption; and to the impact analysis in Level IV, which attempts to value the effects of adoption. As well as providing information to researchers as to the appropriateness of their products, they are an essential element of the framework for evaluation in the NARS.

iii. **Various forms of survey.** These may be directed primarily to improving understanding of a situation prior to undertaking a research program as part of the planning process; or for gathering data ex post for evaluative purposes.

Pre-investment surveys may involve characterization of agro-ecological zones to establish baseline data on the physical and land use situation in a program or project area; followed by rapid rural appraisal to determine the social and economic parameters and identify "recommendation domains" where farming or other conditions are reasonably uniform over a substantial area. The AEZ assessment and rural appraisal may be sufficient to characterize the situation ex ante, and establish the broad parameters of a research program, they may also be useful for gathering yield and other quantitative data ex post. In-depth surveys of farmers are usually needed for the collection of quantitative data on impact, especially that related to farm investment, constraints, farm income, employment effects, household nutrition and food security.

These surveys need to be built into the planning of research at the institutional level and budgeted for at the program level. Donors should be aware of this need, and be prepared to help with advice and funds to support their conduct and analysis.

Using and Scoring the Matrix

Impact will be studied on two tiers: a) at the farm level in the program area with data gathered through case studies, and b) at the national level using national statistics. In some cases, it may be inappropriate to extrapolate sample survey data to national adoption impacts. Major emphasis will remain with the technology program unless stated otherwise.

The highest impact will be at the farm level with farmers who have successfully adopted the technology. Conversely, the lowest percentage change will be at the national food security level because of the dilution effect of the multitude of people outside the change area. Both figures are needed for a balanced impact determination.

Tables 13, 14, and 15 will be of assistance in tabulating agricultural productivity, farm income, and food security data over a number of years. The questions in section IV are self-explanatory.

Table 13. Impact on Agricultural Productivity
Commodity: _____

	19xx	19xx	19xx	19xx	19xx
Aggregate Production ('000 of Metric Tones)					
Crop Area ('000 Hectare)					
Change in Aggregate Production					
Yield (MT/Hec)					
Change in Yield					
Expenditure on Ag. Inputs					
Change in Expenditure on Ag. Inputs					
Value of Production: per Hectare					
per Farm (by size)					
Value of Production as % of GDP					
Value of Production as % of total Public Investment in Agriculture					

Table 14. Impact on Farm Income

	19xx	19xx	19xx	19xx	19xx
National Level:					
Gross Farm Income					
Cost of Ag. Inputs					
Cost of Hired Labor					
Net Farm Income					
Change in Net Farm Income					
Distribution of Net Farm Income by Commodity:					
Commodity 1					
etc.					
Change in Net Farm Income by Commodity:					
Commodity 1					
etc.					
Distribution of Net Farm Income by Farm Size:					
Farm Size 1					
etc.					
Change in Net Farm Income by Farm Size:					
Farm Size 1					
etc.					
Change in Distribution of Net Farm Income by Gender					
Female owned Farms					
Male owned Farms					

Table 15. Impact on Food Security

Commodities:_____

	19xx	19xx	19xx	19xx	19xx
Value of Total Food Production					
Value of Total Food Imports					
Less Value of Total Food Exports					
Less Buffer Stock					
Total Value of Food Consumption					
Value of Food Consumption per Capita					
Change in Value of per Capita Food Consumption					
Value of Food Imports per Capita					
Change in Value of Food Exports per Capita					
Change in Value of Buffer Stock					

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ANNEXES

ANNEX A

Kenya Maize Commodity Research Program

Kenya Maize Commodity Research Program

Objective of the NARS:

To develop agricultural technology which will promote increased production of food and industrial crops, including livestock products, so as to maintain food self-sufficiency and reduce dependence on imported food and industrial crops. Increase the production of maize by 4.6% per annum.

Agricultural Research Impact Assessment

I. INSTITUTIONAL BASE

The Kenya Agricultural Research Institute (KARI) has been reorganized and strengthen. KARI operates as an autonomous research institute with its Board of Directors (Management) including the Permanent Secretaries of Ministry of Agriculture, Ministry of Livestock, Ministry of Environment and Natural Resources, Ministry of Health, Ministry of Water Development, Ministry of Industry, Ministry of Tourism and Wildlife, Ministry of Energy, Ministry of Land and Settlement, National Council for Science and Technology and the Vice-Chancellor of Moi University. This apex body makes policy decisions and sets research priorities consistent with national economic development objectives.

KARI has well established linkages with international research institutions including the Consultative Groups of International Agricultural Research Centres (CGIARCs), International Centre of Insect Physiology and Ecology (ICEPE) and the International Centre for Research in Agro-forestry (ICRAF). KARI also has linkages with private sector research institutes such as the East African Industries, the Kenya Breweries of East Africa and Wellcome Company.

KARI's scientists participate actively in workshops and seminars of various scientific societies which include the Animal Production Society of Kenya, Soil Science Society of East Africa, Agronomy Society of Kenya, Plant Pathology Society, African Potato Association and East African Society of Parasitologist. These workshops and seminars are used as a forum for discussing research results.

Kenya's agricultural research system currently employees:

Researchers	537
Technicians	1,285
Non-research Staff	4,374
Total	6,196

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The ratio of Technicians to Researchers is approximately 2 to 1.

In terms of funding, KARI is well funded. For the calendar year 1989/90 KARI's total research budget was estimated at KSh 27 million. However, personnel costs as a percent of total recurrent budget is significantly high, averaging about 82 %. Agricultural research budget is approximately 1.5 % of the Kenya's total agricultural Gross Domestic Product (GDP).

	('000 of KSh)
Personnel Costs	11,277
Operating Expenses	2,491
Total Recurrent Budget	13,768
Other	13,579
Total Research Budget	27,347
Personnel Costs as % of Recurrent Budget	82%
Research Budget per Researcher	51
Total AG. GDP	1,814,000
Research Budget as % of Ag. GDP	1.5%

It also appears that agricultural extension services are well funded. The estimated budget for extension service for the calendar year 1989/90 is shown below.

	('000 of KSh)
Personnel Costs	10,514
Operating Expenses	1,157
Total Recurrent Budget	11,671
Personnel Cost as % of Recurrent Budget	89%

On the basis of our analysis of KARI's financial, organizational and management KARI receives an overall score of 3 for Level I in the ARIIM matrix.

II. TECHNOLOGY GENERATION & TRANSFER

KARI's maize research program is geared to maize breeding, maize agronomy, maize production systems, maize protection and maize quality improvement. KARI has been successful in developing and releasing new maize hybrids. In 1989 alone three varieties were developed and released.

Variety	Growing Altitude (ft)	Days to Maturity	Yield (Ton/Hec)
PH I	0 - 1,300	100 - 130	3.78
DC I	1,000 - 1,900	80 - 110	2.89
H626	1,500 - 2,100	180 - 240	6.78

In terms of technology KARI received an overall score of 3 for Level II in the ARIIM matrix. Had the linkage between researchers and farmers been strong KARI would have attained a higher score.

III. INTERMEDIATE IMPACT

Adoption rate has historical been significantly high for new hybrid maize. There are considerable constraints that have limited adoption, however. Movement restrictions and availability of agricultural inputs such as fertilizers, pesticides, and credit have been most limiting. The gap between actual and potential yield per hectare is indicative of limitations in the use of fertilizers.

Over all KARI received a composite score of 3 for Level III in the ARIIM matrix.

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IV. IMPACT

Maize is a very important food crop in Kenya. However, production of maize has not kept up with the growth of the population which is about 3.8 % per annum. The objective of increasing maize production by about 4.6% per annum has not been achieved.

	1986	1987	1988	1989	1990
Production (000 MT)	2,825	2,450	2,860	2,810	2,840
Crop Area (000 Hec)	1,795	1,600	1,800	1,815	1,830
Yield (MT/Hec)	1.57	1.53	1.59	1.55	1.55
Change in Yield --	(2.5%)	3.9%	(2.5%)	0.0%	
Change in Production	(13.3%)	16.7%	(1.7%)	1.1%	

Overall KARI received a composite score of 2 for Level IV. This score reflects the fact that the production growth rate is significantly below the targeted growth rate of over 4.6% per annum and that production growth over the last decade did not keep pace with the growth in the population of Kenya.

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AGRICULTURAL RESEARCH IMPACT INDICATORS MATRIX

KENYA - MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base				
A. National Level				
A.1 NARS Institutional Capacity	1.1 Is the NARS adequately coordinated or highly fragmented?	. Presence of apex management organization (i.e., Ag. Research Council) . NARS management and control centralized under few ministries or departments . Regional differences addressed within a coordinated framework . NARS enjoy reasonable autonomy	3	NARS, MOA MOP, MS&T
	1.2 Does the NARS provide for adequate linkages among MOA research institutions, other relevant ministries, universities, NGOs, farmers, development projects, local agro-business, private sector research organizations?	Linkages with respect to: . Priority setting process . NARS board membership . Training . Technology & seminars in exchange . Contract or collaborative research (in & out) . NARS representation on other boards	3	NARS, MOA MOP, MS&T NGOs Universities USAID
A.2 Adequacy of NARS Policy & Plan Formulation Process	2.1 Does the country have an effective organization for planning, management, or coordination of the NARS in line with national agricultural policy?	. Research programs support national ag. polices. . Research program priorities set by national planners. . NARS operating budgets reviewed and approved by national planners.	3	NARS, MOA MOP, MS&T
	2.2 Are existing processes adequate for setting research priorities and for resource allocation?	Process accounts for: . The potential impact of the research thrust on the national economy and society, including the area affected, value of the commodity, changing demand, urgency of problem, constraints, distribution of benefits, political considerations, availability of external technology, extent of NARS staffing including scientists per commodity group, the probability and cost of research success.	3	NARS, MOA MOP, MS&T

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ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Cont d.)	2.3 Are the planning and policy formulation linkages between national planners and NARS effective?	Extent of NARS involvement in formulating agricultural policies: . input polices . output polices . foreign exchange polices	3	NARS, MOA MOP, MS&T
	2.4 Are there adequate facilities for collecting, analyzing, and updating agricultural research related data?	Organization and procedures for: . Collecting baseline and time series data on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc. . Data analysis & reporting	2	NARS, MOA MOP, NBS
A.3 NARS Financial & Human Resources Strength	3.1 Does NARS receive an adequate level of funding overtime?	. Total budget for research(i.e., salaries & wages, operating expenses plus capital expenditures) . % of actual funding to approved budget . Salaries & Wages as % of total operating budget . Stability of funding overtime and by sector . Research budget as % of Ag. GDP . Total expenditures per researcher . Research budget as % of public investment in agriculture . % of budget from external sources	3	NARS, MOA, MOF/Treasury, MS&T WORLD BANK FAO USAID
	3.2 Does NARS have adequate control over donor-financed research?	Donor-financed research activities initiated, received and coordinated by: . NARS . the parent ministry . various of other ministries	?	NARS, MOA MS&T, MOF/Treasury USAID
	3.3 Are adequate accounting procedures and staff in place throughout the system?	. Centralized Financial Management System . Clear and proper accounting procedures . Timely reporting of financial transactions	?	NARS, MOA, MS&T

KENYA MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Contd)	3.4 Is NARS adequately staffed to perform research activities articulated in the national agricultural strategic plan?	. Size of system (number of scientists) . Quality of system (number of postgraduate to BS) . Ratio of trained technicians to scientists . Distribution of researchers by commodity and/or disciplines	3	NARS, MOA MS&T WORLD BANK FAO
A.4 Effectiveness of Monitoring & Evaluation Process	4.1 Are monitoring and evaluation processes adequate?	. Active annual process . #of projects revised or canceled . Provisions for external reviews . Peer or expert review . # of projects redesigned	?	NARS, MOA MS&T
A.5 Soundness of NARS External Linkages	5.1 Does the NARS have satisfactory linkages with IARCs, developed countries, international private sector research institutions (e.g., agro-business)?	Linkages with respect to: . technology exchange . training . networking . consultation	3	NARS, MOA MS&T, MOE Universities
B. Institute/Program Level				
B.1 Appropriateness of the Program Planning and Management Process	1.1 Do programs have a soundly conceived research plan?	. Program plan incorporates: - farmer organizations feedback - agro-ecological, provincial, and cultural differences . Plan articulates priorities and allocates resources . Plan includes program budget with projections for salaries & wages, capital expenditures and operating expenses . Plan is properly documented	2	NARS, MOA MS&T, MOP
	1.2 Is program adequately funded?	. Proportion of funding to requested budget . Expenditures directly controlled by program/station . Funds are received on a timely manner	3	NARS, MOA MS&T,MOF USAID

KENYA - MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Contd)	1.3 Are programs adequately staffed?	. Size of program (# of scientists per programs) . Quality of program (# of postgraduates to BS) . Ratio of technicians to scientists	3	NARS, MOA MS&T WORLD BANK FAO
B.2 Soundness of Institute/Program Linkages	2.1 Within programs are linkages among disciplines adequate?	. Programs designed and worked on by a multi-disciplinary team . Program results reviewed by a multi-disciplinary team . Institute and programs have both formal and informal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agro-business organizations for problem identification, program formulation and execution.	3	NARS, MOA MS&T Universities
B.3 Effectiveness of Program Monitoring & Evaluation Process	3.1 Are program level monitoring and evaluation systems adequate?	. Active annual process . #of projects revised or canceled . Provisions for external reviews . Peer or expert review . # of projects redesigned	?	NARS, MOA MS&T
C. Sufficiency of the Institutional Capacity of Extension Services	1.1 Is there an adequate institutional base for extension?	. Presence of APEX management (i.e. Extension Services Consul) . Extensions management & control centralized under few ministries and departments . Extensions enjoy reasonable autonomy	3	NARS, MOA MS&T
	1.2 Are extension services receiving an adequate level of funding overtime?	. Total budget for extension (i.e., salaries & wages, operating expenses plus capital expenditures) . % of actual funding to approved budget . Salaries & Wages as % of total operating budget . Stability of funding overtime and by sector . Extension budget as % of Ag. GDP . Total expenditures per extension officer . Extension budget as % of public investment in agriculture . % of budget from external sources	3	NARS, MOA MS&T MOF/Treasury WORLD BANK FAO USAID

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Contd)	1.3 Do extension services have adequate control over donor-financed extension programs?	Donor-financed extension activities initiated, received and coordinated by: . Extension Service . the parent Ministry . various of other ministries	1	NARS, MOA MS&T MOF/Treasury WORLD BANK USAID
	1.4 Is the extension service adequately staffed?	. Total number of extension workers (i.e., extenrion officers) . Distribution of extension workers by gender . Farmers per extension agent	3	MOA
	1.5 How suitable are the methods developed to monitor and evaluate technology transfer and adoption?	. Accuracy of adoption reports	3	NARS, MOA
	1.6 How appropriate are the extension-farmer linkages?	. Frequency of visits . Demonstration plots . Number of scheduled farmer meetings with subject matter specialists	3	NARS, MOA Sample Survey

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer				
A. Research System Output				
A.1 Rate of Technology Generation	1.1 Have new varieties and technologies been developed and released?	. Number of technologies generated . Number of technologies released . Number of scientific, technical and farmer level publications	4	NARS, MOA
	1.2 Does the Menu of technological choices developed and offered to farmers accommodate different systems and situations?	. % of released varieties responding to low and high input systems . Proportion of technologies responding to specific NRM issues . Divisibility of package	2	NARS, MOA
A.2 Suitability of Training Programs	2.1 Is sufficient training planned and given to collaborators and clients?	. Number trained by category (ST & LT Training) . Training aligned to goals of program . Adequate funding ear-marked for training	3	NARS, MOA
B. Interaction between Research & Extension				
B.1 Effectiveness of the Collaboration between Research & Extension	1.1 Is the collaboration between research and extension effective?	. Frequency of interaction . Liaison officer . Baseline survey participation . Program-level or center-level planning meetings . Regularly scheduled field days . Publications . Regularly scheduled workshops . OFR or other trials . Tracking system exists.	3	NARS, MOA
	1.2 Is there a satisfactory feedback mechanism to researchers?	. Number of programs changed based on feedback from extension.	2	NARS, MOA MS&T
	1.3 Is there a suitable feedback mechanism to policy makers?	. Regularly scheduled meetings of research & extension staff with policy makers	3	NARS, MOA MS&T, MOP

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact				
A. Technology Adoption & Utilization				
A.1 Level of Technology Adoption	1.1 Have new technologies been adopted by farmers?	. Number of technologies adopted - New seed varieties - Other technologies (specify) . Completeness of adoption (for each technology)	4	NARS, MOA Sample Survey
	1.2 How beneficial was each technology as viewed by farmers?	. Shorter maturity . Increased yield . Improved quality . Improved Taste . Higher price . Resistance to biological stress . Better storage life etc:	3	NARS Sample Survey
	1.3 How widely has each new technology been adopted?	. % of total arable area affected by the new technology . % of total crop adopting the new technology . % of total program area affected by new technology . % of farmers adopting new technology - in crop area - in program area - by farm size - by gender	3	MOA NBS Sample Survey District Commissioners
A.2 Restrictiveness of the Constraints to Adoption	2.1 How severe are the major ecological factors limiting adoption?	. Soil Problems (fertility, salinity, alkalinity, impeded drainage etc.) . Climatic variability (temperature, variability and distribution of rainfall) . Slope . Pests	4	NARS, MOA

KENYA: MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. **Intermediate Impact** (contd)	2.2 Is the availability and supply of key agricultural inputs limiting adoption?	. Sufficient supply of farm inputs . Appropriate choice of input (packaging size/quantity, toxicity, application difficulty, and storability) . Timing of input purchase . Accessibility to farmers (conditions of rural roads and availability of nearby input distribution outlets) . Availability of credit . Prices of inputs	2	NARS, MOA Sample Survey Central Bank USAID
	2.3 How formidable are market constraints?	. Farm to market transportation: - average distance farm to market - proportion of transport cost to total cost . Farmgate vs market price . Required marketing channels . Nature & availability of market information . Onerous marketing standards	2	MOA, MOPW NBS Sample Survey Marketing Boards
	2.4 How adequate are processing and storage facilities?	. Losses & deterioration of quality: - On-farm - Off-farm . Sufficient capacity	3	MOA, NBS Sample Survey Commodity Boards Cooperatives
	2.5 How significant are the producer disincentives created by restrictive government policies?	. Price & Tax policies . Subsidies . Overvalued exchange rate	2	Special Studies USAID WORLD BANK
	2.6 How has the technological change influenced government policy?	. Price and/or subsidy policy . Input policy . Marketing policy . Tax policy . Exchange rate policy . Land reform . Public investment in irrigation, infrastructure, and institutional support to research & extension	3	Special Studies USAID WORLD BANK

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact				
A. Impact on Agricultural Productivity	1.1 By how much has the technology increased agricultural productivity?	For relevant crops: . Change in yield . Stability of yield . Change in aggregate production . Change in gross value of production per farm by farm size	2	NBS MOA WORLD BANK FAO Sample Survey
	1.2 Has the technology caused a significant increase in agricultural investment in the program area?	. Investment in farm improvement (e.g., drainage, liming, soil conservation, fencing water supply, buildings, machinery, livestock, trees, roads); . Electrification	2	NBS MOA, MOPW Sample Survey
	1.3 Has the new technology affected farmers cropping intensity?	. Soil cultivation . Weed control . Planting date . Population . Irrigation . Mechanization	?	Sample Survey
	1.4 Has the new technology increased expenditures on agricultural inputs?	. Fertilizer . Seed . Pesticides . Labor . Tools . Power	?	NBS Sample Survey
	1.5 Has there been a technology related shift in farming systems?	. Inter-cropping . Alley cropping . Crop substitution . Introduction of livestock into system	?	Sample Survey
B. Effect on the Natural Resource Base	1.1 How sustainable is the technology adopted?	Changes in: . land use . farm size . forest cover . erosion . sedimentation . desertification . salination . pollution	3	Sample Survey

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact (Contd)				
C. Influence on Net Farm Income	1.1 Has there been an increase in net farm income?	. Change in net farm income (distribution & by commodity composition) at national aggregate level in rea l terms. . Change in net farm income per farm in real terms disaggregated by farm size, male per female household heads, by commodity	?	NBS, MOA USA'D WORLD BANK Sample Survey
D. Consequences on Food Security	1.1 Has agricultural research improved food security?	. Change in per capita food production by major commodities . Reduced variability in agricultural production. . Change in per capita food imports by value by major commodities . Change in food exports by value . Adequate carryover stocks of basic food stuffs	2	NBS, MOA WORLD BANK FAO
E. Effect on Rural Agro-Industrial Transformation	1.1 To what degree has agro-industrial transformation occurred?	. Increased rural employment . Increased number of rural-based small enterprises by regions (female vs male-owned) . Increased rural savings	?	NBS, MOA WORLD BANK FAO
F. Impact on Nutritional Improvement	1.1 Has agricultural research improved health?	. Reduction in number of people in poverty . Increased caloric consumption per capita . Improved weight to age ratio in children . Increased longevity	2	NBS, MOA MOH WORLD BANK FAO

ANNEX B

Kenya On-Farm Grain Storage Project

Kenya On-Farm Grain Storage Project

General Project Description

The On-Farm Grain Storage Project (OFGSP) has been active in Nyanga and Western Provinces since July 1983 through a A.I.D. grant to the Ministry of Agriculture (MOA). The implementing contractor is Development, Planning and Research Associates (DPRA). The project aims to support Kenya's policy of food self-sufficiency by reducing crop losses through improved harvesting, drying, storage and handling practices by small farmers. The project has focussed on maize, which is the predominant crop in the poor western provinces of Kenya as well as the primary cereal grain nationally.

The project was executed in three phases. The first concentrated on technology development and included a thorough baseline survey of existing crop storage practices and problem identification. Most of the technology extended by the project was based on research conducted elsewhere, and was made available through the linkages developed between the project and international agricultural research organizations, similar projects located in Kenya, and universities. While this was a positive approach to technology development which saved the project both time and money, in retrospect, this phase should have continued at some level to incorporate farmer feedback from extension efforts.

The second phase concentrated on introducing technical packages. This involved briefing district-level leadership (government, churches, etc.), conducting widespread training of provincial, district, and divisional-level extension personnel, and organizing an aggressive campaign of "single focus" field days based on mini-cluster demonstration sites. The project worked with the Training & Visit (T&V) extension officers. The first technologies extended were improved grain drying and storage structures which were given free of charge to participating mini-clusters. When the project adopted a cost-sharing basis of payment, farmers were slow to adopt this more expensive technology. Some of the problems encountered had, in fact, been predicted in the original baseline survey, which was, unfortunately, not fully utilized by the technical team. However, the project did modify its approach to focus more on low-cost, locally available practices which would provide some degree of improvement in grain losses, regardless of whether the entire package was adopted. These included pre-storage hygiene, optimal harvesting dates, modified local drying and storage structures, shelling and chemical treatment, and monitoring of stored grain.

The third phase concentrated on transferring project components to Kenyan institutions, including research, training, and extension. As part of this effort, the project has worked with local farmer training centers to increase their capacity by providing training aids and equipment for use in professional group meetings, monthly workshops, and T&V sessions. In addition, the project has helped develop curricula for technical and BS-level training at Bukura Institute of Agriculture, and Kenyatta and Egerton Universities in post-harvest and cereal technology.

The project has cultivated beneficial relationships with the extension communications branches of the MOA, jointly producing video, radio broadcasts, songs and leaflets. Progressively more emphasis has been placed on providing training to extension workers on improved communication techniques, such as the use of visual aids and collaborative dialogue. The project has made some progress towards equipping a Grain Monitoring Unit, through this needs strengthening and a clearer integration with other testing labs and with policy-making bodies.

Remaining to be developed are closer relationships with the Kenya Agricultural Research Institute (KARI), especially at the Regional Research Centers level. Exchange of post-harvest technologies, collaborative testing, and joint field days could be developed to the benefit of all parties.

In addition, while the project has successfully monitored adoption and potential impact of its technology through various survey mechanisms, this capacity has not been developed within the parent ministry, MOA. Also, the financial problems encountered in the project, which were somewhat softened by a flexible use of donor monies at those times when allocated government funds were not made available, have not been resolved.

In order to make the transition from a donor-managed project operating on one commodity in two provinces to a national program for crop post-harvest management which would include all of the staple food crops, the MOA has set up a Task Force to propose a strategy. This strategy proposes measures to strengthen the MOA and its linkages with relevant bodies. The report makes projections based on national crop production and loss statistics of expected benefits to be derived from such a program on a national scale, generally a benefit-cost ratio of 2.06 by the year 2001 with a Net Present Value (NPV) of 2 billion Ksh. It would require continued donor support for ten years.

Applying the ARIIM Framework

Because the On-Farm Grain Storage Project is not formally within the national agricultural research system, some modification of the evaluation framework developed for intermediate impact indicators was necessary. This did not pose serious methodological problems, as will be explained, since regardless of ministerial tutelage, the project does include similar institutional aspects of technology generation and transfer. In addition, to be sustainable, project activities will need to be more closely integrated with the NARS and its client ministries.

Level I: Institutional Base

Indicators of an adequate national interest in agricultural research and extension provide the backdrop for discussing the more specific On-Farm Grain Storage Project activities, and provide some assurance that the activities could be sustained as part of a sound national agricultural system. Since the OFGSP was not part of the NARS in Kenya, at the next level of institutional analysis, the project itself was analyzed in lieu of KARI, using essentially the same questions and indicators. This included inquiries into how researchable problems were

defined, how research was programmed and funded, its monitoring and evaluation systems, external and internal linkages, and financial resource management. Some of the most positive aspects of this level of analysis are that a thorough baseline study and constraints analysis was performed to identify researchable problems, that research was essentially "borrowed" from other research institutions thus saving the project time and money, and that strong linkages were developed with the existing T&V extension system in the provinces. Overall the OFGSP received a composite score of 3 for Level I.

Level II: Technology Generation & Transfer

The project analyzed and documented extension activities, farmer participation and adoption through various mechanisms. An initial baseline study was conducted to assess existing practices when the project began. Subsequently, two different sample surveys were conducted, and a questionnaire was distributed to extension agents to assess farmer awareness and adoption recommendations. A "menu" of technological choices was made available to farmers, each resulting in some reduction of grain losses. A great deal of effort was spent on strengthening the participation of extension officers at different levels in the service, and in developing training capabilities in post-harvest technologies at both farmer training and academic institutions. This strong and focused involvement in extension technologies when it appeared that farmers could not assume the more sophisticated ones resulted in a very encouraging uptake of recommendations. From extensive surveys using various sampling procedures, there is an 80-85% awareness level in the project area of recommended technologies. Overall OFGSP received a composite score of 3 for Level II.

Level III: Intermediate Impact

Nearly one quarter of the farmers in the project area have already adopted one or more recommendations. This would indicate that 10-20% of their total maize production would be saved from harvest and storage losses, with potentially higher savings if additional recommendations were adopted. Though the project has the potential, particularly through Grain Monitoring Unit, to influence grain marketing policies by establishing quality standards, this has thus far not occurred. The primary incentive at this point for farmers to adopt improved post-harvest management is the reduction in grain weight losses and the preferences of individual customers for higher quality grain. Again for Level III the project received a composite score of 3.

Level IV: Long-Term Impact

The Task Force, established by the Ministry of Agriculture to analyze the benefits to be gained from expanding the OFGSP nation-wide on several important staple crops, recommended the expansion of the OFGSP nationally. The Task Force showed that even under a modest adoption rate higher returns on investment can be achieved. Including the costs of donor support, and based on a real opportunity cost of 15% per annum, the Task Force suggests a benefit-cost ratio of 2.06 by the year 2001, and that a corresponding Net Present Value of Ksh 2 billion can be achieved.

In addition, OFGSP has generated a rural agro-industrial transformation. OFGSP has trained 1,500 artisans to fabricate for profit improved grain drying and storage structures and simple maize shellers. The demand for these services far exceeds the supply and an expansion of these industries is expected. At this level, OFGSP received a composite score of 3.

KENYA NATIONAL FARMER RESEARCH PROJECT

AGRICULTURAL RESEARCH IMPACT INDICATORS MATRIX

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base				
A. National Level				
A.1 NARS Institutional Capacity	1.1 Is the NARS adequately coordinated or highly fragmented?	. Presence of apex management organization (i.e., Ag. Research Council) . NARS management and control centralized under few ministries or departments . Regional differences addressed within a coordinated framework . NARS enjoy reasonable autonomy	NA	NARS, MOA MOP, MS&T
	1.2 Does the NARS provide for adequate linkages among MOA research institutions, other relevant ministries, universities, NGOs, farmers, development projects, local agro-business, private sector research organizations?	Linkages with respect to: . Priority setting process . NARS board membership . Training . Technology & seminars in exchange . Contract or collaborative research (in & out) . NARS representation on other boards	NA	NARS, MOA MOP, MS&T NGOs Universities USAID
A.2 Adequacy of NARS Policy & Plan Formulation Process	2.1 Does the country have an effective organization for planning, management, or coordination of the NARS in line with national agricultural policy?	. Research programs support national ag. polices. . Research program priorities set by national planners. . NARS operating budgets reviewed and approved by national planners.	NA	NARS, MOA MOP, MS&T
	2.2 Are existing processes adequate for setting research priorities and for resource allocation?	Process accounts for: . The potential impact of the research thrust on the national economy and society, including the area affected, value of the commodity, changing demand, urgency of problem, constraints, distribution of benefits, political considerations, availability of external technology, extent of NARS staffing including scientists per commodity group, the probability and cost of research success.	NA	NARS, MOA MOP, MS&T

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Cont d.)	2.3 Are the planning and policy formulation linkages between national planners and NARS effective?	Extent of NARS involvement in formulating agricultural policies: . input polices . output polices . foreign exchange polices	NA	NARS, MOA MOP, MS&T
	2.4 Are there adequate facilities for collecting, analyzing, and updating agricultural research related data?	Organization and procedures for: . Collecting baseline and time series data on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc. . Data analysis & reporting	NA	NARS, MOA MOP, NBS
A.3 NARS Financial & Human Resources Strength	3.1 Does NARS receive an adequate level of funding overtime?	. Total budget for research(i.e., salaries & wages, operating expenses plus capital expenditures) . % of actual funding to approved budget . Salaries & Wages as % of total operating budget . Stability of funding overtime and by sector . Research budget as % of Ag. GDP . Total expenditures per researcher . Research budget as % of public investment in agriculture . % of budget from external sources	NA	NARS, MOA, MOF/Treasury, MS&T WORLD BANK FAO USAID
	3.2 Does NARS have adequate control over donor-financed research?	Donor-financed research activities initiated, received and coordinated by: . NARS . the parent ministry . various of other ministries	NA	NARS, MOA MS&T, MOF/Treasury USAID
	3.3 Are adequate accounting procedures and staff in place throughout the system?	. Centralized Financial Management System . Clear and proper accounting procedures . Timely reporting of financial transactions	NA	NARS, MOA, MS&T

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (Contd)	3.4 Is NARS adequately staffed to perform research activities articulated in the national agricultural strategic plan?	. Size of system (number of scientists) . Quality of system (number of postgraduate to BS) . Ratio of trained technicians to scientists . Distribution of researchers by commodity and/or disciplines	NA	NARS, MOA MS&T WORLD BANK FAO
A.4 Effectiveness of Monitoring & Evaluation Process	4.1 Are monitoring and evaluation processes adequate?	. Active annual process . #of projects revised or canceled . Provisions for external reviews . Peer or expert review . # of projects redesigned	NA	NARS, MOA MS&T
A.5 Soundness of NARS External Linkages	5.1 Does the NARS have satisfactory linkages with IARCs, developed countries, international private sector research institutions (e.g., agro-business)?	Linkages with respect to: . technology exchange . training . networking . consultation	NA	NARS, MOA MS&T, MOE Universities
B. Institute/Program Level				
B.1 Appropriateness of the Program Planning and Management Process	1.1 Do programs have a soundly conceived research plan?	. Program plan incorporates: - farmer organizations feedback - agro-ecological, provincial, and cultural differences . Plan articulates priorities and allocates resources . Plan includes program budget with projections for salaries & wages, capital expenditures and operating expenses . Plan is properly documented	3	NARS, MOA MS&T, MOP
	1.2 Is program adequately funded?	. Proportion of funding to requested budget . Expenditures directly controlled by program/station . Funds are received on a timely manner	3	NARS, MOA MS&T,MOF USAID

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (Contd)	1.3 Are programs adequately staffed?	. Size of program (# of scientists per programs) . Quality of program (# of postgraduates to BS) . Ratio of technicians to scientists	3	NARS, MOA MS&T WORLD BANK FAO
B.2 Soundness of Institute/Program Linkages	2.1 Within programs are linkages among disciplines adequate?	. Programs designed and worked on by a multi-disciplinary team . Program results reviewed by a multi-disciplinary team . Institute and programs have both formal and informal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agro-business organizations for problem identification, program formulation and execution.	3	NARS, MOA MS&T Univeraities
B.3 Effectiveness of Program Monitoring & Evaluation Process	3.1 Are program level monitoring and evaluation systems adequate?	. Active annual process . #of projects revised or cancc'ed . Provisions for external reviews . Peer or expert review . # of projects redesigned	3	NARS, MOA MS&T
C. Sufficiency of the Institutional Capacity of Extension Services	1.1 Is there an adequate institutional base for extension?	. Presence of APEX management (i.e. Extension Services Consul) . Extensions management & control centralized under few ministries and departments . Extensions enjoy reasonable autonomy	3	NARS, MOA MS&T
	1.2 Are extension services receiving an adequate level of funding overtime?	. Total budget for extension (i.e., salaries & wages, operating expenses plus capital expenditures) . % of actual funding to approved budget . Salaries & Wages as % of total operating budget . Stability of funding overtime and by sector . Extension budget as % of Ag. GDP . Total expenditures per extension officer . Extension budget as % of public investment in agriculture' . % of budget from external sources	?	NARS, MOA MS&T MOF/Treasury WORLD BANK FAO USAID

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Contd)	1.3 Do extension services have adequate control over donor-financed extension programs?	Donor-financed extension activities initiated, received and coordinated by: . Extension Service . the parent Ministry . various of other ministries	3	NARS, MOA MS&T MOF/Treasury WORLD BANK USAID
	1.4 Is the extension service adequately staffed?	. Total number of extension workers (i.e., extension officers) . Distribution of extension workers by gender . Farmers per extension agent	3	MOA
	1.5 How suitable are the methods developed to monitor and evaluate technology transfer and adoption?	. Accuracy of adoption reports	3	NARS, MOA
	1.6 How appropriate are the extension-farmer linkages?	. Frequency of visits . Demonstration plots . Number of scheduled farmer meetings with subject matter specialists	3	NARS, MOA Sample Survey

KENYA AGRICULTURAL RESEARCH INSTITUTE PROJECT

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer				
A. Research System Output				
A.1 Rate of Technology Generation	1.1 Have new varieties and technologies been developed and released?	. Number of technologies generated . Number of technologies released . Number of scientific, technical and farmer level publications	3	NARS, MOA
	1.2 Does the Menu of technological choices developed and offered to farmers accommodate different systems and situations?	. % of released varieties responding to low and high input systems . Proportion of technologies responding to specific NRM issues . Divisibility of package	3	NARS, MOA
A.2 Suitability of Training Programs	2.1 Is sufficient training planned and given to collaborators and clients?	. Number trained by category (ST & LT Training) . Training aligned to goals of program . Adequate funding ear-marked for training	34	NARS, MOA
B. Interaction between Research & Extension				
B.1 Effectiveness of the Collaboration between Research & Extension	1.1 Is the collaboration between research and extension effective?	. Frequency of interaction . Liaison officer . Baseline survey participation . Program-level or center-level planning meetings . Regularly scheduled field days . Publications . Regularly scheduled workshops . OFR or other trials . Tracking system exists.	3	NARS, MOA
	1.2 Is there a satisfactory feedback mechanism to researchers?	. Number of programs changed based on feedback from extension.	NA	NARS, MOA MS&T
	1.3 Is there a suitable feedback mechanism to policy makers?	. Regularly scheduled meetings of research & extension staff with policy makers	2	NARS, MOA MS&T, MOP

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact				
A. Technology Adoption & Utilization				
A.1 Level of Technology Adoption	1.1 Have new technologies been adopted by farmers?	. Number of technologies adopted - New seed varieties - Other technologies (specify) . Completeness of adoption (for each technology)	3	NARS, MOA Sample Survey
	1.2 How beneficial was each technology as viewed by farmers?	. Shorter maturity . Increased yield . Improved quality . Improved Taste . Higher price . Resistance to biological stress . Better storage life etc:	3	NARS Sample Survey
	1.3 How widely has each new technology been adopted?	. % of total arable area affected by the new technology . % of total crop adopting the new technology . % of total program area affected by new technology . % of farmers adopting new technology - in crop area - in program area - by farm size - by gender	3	MOA NBS Sample Survey District Commissioners
A.2 Restrictiveness of the Constraints to Adoption	2.1 How severe are the major ecological factors limiting adoption?	. Soil Pro[illegible]s (fertility, salinity, alkalinity, impeded drainage etc.) . Climatic variability (temperature, variability and distribution of rainfall) . Slope . Pests	NA	NARS, MOA

KENYA ONE YEAR MANAGEMENT TO PACE PROJECT

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. **Intermediate Impact** (contd)	2.2 Is the availability and supply of key agricultural inputs limiting adoption?	. Sufficient supply of farm inputs . Appropriate choice of input (packaging size/quantity, toxicity, application difficulty, and storability) . Timing of input purchase . Accessibility to farmers (conditions of rural roads and availability of nearby input distribution outlets) . Availability of credit . Prices of inputs	3	NARS, MOA Sample Survey Central Bank USAID
	2.3 How formidable are market constraints?	. Farm to market transportation: - average distance farm to market - proportion of transport cost to total cost . Farmgate vs market price . Required marketing channels . Nature & availability of market information . Onerous marketing standards	3	MOA, MOPW NBS Sample Survey Marketing Boards
	2.4 How adequate are processing and storage facilities?	. Losses & deterioration of quality: - On-farm - Off-farm . Sufficient capacity	NA	MOA, NBS Sample Survey Commodity Boards Cooperatives
	2.5 How significant are the producer disincentives created by restrictive government policies?	. Price & Tax policies . Subsidies . Overvalued exchange rate	NA	Special Studies USAID WORLD BANK
	2.6 How has the technological change influenced government policy?	. Price and/or subsidy policy . Input policy . Marketing policy . Tax policy . Exchange rate policy . Land reform . Public investment in irrigation, infrastructure, and institutional support to research & extension	3	Special Studies USAID WORLD BANK

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact				
A. Impact on Agricultural Productivity	1.1 By how much has the technology increased agricultural productivity?	For relevant crops: . Change in yield . Stability of yield . Change in aggregate production . Change in gross value of production per farm by farm size	3	NBS MOA WORLD BANK FAO Sample Survey
	1.2 Has the technology caused a significant increase in agricultural investment in the program area?	. Investment in farm improvement (e.g., drainage, liming, soil conservation, fencing water supply, buildings, machinery, livestock, trees, roads); . Electrification	NA	NBS MOA, MOPW Sample Survey
	1.3 Has the new technology affected farmers cropping intensity?	. Soil cultivation . Weed control . Planting date . Population . Irrigation . Mechanization	NA	Sample Survey
	1.4 Has the new technology increased expenditures on agricultural inputa?	. Fertilizer . Seed . Pesticides . Labor . Tools . Power	3	NBS Sample Survey
	1.5 Has there been a technology related shift in farming systems?	. Inter-cropping . Alley cropping . Crop substitution . Introduction of livestock into system	?	Sample Survey
B. Effect on the Natural Resource Base	1.1 How sustainable is the technology adopted?	Changes in: . land use . farm size . forest cover . erosion . sedimentation . desertification . salination . pollution	3	Sample Survey

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact (Contd)				
C. Influence on Net Farm Income	1.1 Has there been an increase in net farm income?	. Change in net farm income (distribution & by commodity composition) at national aggregate level in rea l terms. . Change in net farm income per farm in real terms disaggregated by farm size, male per female household heads, by commodity	?	NBS, MOA USAID WORLD BANK Sample Survey
D. Consequences on Food Security	1.1 Has agricultural research improved food security?	. Change in per capita food production by major commodities . Reduced variability in agricultural production. . Change in per capita food imports by value by major commodities . Change in food exports by value . Adequate carryover stocks of basic food stuffs	3	NBS, MOA WORLD BANK FAO
E. Effect on Rural Agro-Industrial Transformation	1.1 To what degree has agro-industrial transformation occurred?	. Increased rural employment . Increased number of rural-based small enterprises by regions (female vs male-owned) . Increased rural savings	3	NBS, MOA WORLD BANK FAO
F. Impact on Nutritional Improvement	1.1 Has agricultural research improved health?	. Reduction in number of people in poverty . Increased caloric consumption per capita . Improved weight to age ratio in children . Increased longevity	3	NBS, MOA MOH WORLD BANK FAO

ANNEX C

Malawi Maize Commodity Research Program

Malawi Maize Commodity Research Program

Objective of the NARS:

The objective of DAR is to develop agricultural technology which will promote increased production of food and industrial crops, including livestock products, so as to maintain food self-sufficiency and reduce dependence on imported food and industrial crops.

Maize forms the most important food crop for Malawi. It is the dietary staple of over 90% of the population, with an annual consumption of 225 - 250 kg per capita. Maize is grown on approximately 55% of the total arable and permanent cropland of 2,376,000 hectares.

Agricultural Research Impact Assessment

I. INSTITUTIONAL BASE

Maize research is conducted under the auspices of the Department of Agricultural Research (DAR) under the leadership of the Chief Agricultural Research Officer (CARO) who reports to the Controller of Agricultural Services (CAS). The Controller reports to the Principal Secretary of the Ministry of Agriculture (MOA).

Reporting to the DAR are the eight Agricultural Development Divisions (ADDs) which represent the eight major districts -- Karonga, Kasungu, Lilongwe, Salima, Liwonde, Blantyre, Nagbu, and Mzuzu. About 30 Rural Development Projects (RDPs) report into the ADDs. And in turn, 173 Extension Planning Areas (EPAs) report into the RDPs. It appears that extension services are vertically integrated into the DAR.

The DAR operates under an institutional and policy environment which allow critical research of the maize program to be carried out with adequate staff and funding. The Government of Malawi (GOM) Statement of Development Policies (1987-1996) provides the umbrella under which the DAR's Agricultural Research Master Plan can be implemented. With the development and review of the Agricultural Master Research Plan, the DAR is well positioned to communicate research priorities and resource requirements to national planners. The MOA has also been effective in articulating its needs in proposals to the donor community. Although the exact amount is not known, MOA has received a significant sum of funds and material assistance from donors to support agricultural research activities.

DAR's scientists participate actively in workshops and seminars of various scientific societies. Since its formation DAR has actively pursued establishing linkages with International Agricultural Research Centers (IARCs), national research organizations, private sector international research organizations and other successful maize development organizations within Eastern and Southern Africa. These linkages have provided for successful technology exchange, training and consultations.

The Malawi agricultural research department currently employees 193 researchers, 120 technicians and 49 assistants. Of the total number of researchers 31 are expatriates.

DAR's Research Staff		
Researchers		
PhD	33	
MSc	56	
BSc	104	
Subtotal		193
Technicians		120
Field Assistants		49
Total		362

The ratio of Technicians to Researchers is approximately 0.6 to 1, which is significantly below the 2:1 ratio recommended by FAO and the World Bank. The skills of DAR scientists cover the following disciplines:

Soil Science	Farm Machinery
Animal Science	Soil Microbiology
Anthropology	Plant Breeding
Biometrics	Agronomy
Agro-forestry	Entomology
Agricultural Economics	Plant Pathology
Seed Science	

These disciplines cover about 90 percent of the skills needed in a well-staffed and well-managed research institute. Perhaps what is missing from this list of disciplines are marketing disciplines that could assist in determining the needs of farmers and consumers so that research efforts could be focussed to generating technologies that will directly address these needs.

For the calendar year 1989/90, DAR's total research budget was estimated at LCU 7.8 million (LCU = Kwacha). Personnel costs as a percent of total recurrent budget are about 67 %, which is well within the recommended range of 70%. The agricultural research budget is only about 0.6% of total estimated Gross Domestic Product (GDP).

Staff and budget information on Extension Services was not available at the time of this analysis.

DAR's Estimated 1989/90 Budget	('000 of LCU)
Personnel Costs	2,886
Operating Expenses	1,422
Total Recurrent Budget	4,308
Capital	3,539
Total Research Budget	7,847
Personnel Costs as % of Recurrent Budget	67%
Research Budget per Researcher	25
Total Ag. GDP	1,275,000
Research Budget as % of Ag. GDP	0.6%

Maize research is conducted by a Maize Commodity Research Team (MCRT). The MCRT is lead by a National Research Coordinator (NRC) who is a senior maize breeder at the Chetedzi Research Station. The number and distribution of the Maize Commodity Research Team by discipline is shown below.

Maize Commodity Research Team

Field	Number	Degree
Plant Breeding	3	1 PhD 2 MSc
Agronomy	3	1 PhD 1 MSc 1 BSc
Field Officers	5	Diploma
Field Assistants	8	Certificates

On the basis of our analysis of the DAR's financial, organizational and management strengths and our assessment of the adequacies of the linkages it has forged with external research centers, technology transfer agents and users, the DAR receives an overall score of 3 for Level I in the ARIIM matrix.

II. TECHNOLOGY GENERATION & TRANSFER

The DAR's maize research program is geared to maize breeding, maize agronomy, maize production systems, maize protection and maize quality improvement. Since 1976, the DAR has released four new hybrid varieties and two composite varieties of maize to the Malawi National Seed Company. That averages one new variety every two years. As of January 1990 the following hybrids are available from the National Seed Company of Malawi.

Hybrids & Composites Released By the DAR

White Hybrids	White Composites
MH12 (single cross dent)	UCA (Ukiriguru Composit A)
MH15 (single cross dent)	CCA (Chtetdzi Composite A)
MH16 (single cross dent)	Toxpeno (Pop 21)
NSCM41 (3 way dent hybrid)	Kalahari Early Pearl

Producing a flint hybrid variety has been very difficult and this difficulty has constrained the increase in the production of maize. Recognizing this problem the DAR is committing a significant amount of its breeding resources to come up with a good flint hybrid and composite varieties. Currently, there is one hybrid (MH16) and one composite (CCA) which are considered to be semi-flint. It is estimated that a new flint hybrid will be available within the next four years.

With the implementation of the DAR's Research Master Plan, both the Maize Commodity Research Team and the Adaptive Research Team (ART) are conducting adaptive and verification trials on farmers' fields. The link between the MCRT and ART is, however, weak. The ART work is prioritized through interactions with extension agents rather than by both the MCRT, extension agents and farmers.

In terms of technology generation and transfer (Level II) DAR received an overall score of 2 in the ARIIM matrix. Had the linkage between researchers and farmers been stronger the DAR would have attained a higher score.

III. INTERMEDIATE IMPACT

Though Maize research has a long history in Malawi and various varieties and management technologies have been developed and recommended, the adoption of these improved technologies by small-holder farmers, who produce approximately 90% of the maize, has been very limited. One of the many reasons for lack of adoption of the newer technologies is the lack of improved flint (hard endosperm) genetic materials for use by small-holder farmers. The flint materials when processed by traditional methods produce a higher yield of acceptable maize flour for traditional Malawian maize dishes. In addition, the flint varieties have better storage

qualities and are not as susceptible to insect damage under smallholder storage conditions.

The low adoption rates for the new hybrid maize varieties demonstrate the importance of linking research objectives to farmers' needs and socio-cultural priorities. Even though hybrid varieties have significantly higher yield per hectare than local varieties under experimental conditions, farmers have chosen to stay with the local varieties for the reasons cited above. Indeed, as can be seen from the table below, cropping patterns and the allocation of maize fields to new hybrid and composite varieties have not shifted significantly over the years.

Cropping Pattern
% of Total Land Area per Crop
(000 of Hectares)

Crop	1983	1985	1986	1987	1988	1989
Maize						
Local	1,068	1,048	1,104	1,132	1,137	1,160
Composite	26	21	20	14	19	25
Hybrid	89	75	69	37	59	86
Total Maize	1,183	1,144	1,193	1,183	1,215	1,271
Rice	22	21	23	19	23	26
Millet	15	17	17	18	19	18
Sorghum	21	33	32	31	30	30
Groundnut	145	136	176	210	176	140
Wheat	2	1	2	3	2	2
Sunflower	3	4	4	3	3	4
Pulses	91	80	114	152	160	149
Total Arable Land	2,344	2,345	2,376	2,376	2,410	2,410
Maize						
Local	45.56%	44.69%	46.46%	47.64%	47.18%	48.13%
Composite	1.11%	0.90%	0.84%	0.59%	0.79%	1.04%
Hybrid	3.80%	3.20%	2.90%	1.56%	2.45%	3.57%
Total Maize	50.47%	48.78%	50.21%	49.79%	50.41%	52.74%
Rice	0.94%	0.90%	0.97%	0.80%	0.95%	1.08%
Millet	0.64%	0.72%	0.72%	0.76%	0.79%	0.75%
Sorghum	0.90%	1.41%	1.35%	1.30%	1.24%	1.24%
Groundnut	6.19%	5.80%	7.41%	8.84%	7.30%	5.81%
Wheat	0.09%	0.04%	0.08%	0.13%	0.08%	0.08%
Sunflower	0.13%	0.17%	0.17%	0.13%	0.12%	0.17%
Pulses	3.88%	3.41%	4.80%	6.40%	6.64%	6.18%

In addition, there are considerable constraints that have limited adoption of technologies that would have increased production of maize. Movement restrictions due to poor transportation facilities and availability of agricultural inputs such as fertilizers, pesticides, and credit have been most limiting. The gap between actual and potential yield per hectare is indicative of limitations in the use of fertilizers. Experiment station yields range from 4 Mt/Ha for local hybrids and 11 Mt/Ha for improved materials. As shown below, yield for hybrid maize has only been about 2.7 MT/Ha and only about 1.5 MT/Ha for composite varieties. Yield for local maize varieties has been about 1 MT/Ha.

Malawi Maize

	1986	1987	1988	1989	Estimated 1990	Annual Growth Rate
Production ('000 OF MT)						
Local	1,058	1,079	1,244	1,221	1,256	4.4%
Composite	35	23	22	44	46	7.1%
Hybrid	202	100	157	245	255	6.0%
Total	1,295	1,202	1,423	1,510	1,557	4.7%
Area '000 of Ha)						
Local	1,105	1,132	1,137	1,160	1,179	1.6%
Composite	20	14	19	25	26	6.8%
Hybrid	69	37	59	86	90	6.9%
Total	1,194	1,183	1,215	1,271	1,295	2.1%
Yield (Mt/Ha)						
Local	0.96	0.95	1.09	1.05	1.07	2.7%
Composite	1.75	1.64	1.16	1.76	1.77	0.3%
Hybrid	2.93	2.70	2.66	2.85	2.83	-0.8%
Average	1.08	1.02	1.17	1.19	1.20	2.6%

Furthermore, the statistics on the sales of fertilizer do not exhibit significant increases over time.

Fertilizer Sales

	1980	1983	1985	1986	1989
Sales (Mt.)	64,450	57,760	63,000	67,300	65,700
% Change	(10.4%)		9.1%	6.8%	(2.4%)

The relative value of cereals versus the value of agricultural inputs, i.e., fertilizers and pesticides, indicates that the price of crops has been depressed while the price of inputs has increased significantly since 1970.

Relative Value of Crops to Value of Fertilisers & Pesticides (000 of $)

	1970	1975	1980	1985
Value of Crops Produced	466,000	601,000	716,000	830,000
Value of Fert. & Pest. Import	4,713	21,033	22,926	26,541
Index	99	29	31	31

Meanwhile, producer prices for maize and many other crops have remained stagnant over the last decade, thus discouraging the increased use of agricultural inputs.

Producer Price for Maize (Kwachas/Kg)

1982	11.1
1983	11.1
1984	12.2
1985	12.2
1986	12.2
1987	12.2
1988	16.6

Overall, the DAR receives a score of 2 for Level III in the ARIIM matrix.

IV. IMPACT

Maize is a very important food crop in Malawi. However, production of maize has not kept up with the growth of the population which is about 3.3 % per annum.

Malawi Crop Production	1986	1987	1988	Est. 1989	Est. 1990
Production (000 MT)	1,295	1,202	1,423	1,510	1,557
Crop Area (000 Ha)	1,193	1,153	1,215	1,271	1,295
Yield (MT/Ha)	1.09	1.04	1.17	1.19	1.20
Change in Yield --		(4.6%)	12.5%	1.7%	0.8%
Change in Production		(7.2%)	18.5%	6.0%	3.1%

Although the production of cereals had increased by about 50% between 1970 and 1989 and the production of maize has increased by about 58% over the same period, per capita production of cereals and maize has declined steadily since the early 1970s. The decline in per capita production reflects the high population growth rate. The population of Malawi increased by about 81% between 1970 and 1989.

Maize Production Pattern (000 of MT)	1970	1975	1980	1985	1986	Est. 1989
Total Cereals	995	1,178	1,346	1,438	1,363	1,580
Maize	900	1,000	1,165	1,355	1,295	1,510
Maize as % of Total Cereals	90.5%	84.9%	86.6%	94.2%	95.0%	95.5%
Total Population (000)	4,400	5,200	6,000	7,000	7,200	7,954
Per Capita Production						
Total Cereals	0.23	0.23	0.22	0.21	0.19	0.20
Maize	0.20	0.19	0.19	0.19	0.18	0.19

As can be inferred from the following food consumption table, agricultural research has not significantly improved the amount

and/or quality of food consumed by the average Malawian. In fact, the consumption of cereals, caloric and protein intakes have declined since 1970 despite the improvement in the DAR's research capacity.

Improvement In Food Consumption

	1970	1975	1980	1985	1986
Per Capita Cereal Consumption (Kg/	257	251	243	246	238
Per Capita Caloric Intake (Calories	2,395	2,473	2,381	2,381	2,299
Per Capita Protein Intake (Grams/da	73	72	69	68	65

On the positive side, agricultural research may have reduced dependence on imported agricultural products. The trade balance calculations shown below indicate that Malawi is a net exporter of agricultural products. The trade balance for cereals since 1983 has been positive suggesting a trend towards self-sufficiency in cereal production.

Food Self-sufficiency
(000 of $)

	1970	1975	1980	1985	1986
Total Ag. Products					
Total Exports	50,000	122,000	251,000	232,000	230,000
Total Imports	17,000	24,000	34,000	22,000	16,000
Trade Balance	33,000	98,000	217,000	210,000	214,000
Cereals					
Total Exports	699	2,999	4,131	17,981	7,889
Total Imports	8,307	6,875	11,216	5,691	3,958
Trade Balance	(7,608)	(3,876)	(7,085)	12,290	3,931

Overall, DAR received a composite score of 2 for Level IV. This score reflects the fact that past research efforts have not addressed farmers' and consumers' needs effectively.

AGRICULTURAL RESEARCH IMPACT INDICATORS MATRIX

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base				
A. National Level				
A.1 NARS Institutional Capacity	1.1 Is the NARS adequately coordinated or highly fragmented?	. Presence of apex management organization (i.e., Ag. Research Council) . NARS management and control centralized under few ministries or departments . Regional differences addressed within a coordinated framework . NARS enjoy reasonable autonomy	3	NARS, MOA MOP, MS&T
	1.2 Does the NARS provide for adequate linkages among MOA research institutions, other relevant ministries, universities, NGOs, farmers, development projects, local agro-business, private sector research organizations?	Linkages with respect to: . Priority setting process . NARS board membership . Training . Technology & seminars in exchange . Contract or collaborative research (in & out) . NARS representation on other boards	3	NARS, MOA MOP, MS&T NGOs Universities USAID
A.2 Adequacy of NARS Policy & Plan Formulation Process	2.1 Does the country have an effective organization for planning, management, or coordination of the NARS in line with national agricultural policy?	. Research programs support national ag. polices. . Research program priorities set by national planners. . NARS operating budgets reviewed and approved by national planners.	3	NARS, MOA MOP, MS&T
	2.2 Are existing processes adequate for setting research priorities and for resource allocation?	Process accounts for: . The potential impact of the research thrust on the national economy and society, including the area affected, value of the commodity, changing demand, urgency of problem, constraints, distribution of benefits, political considerations, availability of external technology, extent of NARS staffing including scientists per commodity group, the probability and cost of research success.	2	NARS, MOA MOP, MS&T

MALTAMALTAMALTE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Cont d.)	2.3 Are the planning and policy formulation linkages between national planners and NARS effective?	Extent of NARS involvement in formulating agricultural policies: . input polices . output polices . foreign exchange polices	3	NARS, MOA MOP, MS&T
	2.4 Are there adequate facilities for collecting, analyzing, and updating agricultural research related data?	Organization and procedures for: . Collecting baseline and time series data on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc. . Data analysis & reporting	2	NARS, MOA MOP, NBS
A.3 NARS Financial & Human Resources Strength	3.1 Does NARS receive an adequate level of funding overtime?	. Total budget for research(i.e., salaries & wages, operating expenses plus capital expenditures) . % of actual funding to approved budget . Salaries & Wages as % of total operating budget . Stability of funding overtime and by sector . Research budget as % of Ag. GDP . Total expenditures per researcher . Research budget as % of public investment in agriculture . % of budget from external sources	?	NARS, MOA, MOF/Treasury, MS&T WORLD BANK FAO USAID
	3.2 Does NARS have adequate control over donor-financed research?	Donor-financed research activities initiated, received and coordinated by: . NARS . the parent ministry . various of other ministries	?	NARS, MOA MS&T, MOF/Treasury USAID
	3.3 Are adequate accounting procedures and staff in place throughout the system?	. Centralized Financial Management System . Clear and proper accounting procedures . Timely reporting of financial transactions	?	NARS, MOA, MS&T

MATRAMAZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Contd)	3.4 Is NARS adequately staffed to perform research activities articulated in the national agricultural strategic plan?	. Size of system (number of scientists) . Quality of system (number of postgraduate to BS) . Ratio of trained technicians to scientists . Distribution of researchers by commodity and/or disciplines	3	NARS, MOA MS&T WORLD BANK FAO
A.4 Effectiveness of Monitoring & Evaluation Process	4.1 Are monitoring and evaluation processes adequate?	. Active annual process . #of projects revised or canceled . Provisions for external reviews . Peer or expert review . # of projects redesigned	?	NARS, MOA MS&T
A.5 Soundness of NARS External Linkages	5.1 Does the NARS have satisfactory linkages with IARCs, developed countries, international private sector research institutions (e.g., agro-business)?	Linkages with respect to: . technology exchange . training . networking . consultation	3	NARS, MOA MS&T, MOE Universities
B. Institute/Program Level				
B.1 Appropriateness of the Program Planning and Management Process	1.1 Do programs have a soundly conceived research plan?	. Program plan incorporates: - farmer organizations feedback - agro-ecological, provincial, and cultural differences . Plan articulates priorities and allocates resources . Plan includes program budget with projections for salaries & wages, capital expenditures and operating expenses . Plan is properly documented	1	NARS, MOA MS&T, MOP
	1.2 Is program adequately funded?	. Proportion of funding to requested budget . Expenditures directly controlled by program/station . Funds are received on a timely manner	3	NARS, MOA MS&T,MOF USAID

MALAWI-EMAZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Contd)	1.3 Are programs adequately staffed?	. Size of program (# of scientists per programs) . Quality of program (# of postgraduates to BS) . Ratio of technicians to scientists	3	NARS, MOA MS&T WORLD BANK FAO
B.2 Soundness of Institute/Program Linkages	2.1 Within programs are linkages among disciplines adequate?	. Programs designed and worked on by a multi-disciplinary team . Program results reviewed by a multi-disciplinary team . Institute and programs have both formal and informal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agro-business organizations for problem identification, program formulation and execution.	3	NARS, MOA MS&T Universities
B.3 Effectiveness of Program Monitoring & Evaluation Process	3.1 Are program level monitoring and evaluation systems adequate?	. Active annual process . #of projects revised or canceled . Provisions for external reviews . Peer or expert review . # of projects redesigned	?	NARS, MOA MS&T
C. Sufficiency of the Institutional Capacity of Extension Services	1.1 Is there an adequate institutional base for extension?	. Presence of APEX management (i.e. Extension Services Consul) . Extensions management & control centralized under few ministries and departments . Extensions enjoy reasonable autonomy	3	NARS, MOA MS&T
	1.2 Are extension services receiving an adequate level of funding overtime?	. Total budget for extension (i.e., salaries & wages, operating expenses plus capital expenditures) . % of actual funding to approved budget . Salaries & Wages as % of total operating budget . Stability of funding overtime and by sector . Extension budget as % of Ag. GDP . Total expenditures per extension officer . Extension budget as % of public investment in agriculture . % of budget from external sources	?	NARS, MOA MS&T MOF/Treasury WORLD BANK FAO USAID

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Contd)	1.3 Do extension services have adequate control over donor-financed extension programs?	Donor-financed extension activities initiated, received and coordinated by: . Extension Service . the parent Ministry . various of other ministries	1	NARS, MOA MS&T MOF/Treasury WORLD BANK USAID
	1.4 Is the extension service adequately staffed?	. Total number of extension workers (i.e., extension officers) . Distribution of extension workers by gender . Farmers per extension agent	3	MOA
	1.5 How suitable are the methods developed to monitor and evaluate technology transfer and adoption?	. Accuracy of adoption reports	3	NARS, MOA
	1.6 How appropriate are the extension-farmer linkages?	. Frequency of visits . Demonstration plots . Number of scheduled farmer meetings with subject matter specialists	3	NARS, MOA Sample Survey

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer				
A. Research System Output				
A.1 Rate of Technology Generation	1.1 Have new varieties and technologies been developed and released?	. Number of technologies generated . Number of technologies released . Number of scientific, technical and farmer level publications	2	NARS, MOA
	1.2 Does the Menu of technological choices developed and offered to farmers accommodate different systems and situations?	. % of released varieties responding to low and high input systems . Proportion of technologies responding to specific NRM issues . Divisibility of package	2	NARS, MOA
A.2 Suitability of Training Programs	2.1 Is sufficient training planned and given to collaborators and clients?	. Number trained by category (ST & LT Training) . Training aligned to goals of program . Adequate funding ear-marked for training	2	NARS, MOA
B. Interaction between Research & Extension				
B.1 Effectiveness of the Collaboration between Research & Extension	1.1 Is the collaboration between research and extension effective?	. Frequency of interaction . Liaison officer . Baseline survey participation . Program-level or center-level planning meetings . Regularly scheduled field days . Publications . Regularly scheduled workshops . OFR or other trials . Tracking system exists.	3	NARS, MOA
	1.2 Is there a satisfactory feedback mechanism to researchers?	. Number of programs changed based on feedback from extension.	2	NARS, MOA MS&T
	1.3 Is there a suitable feedback mechanism to policy makers?	. Regularly scheduled meetings of research & extension staff with policy makers	3	NARS, MOA MS&T, MOP

MEATA WIRE MATIZE

MALAWI - MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact				
A. Technology Adoption & Utilization				
A.1 Level of Technology Adoption	1.1 Have new technologies been adopted by farmers?	. Number of technologies adopted - New seed varieties - Other technologies (specify) . Completeness of adoption (for each technology)	2	NARS, MOA Sample Survey
	1.2 How beneficial was each technology as viewed by farmers?	. Shorter maturity . Increased yield . Improved quality . Improved Taste . Higher price . Resistance to biological stress . Better storage life etc:	2	NARS Sample Survey
	1.3 How widely has each new technology been adopted?	. % of total arable area affected by the new technology . % of total crop adopting the new technology . % of total program area affected by new technology . % of farmers adopting new technology - in crop area - in program area - by farm size - by gender	2	MOA NBS Sample Survey District Commissioners
A.2 Restrictiveness of the Constraints to Adoption	2.1 How severe are the major ecological factors limiting adoption?	. Soil Problems (fertility, salinity, alkalinity, impeded drainage etc.) . Climatic variability (temperature, variability and distribution of rainfall) . Slope . Pests	2	NARS, MOA

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. **Intermediate Impact** (contd)	2.2 Is the availability and supply of key agricultural inputs limiting adoption?	. Sufficient supply of farm inputs . Appropriate choice of input (packaging size/quantity, toxicity, application difficulty, and storability) . Timing of input purchase . Accessibility to farmers (conditions of rural roads and availability of nearby input distribution outlets) . Availability of credit . Prices of inputs	2	NARS, MOA Sample Survey Central Bank USAID
	2.3 How formidable are market constraints?	. Farm to market transportation: - average distance farm to market - proportion of transport cost to total cost . Farmgate vs market price . Required marketing channels . Nature & availability of market information . Onerous marketing standards	2	MOA, MOPW NBS Sample Survey Marketing Boards
	2.4 How adequate are processing and storage facilities?	. Losses & deterioration of quality: - On-farm - Off-farm . Sufficient capacity	2	MOA, NBS Sample Survey Commodity Boards Cooperatives
	2.5 How significant are the producer disincentives created by restrictive government policies?	. Price & Tax policies . Subsidies . Overvalued exchange rate	2	Special Studies USAID WORLD BANK
	2.6 How has the technological change influenced government policy?	. Price and/or subsidy policy Input policy . Marketing policy . Tax policy . Exchange rate policy . Land reform . Public investment in irrigation, infrastructure, and institutional support to research & extension	3	Special Studies USAID WORLD BANK

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact				
A. Impact on Agricultural Productivity	1.1 By how much has the technology increased agricultural productivity?	For relevant crops: . Change in yield . Stability of yield . Change in aggregate production . Change in gross value of production per farm by farm size	2	NBS MOA WORLD BANK FAO Sample Survey
	1.2 Has the technology caused a significant increase in agricultural investment in the program area?	. Investment in farm improvement (e.g., drainage, liming, soil conservation, fencing water supply, buildings, machinery, livestock, trees, roads); . Electrification	2	NBS MOA, MOPW Sample Survey
	1.3 Has the new technology affected farmers cropping intensity?	. Soil cultivation . Weed control . Planting date . Population . Irrigation . Mechanization	2	Sample Survey
	1.4 Has the new technology increased expenditures on agricultural inputs?	. Fertilizer . Seed . Pesticides . Labor . Tools . Power	3	NBS Sample Survey
	1.5 Has there been a technology related shift in farming systems?	. Inter-cropping . Alley cropping . Crop substitution . Introduction of livestock into system	?	Sample Survey
B. Effect on the Natural Resource Base	1.1 How sustainable is the technology adopted?	Changes in: . land use . farm size . forest cover . erosion . sedimentation . desertification . salination . pollution	2	Sample Survey

MALAWI-MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact (Contd)				
C. Influence on Net Farm Income	1.1 Has there been an increase in net farm income?	. Change in net farm income (distribution & by commodity composition) at national aggregate level in rea l terms. . Change in net farm income per farm in real terms disaggregated by farm size, male per female household heads, by commodity	?	NBS, MOA USAID WORLD BANK Sample Survey
D. Consequences on Food Security	1.1 Has agricultural research improved food security?	. Change in per capita food production by major commodities . Reduced variability in agricultural production. . Change in per capita food imports by value by major commodities . Change in food exports by value . Adequate carryover stocks of basic food stuffs	3	NBS, MOA WORLD BANK FAO
E. Effect on Rural Agro-Industrial Transformation	1.1 To what degree has agro-industrial transformation occurred?	. Increased rural employment . Increased number of rural-based small enterprises by regions (female vs male-owned) . Increased rural savings	2	NBS, MOA WORLD BANK FAO
F. Impact on Nutritional Improvement	1.1 Has agricultural research improved health?	. Reduction in number of people in poverty . Increased caloric consumption per capita . Improved weight to age ratio in children . Increased longevity	2	NBS, MOA MOH WORLD BANK FAO

MALAWI-MAIZE

ANNEX D

Cameroon Maize Breeding In the Western Highlands

MAIZE BREEDING IN THE WESTERN HIGHLANDS[1]

General Project Description

When the original IITA project team arrived in Cameroon in 1981-1982, little significant work had been done in cereals improvement in Cameroon. One important exception to this rule was the work done on open-pollinated maize varieties by Dr. Ayuk-Takim, then director of the IRA Bambui station and the principal maize breeder in Cameroon. At that time IRA had a number of varieties suitable for both the humid highlands (>1000 m) and humid lowlands (<1000 m). The highland varieties included Polyhybrid 290 developed by Mr. Praquin at Dschang in the 1960s and several varieties developed by Dr. Ayuk-Takim in the 1970s (COCA, BACOA, MLC, COCAB, and BACOB). Polyhybrid 290 was actively extended to farmers by UCCAO for several years prior to 1982 and a considerable proportion of farmers were growing it at that time. In the North West Province, a few progressive farmers came to IRA-Bambui each year to obtain COCA and other IRA varieties. However, a study conducted by Mr. E. Ngong-Nassah in 1980 showed that the vast majority of farmers were unaware of the existence of improved varieties (McHugh, 1989).

The TLU began testing maize varieties on farms in 1982 and continued through 1985. In 1989 two new high altitude (>1600m) varieties and two maize streak resistant varieties were provided to the TLU for another round of on-farm testing. In addition, the TLU tested selected varieties provided through CIMMYT to NCRE's maize breeder and several varieties from Zaire.

The TLU has taken several complemetary approaches to on-farm testing of maize varieties. The first involves researcher-managed, farmer-implemented (RMFI) trials. the second involves farmer-managed trials in which the TLU provides the seed and returns periodically to monitor the farmers' plots. The third approach involves the provision of "mini-kits" and was implemented beginning in 1983. The mini-kits contain all the materials necessary to perform a field trial including seed, fertilizer, measuring string, plot labels, instruction sheet, observation sheet and a preaddressed envelope. The kits have been distributed by extension agents from MIDENO and UCCAO at a rate of about 300 per year since 1983. They are planted under the supervision of the extension agent who records the necessary observations over the season and the farmer's comments and mails the form to the TLU.

1 This annex draws heavily on a brief report prepared by Dermot McHugh entitled "NCRE/TLU On-Farm Maize and Rice Research and the Adoption of Improved Practices in the Western Highlands of Cameroon (1982-89)."

On-farm trials conducted in this manner permitted screening of 14 varieties and retention of six for release to farmers. The screening process has been rather detailed and diverse in its objectives including: 1) yield, 2) disease resistance, 3) plant type (with short plants preferred for intercropping), 4) farmers' observation, and 5) exclusion of varieties with similar performance. In the North West Province three mid-altitiude and two lowland varieties have been distributed. In the West province PH290 is still the preferred improved variety because of yield performance. In the high altitude areas of the North West Province, mid-altitude cultivars were outperformed by local varieties in field trials begun in 1984. Only this year were two varieties made available for preliminary testing on farms that were specifically designed for high altitudes.

While this annex focuses on breeding of new maize varieties, it should be noted that considerable complementary agronomic work has also been done through the TLU. This includes trials focusing on fertilizer requirements and plant density. Since 1984 all on-farm maize trials have involved intercropping with either Phaseolus beans or groundnuts.

Applying the Evaluation Framework

Level I: Institutional Base.

The overview of the NCRE project as noted above applies to this particular section as well. However, there are particular aspects of the institutional base that are specific to the Western highlands. In particular is the important role played in this area by two parastatal organizations with whom the project works closely: UCCAO and MIDENO. The former is a coffee growers' cooperative that provides inputs such as fertilizer and seeds to farmers.[2] As such, timeliness of inputs is only occasionally a problem in this region. UCCAO engages in seed multiplication and does a respectable job, although some problems have been reported. MIDENO, a multi-donor, multi-faceted integrated rural development project, is newer than the NCRE project. They provide training of extension staff who until recently worked entirely on coffee production. They also have their own Planning, Evaluation, and Monitoring Unit (PEM) that is actively engaged in numerous on-going agronomic and economic surveys. These surveys complement the more detailed but less current data collected by MINAGRI.

NCRE team members report that the cooperation and commitment of IRA has been a big factor in the success of their project to date. Lines of authority are clear and researchers appear to have wide latitude in carrying out their research in accordance with the overall NCRE plan. Staff turnover has been relatively low. IRA funding appears to have been somewhat erratic, though individual researchers appear to have had considerable latitude in spending within their budgets with only the usual auditing. The

program is also adequately staffed; indeed, taken as a whole, the NCRE project is quite large, having nearly 20 expatriate staff.

The marketing picture for maize is unclear. Different sources appear to have different views as to the current picture. Some argue that the market is nearing saturation while others argue that price levels are quite high as a result of demand by animal agriculture. There is little question that chicken raising has caught on in a big way in Cameroon; every city of any size has numerous "chicken parlours" where middle-class Cameroonians (and visiting teams such as this one) can get chicken and french fries and/or plantain dinners. However, more data on the marketing situation for maize is clearly necessary and will become urgent as the number of farmers adopting new variety packages increases.

Communications overall with both UCCAO and MIDENO are excellent, though they are hampered by the lack of telephone service to the Bambui station. (This represents a deterioration of service that existed in colonial times and has been abandoned.)

The funding situation was excellent until recently when the local fiscal crisis (caused by declining oil and export crop revenues) forced severe cutbacks. Rather than promise the impossible, the GRC asked AID to pick up counterpart project costs for the near future. How long this will be necessary remains to be seen.

Level II: Technology Generation and Transfer.

Researchers have had numerous training opportunities under the NCRE project. Expatriate staff report that many of those selected for further training have been well-qualified.

The TLU system appears to have been very effective in moving research onto the farm. While not using a farming systems methodology in the narrow sense, the TLUs have borrowed heavily on that philosophy. One researcher did suggest, however, that agricultural economic baseline studies at the inception of the project would have been helpful. Over time the research program has moved more and more from the station to the farm. And, with that, the mix of staff has been the subject of ongoing discussion.

As noted above, extension and (especially) development agencies participate in on-farm testing. Trials are jointly planned and implemented and farmer participation in evaluation is taken seriously.

Numerous new varieties have been tested and released along with recommendations as to plant density, intercropping, and fertilizer applications. Storage losses, on the other hand, remain a serious problem in this relatively humid area of the country.

No scientific papers on maize have been produced by the staff of the Bambui station. A few publications for extension agents have been produced. On the other hand, no effort has been made to develop extension bulletins for farmers. A radio show for farmers has been developed.

Marketing issues are also raised at the technology transfer level. Some reliable price data for maize over time exist. Nor are there commodity marketing standards for the crop. Moreover, only a small percentage of the crop

is marketed as maize has been the major staple food crop in this region for some time. In the mid-altitude zone maize acccounts for 74% of the market value of field crops but only 6% of the value of crop sales. Similarly, in the highlands, maize accounts for 42% of market value but only 8% of sales.

Level III: Intermediate Impact Indicators.

A recent survey by the PEM estimated that 46% of all North West Province farmers (61,000 farmers) have adopted the improved variety package, although NCRE staff suggest that these data are probably overestimated. However, adoption does not necessarily mean that all practices are adopted on all fields. The seed produced by MIDENO would plant an area equal to 25-30% of the maize growing area in the province; however, only a part of this is packaged and sent out for distribution and not all of it is distributed since MIDENO cannot accurately forecast farmer demand. In addition, since the new cultivars are open-pollinated varieties rather than hybrids, farmers can and do save their seed from year to year and might even give some of it to neighbors to try. The PEM unit plans to carry out another yield study in 1990 that may resolve some of the shortcomings of previous studies.

Level IV: Impact

To date no impacts can be observed due to the short time elapsed since release of new cultivars.

AGRICULTURAL RESEARCH IMPACT INDICATORS MATRIX

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base				
A. National Level				
A.1 NARS Institutional Capacity	1.1 Is the NARS adequately coordinated or highly fragmented?	. Presence of apex management organization (i.e., Ag. Research Council) . NARS management and control centralized under few ministries or departments . Regional differences addressed within a coordinated framework . NARS enjoy reasonable autonomy	2	NARS, MOA MOP, MS&T
	1.2 Does the NARS provide for adequate linkages among MOA research institutions, other relevant ministries, universities, NGOs, farmers, development projects, local agro-business, private sector research organizations?	Linkages with respect to: . Priority setting process . NARS board membership . Training . Technology & seminars in exchange . Contract or collaborative research (in & out) . NARS representation on other boards	3	NARS, MOA MOP, MS&T NGOs Universities USAID
A.2 Adequacy of NARS Policy & Plan Formulation Process	2.1 Does the country have an effective organization for planning, management, or coordination of the NARS in line with national agricultural policy?	. Research programs support national ag. polices. . Research program priorities set by national planners. . NARS operating budgets reviewed and approved by national planners.	2	NARS, MOA MOP, MS&T
	2.2 Are existing processes adequate for setting research priorities and for resource allocation?	Process accounts for: . The potential impact of the research thrust on the national economy and society, including the area affected, value of the commodity, changing demand, urgency of problem, constraints, distribution of benefits, political considerations, availability of external technology, extent of NARS staffing including scientists per commodity group, the probability and cost of research success.	2	NARS, MOA MOP, MS&T

PROJECT MATERIAL

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Cont d.)	2.3 Are the planning and policy formulation linkages between national planners and NARS effective?	Extent of NARS involvement in formulating agricultural policies: . input polices . output polices . foreign exchange polices	?	NARS, MOA MOP, MS&T
	2.4 Are there adequate facilities for collecting, analyzing, and updating agricultural research related data?	Organization and procedures for: . Collecting baseline and time series data on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc. . Data analysis & reporting	2	NARS, MOA MOP, NBS
A.3 NARS Financial & Human Resources Strength	3.1 Does NARS receive an adequate level of funding overtime?	. Total budget for research(i.e., salaries & wages, operating expenses plus capital expenditures) . % of actual funding to approved budget . Salaries & Wages as % of total operating budget . Stability of funding overtime and by sector . Research budget as % of Ag. GDP . Total expenditures per researcher . Research budget as % of public investment in agriculture . % of budget from external sources	2	NARS, MOA, MOF/Treasury, MS&T WORLD BANK FAO USAID
	3.2 Does NARS have adequate control over donor-financed research?	Donor-financed research activities initiated, received and coordinated by: . NARS . the parent ministry . various of other ministries	?	NARS, MOA MS&T, MOF/Treasury USAID
	3.3 Are adequate accounting procedures and staff in place throughout the system?	. Centralized Financial Management System . Clear and proper accounting procedures . Timely reporting of financial transactions	?	NARS, MOA, MS&T

GAMEROON MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Contd)	3.4 Is NARS adequately staffed to perform research activities articulated in the national agricultural strategic plan?	. Size of system (number of scientists) . Quality of system (number of postgraduate to BS) . Ratio of trained technicians to scientists . Distribution of researchers by commodity and/or disciplines	3	NARS, MOA MS&T WORLD BANK FAO
A.4 Effectiveness of Monitoring & Evaluation Process	4.1 Are monitoring and evaluation processes adequate?	. Active annual process . #of projects revised or canceled . Provisions for external reviews . Peer or expert review . # of projects redesigned	3	NARS, MOA MS&T
A.5 Soundness of NARS External Linkages	5.1 Does the NARS have satisfactory linkages with IARCs, developed countries, international private sector research institutions (e.g., agro-business)?	Linkages with respect to: . technology exchange . training . networking . consultation	3	NARS, MOA MS&T, MOE Univeraities
B. Institute/Program Level				
B.1 Appropriateness of the Program Planning and Management Process	1.1 Do programs have a soundly conceived research plan?	. Program plan incorporates: - farmer organizations feedback - agro-ecological, provincial, and cultural differences . Plan articulates priorities and allocates resources . Plan includes program budget with projections for salaries & wages, capital expenditures and operating expenses . Plan is properly documented	2	NARS, MOA MS&T, MOP
	1.2 Is program adequately funded?	. Proportion of funding to requested budget . Expenditures directly controlled by program/station . Funds are received on a timely manner	3	NARS, MOA MS&T,MOF USAID

CAMEROON MAIZE

CAMEROON – MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Contd)	1.3 Are programs adequately staffed?	. Size of program (# of scientists per programs) . Quality of program (# of postgraduates to BS) . Ratio of technicians to scientists	3	NARS, MOA MS&T WORLD BANK FAO
B.2 Soundness of Institute/Program Linkages	2.1 Within programs are linkages among disciplines adequate?	. Programs designed and worked on by a multi-disciplinary team . Program results reviewed by a multi-disciplinary team . Institute and programs have both formal and informal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agro-business organizations for problem identification, program formulation and execution.	4	NARS, MOA MS&T Universities
B.3 Effectiveness of Program Monitoring & Evaluation Process	3.1 Are program level monitoring and evaluation systems adequate?	. Active annual process . #of projects revised or canceled . Provisions for external reviews . Peer or expert review . # of projects redesigned	3	NARS, MOA MS&T
C. Sufficiency of the Institutional Capacity of Extension Services	1.1 Is there an adequate institutional base for extension?	. Presence of APEX management (i.e. Extension Services Consul) . Extensions management & control centralized under few ministries and departments . Extensions enjoy reasonable autonomy	3	NARS, MOA MS&T
	1.2 Are extension services receiving an adequate level of funding overtime?	. Total budget for extension (i.e., salaries & wages, operating expenses plus capital expenditures) . % of actual funding to approved budget . Salaries & Wages as % of total operating budget . Stability of funding overtime and by sector . Extension budget as % of Ag. GDP . Total expenditures per extension officer . Extension budget as % of public investment in agriculture . % of budget from external sources	3	NARS, MOA MS&T MOF/Treasury WORLD BANK FAO USAID

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (Contd)	1.3 Do extension services have adequate control over donor-financed extension programs?	Donor-financed extension activities initiated, received and coordinated by: . Extension Service . the parent Ministry . various of other ministries	?	NARS, MOA MS&T MOF/Treasury WORLD BANK USAID
	1.4 Is the extension service adequately staffed?	. Total number of extension workers (i.e., extension officers) . Distribution of extension workers by gender . Farmers per extension agent	?	MOA
	1.5 How suitable are the methods developed to monitor and evaluate technology transfer and adoption?	. Accuracy of adoption reports	3	NARS, MOA
	1.6 How appropriate are the extension-farmer linkages?	. Frequency of visits . Demonstration plots . Number of scheduled farmer meetings with subject matter specialists	3	NARS, MOA Sample Survey

CAMEROON MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer				
A. Research System Output				
A.1 Rate of Technology Generation	1.1 Have new varieties and technologies been developed and released?	. Number of technologies generated . Number of technologies released . Number of scientific, technical and farmer level publications	3	NARS, MOA
	1.2 Does the Menu of technological choices developed and offered to farmers accommodate different systems and situations?	. % of released varieties responding to low and high input systems . Proportion of technologies responding to specific NRM issues . Divisibility of package	3	NARS, MOA
A.2 Suitability of Training Programs	2.1 Is sufficient training planned and given to collaborators and clients?	. Number trained by category (ST & LT Training) . Training aligned to goals of program . Adequate funding ear-marked for training	3	NARS, MOA
B. Interaction between Research & Extension				
B.1 Effectiveness of the Collaboration between Research & Extension	1.1 Is the collaboration between research and extension effective?	. Frequency of interaction . Liaison officer . Baseline survey participation . Program-level or center-level planning meetings . Regularly scheduled field days . Publications . Regularly scheduled workshops . OFR or other trials . Tracking system exists.	3	NARS, MOA
	1.2 Is there a satisfactory feedback mechanism to researchers?	. Number of programs changed based on feedback from extension.	?	NARS, MOA MS&T
	1.3 Is there a suitable feedback mechanism to policy makers?	. Regularly scheduled meetings of research & extension staff with policy makers	2	NARS, MOA MS&T, MOP

CAMERON MAZZA

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact				
A. Technology Adoption & Utilization				
A.1 Level of Technology Adoption	1.1 Have new technologies been adopted by farmers?	. Number of technologies adopted - New seed varieties - Other technologies (specify) . Completeness of adoption (for each technology)	3	NARS, MOA Sample Survey
	1.2 How beneficial was each technology as viewed by farmers?	. Shorter maturity . Increased yield . Improved quality . Improved Taste . Higher price . Resistance to biological stress . Better storage life etc:	3	NARS Sample Survey
	1.3 How widely has each new technology been adopted?	. % of total arable area affected by the new technology . % of total crop adopting the new technology . % of total program area affected by new technology . % of farmers adopting new technology - in crop area - in program area - by farm size - by gender	3	MOA NBS Sample Survey District Commissioners
A.2 Restrictiveness of the Constraints to Adoption	2.1 How severe are the major ecological factors limiting adoption?	. Soil Problems (fertility, salinity, alkalinity, impeded drainage etc.) . Climatic variability (temperature, variability and distribution of rainfall) . Slope . Pests	3	NARS, MOA

CAMEROON - MEANTIFE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. **Intermediate Impact** (contd)	2.2 Is the availability and supply of key agricultural inputs limiting adoption?	. Sufficient supply of farm inputs . Appropriate choice of input (packaging size/quantity, toxicity, application difficulty, and storability) . Timing of input purchase . Accessibility to farmers (conditions of rural roads and availability of nearby input distribution outlets) . Availability of credit . Prices of inputs	3	NARS, MOA Sample Survey Central Bank USAID
	2.3 How formidable are market constraints?	. Farm to market transportation: - average distance farm to market - proportion of transport cost to total cost . Farmgate vs market price . Required marketing channels . Nature & availability of market information . Onerous marketing standards	3	MOA, MOPW NBS Sample Survey Marketing Boards
	2.4 How adequate are processing and storage facilities?	. Losses & deterioration of quality: - On-farm - Off-farm . Sufficient capacity	2	MOA, NBS Sample Survey Commodity Boards Cooperatives
	2.5 How significant are the producer disincentives created by restrictive government policies?	. Price & Tax policies . Subsidies . Overvalued exchange rate	?	Special Studies USAID WORLD BANK
	2.6 How has the technological change influenced government policy?	. Price and/or subsidy policy . Input policy . Marketing policy . Tax policy . Exchange rate policy . Land reform . Public investment in irrigation, infrastructure, and institutional support to research & extension	2	Special Studies USAID WORLD BANK

CAMEROON-MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact				
A. Impact on Agricultural Productivity	1.1 By how much has the technology increased agricultural productivity?	For relevant crops: . Change in yield . Stability of yield . Change in aggregate production . Change in gross value of production per farm by farm size	2	NBS MOA WORLD BANK FAO Sample Survey
	1.2 Has the technology caused a significant increase in agricultural investment in the program area?	. Investment in farm improvement (e.g., drainage, liming, soil conservation, fencing water supply, buildings, machinery, livestock, trees, roads); . Electrification	?	NBS MOA, MOPW Sample Survey
	1.3 Has the new technology affected farmers cropping intensity?	. Soil cultivation . Weed control . Planting date . Population . Irrigation . Mechanization	?	Sample Survey
	1.4 Has the new technology increased expenditures on agricultural inputs?	. Fertilizer . Seed . Pesticides . Labor . Tools . Power	?	NBS Sample Survey
	1.5 Has there been a technology related shift in farming systems?	. Inter-cropping . Alley cropping . Crop substitution . Introduction of livestock into system	2	Sample Survey
B. Effect on the Natural Resource Base	1.1 How sustainable is the technology adopted?	Changes in: . land use . farm size . forest cover . erosion . sedimentation . desertification . salination . pollution	3	Sample Survey

CAMEROON-MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact (Contd)				
C. Influence on Net Farm Income	1.1 Has there been an increase in net farm income?	. Change in net farm income (distribution & by commodity composition) at national aggregate level in rea l terms. . Change in net farm income per farm in real terms disaggregated by farm size, male per female household heads, by commodity	?	NBS, MOA USAID WORLD BANK Sample Survey
D. Consequences on Food Security	1.1 Has agricultural research improved food security?	. Change in per capita food production by major commodities . Reduced variability in agricultural production. . Change in per capita food imports by value by major commodities . Change in food exports by value . Adequate carryover stocks of basic food stuffs	?	NBS, MOA WORLD BANK FAO
E. Effect on Rural Agro-Industrial Transformation	1.1 To what degree has agro-industrial transformation occurred?	. Increased rural employment . Increased number of rural-based small enterprises by regions (female vs male-owned) . Increased rural savings	?	NBS, MOA WORLD BANK FAO
F. Impact on Nutritional Improvement	1.1 Has agricultural research improved health?	. Reduction in number of people in poverty . Increased caloric consumption per capita . Improved weight to age ratio in children . Increased longevity	2	NBS, MOA MOH WORLD BANK FAO

CAMEROON FINALIZE