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Final Report

THE AGRICULTURAL RESEARCH INTERMEDIATE IMPACT INDICATOR MATRIX

A SYNTHESIS

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Presented to:

Tom Hobgood
AFR/TR/ANR/PA
Agency for International Development
Washington, D.C. 20523

MANAGEMENT SYSTEMS INTERNATIONAL

600 Water Street S.W., NBU 7-7
Washington, D.C. 20024

telephone: (202) 484-7170
telex: 4990821MANSY fax: (202) 488-0754

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EXECUTIVE SUMMARY

THE AGRICULTURAL RESEARCH INTERMEDIATE INDICATORS MATRIX

A SYNTHESIS FOR MANAGERS

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 subsector which requires such indicators is agricultural research. Due to the long duration of most research programs, there is a special need for intermediate indicators by means of which A.I.D. can determine whether continued or additional funding will generate impact over the medium to long term. To meet this need, AFR/TR/ANR contracted with Management Systems International (MSI) to develop a methodology to examine successful 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.

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 with little extra investment in data gathering and analysis. The methodology for using the matrix is discussed, and examples of results presented. If applied to more cases and further refined, these indicators could be used to measure the extent and magnitude of impact which can be attributed to A.I.D.'s agricultural research and extension interventions.

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Introduction:

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 subsector which requires such indicators is agricultural research. Due to the long duration of most research programs, there is a special need for intermediate indicators by means of which A.I.D. can determine 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 successful 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 present 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. We also summarize the results of nine applications of the methodology in three countries.

In the sections that follow, we discuss 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 conclude with a discussion of unresolved issues and suggested next steps. The complete matrices and narrative summaries for each of nine case studies are presented in the Annexes.

The Problem:

Africa Bureau management must be able to demonstrate 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, as is the research process itself.

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 than is true of other types. Agricultural research results (technologies) can be transported, but usually they must be adapted to the local physical and social environment before they will be appropriate for adoption. 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. How long is legitimate is discussed further below.

Nevertheless, A.I.D. needs to be able 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 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:

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 are generally 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. Each team was 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 the intermediate impact indicators matrix (IIIM) that 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 matrix and in applying it to field situations, therefore, we do not stop the clock when the on-station portion of the process is 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 indicator, but bear in mind that it is not necessarily 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 has already occurred, and is observable at the regional (project area) level, if not yet at the national level.

The IIIM:

To make the methodology for data collection and indicator application as user-friendly as possible, we set it up as a matrix (see Annex C). Across the top are issues to be addressed, questions to be posed, answers, and indicators. Going down the other axis, we move from Level I--The Institutional Base, to Level II - Technology Generation and Transfer, to Level III--Adoption and Beyond, and finally to Level IV--Impact. (A sample of the matrix, as well as nine completed ones, are included in the annexes.) These are levels of analysis that correspond to chronological stages in the technology generation-transfer and utilization process.

As may be seen in Table 1, at each level a series of key questions is posed to obtain information about the characteristics of the that stage or level that are likely to be prerequisites for, or positive determinants of, impact. For each question, the type of answer to be solicited is provided. We have tried to make sure that we have covered all the factors that are necessary to achieve impact at each level, knowing that they may not be sufficient. We discuss this in more detail below. Here it is worth noting that this means we are more likely to be able to predict failure--on the basis of elements that are lacking--than to predict success on the basis of those elements we identify as present.

TABLE 1

INTERMEDIATE IMPACT INDICATORS MATRIX

Draft Indicators Method

ISSUES	QUESTIONS AND INDICATORS
I. Institutional Base	Does the NARS have the institutional structure & management to permit all critical research functions to be effective?
II. Technology Generation & Transfer	What are the quantity, quality & nature of the outputs of the research & extension system?
III. Intermediate Impact Indicators (Adoption & Beyond)	How can the adoption of technologies produced by NARS be measured? and How can the results be used to forecast probable impact on the national economy?
IV. Impact	How has investment in research influenced the economy of the country in terms of productivity, production & food security?

Level I - The Institutional Base:

At this first level, questions concern the higher-level decision-making environment surrounding the national agricultural research system (NARS) and the structure and functions of the NARS itself. Indicators of an adequate institutional base include external linkages to policy development, to other institutions, and especially to farmer organizations. Scientific capacity, internal organization, priority setting and other institutional/ organizational indicators are also considered. This section of the matrix is organized so that it is suitable for an open-ended interview approach, and most questions can be answered with a yes or no, or else by simple numerical scoring.

The idea is that a relatively complete (high) score at this level indicates a threshold beyond which the possibilities are good that technology generation and transfer will have an impact (although the extent of that impact may be greater or less, depending on a number of other factors). Significant gaps, or a low score, are likely to constrain research capacity enough that institutional development/strengthening interventions should be funded before funding for research activities is provided. This will help to ensure both impact and sustainability.

A good example regarding capacity building for level I is Kenya's KARI, an agricultural research system which has been in transition for some years, and which is currently receiving funding from 11 donors, including A.I.D. A.I.D.'s support is both for capacity building and for further research on maize, with additional funding to develop research capacity for sorghum. A different example, also from Kenya, is the A.I.D.-funded Small Ruminants Collaborative Research Support Program (SR-CRSP) a very successful part of a world-wide program, which is not now linked to the newly reorganized KARI, despite very successful Kenyanization of the program.

Level II - Technology Generation and Transfer:

We have intentionally included both of these stages in the same section of the matrix, in line with our assumptions about the relations among research, adoption and impact. For ease of discussion and interviewing, we start with technology generation, posing a series of questions and providing a series of indicators on which given cases can be scored. The variables at this level are continuous, and answers to questions are likely to be " ore" or "less", or absolute numbers. At the first level, we are thinking of a threshold that is necessary for impact to occur. At level II, we assume that threshold and are looking at numbers and types of technologies generated, and of those, how many are transferred, how and to whom. In that sense, this section may be seen initially as more descriptive than analytical. However, here again we include questions about intervening variables, especially communication links between farmers and researchers, which we regard as one of the determinants of impact.

Some of our questions at this level are designed to elicit information that allows comparison of the researchers and extensionists in terms of their training, career patterns, and influence on policies which, in turn, affect

research and extension. We also examine the adaptive role of extension in farming systems research and extension (FSR/E) programs and in more traditional extension approaches. Here, we have borrowed substantially from prior work on impact indicators for extension carried out by Swanson et al and funded under INTERPAKS. We have modified some of these indicators, and substituted our own for some of the others. The user's guide in Annex B explains the scoring for each indicator, following Swanson where appropriate.

Another area of emphasis is the availability of agricultural support services, such as input supply, credit, marketing infrastructure, and the role of policies that provide incentives to increased or intensified production, as well as a market orientation among producers, suppliers, extensionists and researchers.

When this section of the matrix has been applied to a particular case, it provides a static picture of the technology generation and transfer process. However, by using commonly accepted indicators that are relevant to most kinds of agricultural research--numbers of varieties released, or numbers of on-farm trials for example--this picture gives some indication of how far along in this process any given program or program component is at the time it is observed. Still, it is not easy to predict the rate of transition from one stage to another, or from technology generation to transfer. Partly, this is a definitional problem, but in part it is caused by the risky nature of the research process, and the unpredictability of adoption.

The maize breeding program in Malawi is a good example, since it has changed significantly over time. As is outlined in the case study in Annex F, this program has gone through three distinct stages. If this matrix had been applied in the 1960s, it would have predicted successful adoption of modern dent varieties which were locally adapted from Rhodesian materials. However, by the 1970s different types of dent varieties were being generated, and transfer was still fairly slow, especially to smallholders. Research was primarily done on-station, and extension was not very closely linked to the technology generation process. These are two indicators of potential impact at level II.

When the matrix is applied in 1990, the results are very different. There has been a fundamental change in the relationship between research and extension, and there are now adaptive research teams which are the mechanism that operationalizes the linkage. There has been an A.I.D.- funded pilot program in communication between farmers and extensionists and researchers, stressing two-way communication and farmer feedback. To emphasize farmer input to the dialogue, the subproject coined the phrase "infusion" (as opposed to diffusion, which is more commonly use to emphasize that the message about a new technology must go out from research through extension to farmers).

Nonetheless, modern varieties are still not adopted by smallholders, and in fact, overall adoption rates are falling. Quite recently, researchers started focusing on local preferences for varietal characteristics, and are beginning to breed improved flint varieties with the characteristics that smallholders want. There is reason to hope that these better-adapted

varieties will be adopted faster and by more farmers if the price and availability of seed, fertilizers and other inputs can be adjusted to allow relatively low-cost and low-risk adoption.

These kinds of changes through time make the scenario of impact approach both interesting and difficult. If we had looked retrospectively at the Malawi maize program in 1985, rather than at the present situation in 1990, we might well have concluded that it was having no impact, and posited that it would not until varieties meeting local preferences were generated and transferred. Or, like those involved at the time, we might have identified other constraints to adoption instead, primarily access to supporting inputs. This is, indeed, part of the problem, but experience has shown that inputs availability did not solve the problem of non-adoption of modern varieties by smallholders.

On the positive side, this example shows that these indicators can be used at different points during implementation to see what the program or project is likely to achieve along these dimensions of impact. This is one way to measure changes and corrections during implementation, or to signal the need for them, thus providing a means of monitoring progress and potential impact.

Level III - Adoption and Beyond:

This is the third and most critical stage or level, and the one where the indicators are logically intermediate. We have identified some indicators that complement and go beyond simple rates of adoption and seem highly correlated with them. Some may be chronologically prior, and others concomitant. Some may be the result of adoption of technologies rather than predictive of them. In either case, the association is likely to be close, and the correlation high.

The more innovative indicators we have included relate to off-farm employment and other aspects of rural transformation, to natural resources management, and to the existence or strengthening of farmer organizations. As we have seen so far, as we go up the levels of complexity and of analysis, and through the stages of the technology generation-transfer-utilization process, the indicators become fewer and hopefully more predictive. Thus, a high score at level III should be more predictive of impact than a low or medium score, and also more predictive than a high score at level I or II.

If we take the Kenya On-Farm Grain Storage Project as an example, we find that there is potential for off-farm employment (1,500 artisans have been trained to make improved storage structures). Post-harvest management recommendations were developed by the project staff in close collaboration with extension agents. They were demonstrated through on-farm trials and field days, both of which are indicators of effective linkages between researchers and extension, and extension and clients respectively. The recommendations are being adopted by 25% of the project area's farm households (a measured adoption rate from surveys). A critical variable illustrated by this case is that the recommendations are presented separately, and a farmer can adopt only some or all, but still have good results. These sets of recommendations form a series of higher and lower

TABLE 2

INTERMEDIATE IMPACT INDICATORS MATRIX

ISSUES	INDICATORS (examples)
I. Institutional Base	Country development plan includes resear Long-term research plan
II. Technology Generation & Transfer	Varieties released % of research on-farm Menu of technologies
III. Intermediate Impact Indicators	Adoption of technology Production increases Fertilizer sales
(Adoption & Beyond)	
Shift in crop-mix Rural small enterprises Increased rural savings Farmer organizations strengthened Intensive vs. extensive land use Input prices	
IV. Impact	Nat'l average by farm size
Value of prod./capita Value of prod./farm Value of agr. prod./hectare of land	
Per capita food consumed Agriculture GDP Variability in agr. prod. Annual carryover stocks	

TABLE 3

INTERMEDIATE IMPACT INDICATOR MATRIX

Draft Results from Country Studies

INDICATORS	KENYA: ON-FARM MAIZE GRAIN STORAGE	CAMEROON: AGRONOMY PROG-NCRE	MALAWI: NATURAL RESOURCES MANAGEMENT
Intermediate			
Technology Utilization	80% farmers aware of package 40% farmers adopted two or more rec.	132% increase in maize land area 394% increase in production	
Natural Resource Management	Farmers saving 10-20% of production	Agronomically sustainable	Nitrogen fixation, less top soil loss, less run-off, increased fertility
Rural Agro-Industries	1500 artisans trained to build structures but demand > supply	Some impact on processing	Lucaena processing for additive to poultry feed seedling sales; some maize processing increase
Final	Assumes National Adoption of Tech.	For Maize Region Only	For Holdings less than 1 ha Only
Net Farm Income	Increase due to higher production but <10%	113% increase in gross income, net income is less	

TABLE 3 - (Cont'd)

INTERMEDIATE IMPACT INDICATOR MATRIX

Draft Results from Country Studies

INDICATORS	KENYA: ON-FARM MAIZE GRAIN STORAGE	CAMEROON: AGRONOMY PROG-NCRE	MALAWI: NATURAL RESOURCES MANAGEMENT
			Maize w/o fert. w/50 kg N w/100 kg N Without Lucaena 1.6 MT/ha 3.0 MT/ha 3.1 MT/ha With Lucaena 2.2 MT/ha 3.7 MT/ha 4.2 MT/ha % Change 81% 74%
Agricultural Productivity	> 10% increase in value of production because more & better quality grain	113% increase in yield/ha	73% potential increase in maize w/ Lucaena
Food Security	Increase in food consumed at household & nat'l	Better farm family nutrition	Better farm family nutrition

TABLE 3 - (Cont'd)

INTERMEDIATE IMPACT INDICATOR MATRIX

Draft Results from Country Studies

INDICATORS	KENYA: ON-FARM MAIZE GRAIN STORAGE	CAMEROON: AGRONOMY PROG-NCRE	MALAWI: NATURAL RESOURCES MANAGEMENT
	Approx. 6% increase in total maize available at nat'l		

cost options from the farmer's perspective: This is another indicator included at this level. The project's successes have been noted, and expansion to the national level--with more adaptive research for ecologically distinct regions--has been proposed. Extrapolating from present adoption rates, it is possible that nation-wide, savings through prevention of post-harvest losses may be on the order of 20 per cent of production. This would substantially increase the amount of maize available in Kenya even absent any other interventions.

Level IV - Impact:

At this final level, we have included commonly-used impact indicators applied at the national level, such as agricultural production per capita, agricultural income per capita, intensification of cropping per hectare of land, food consumption and the like. This is both because they are in common use, and because data to measure them are typically available in most developing countries. Indicator information of this type is also routinely summarized in international reports and data bases, such as those of FAO. In Table 3, we have included illustrations of application of the indicators at level IV to the case study data.

However, it is important to note that these indicators themselves are proxies for a complex set of behaviors and conditions that together constitute what we mean by development. The ones we have included are those which seem to bring us closest to being able to measure the welfare effects of increased food production, productivity and security.

Using the IIIM:

Data Availability and Sources:

During preliminary discussions with ANR and with the Development Programs Office of the Africa Bureau, it was agreed that the predictive reliability of the indicators in the IIIM must be verified through special studies. This is also true because some kinds of data cannot be collected on an annual or biennial basis because of cost and level of effort constraints. However, they can be collected and analyzed, for example, every five or ten years. This is true for agricultural censuses carried out in some African countries; in others, censuses are updated annually. In other cases, as in Kenya, partial surveys can be done annually in a representative subset of clusters from the national sampling frame. Relationships between variables and between indicators can be checked periodically when the entire sample population is surveyed. With some luck, the periodicity of surveys will coincide with the Country Program Strategy Plan (CPSP) timeframe, if not with the current Action Plan time horizon.

To optimize the use of resources, such special studies can be funded as parts of sector analyses, or NPA analyses. Level II and III indicators can be incorporated into project-level monitoring and evaluation systems, usually with little additional cost in money or effort. Some of the indicators, such as adoption rates for technology packages or their components, are not easy to ascertain and evaluate without baseline data. However, many developing countries carry out surveys of adoption rates, using extension agents as

interviewers. Even though these may be biased because it is in the interest of the extension agent to report high rates of adoption, there may be relatively inexpensive ways to correct for this bias, as with yield measurements on farmers' fields.

We have some reservations about data quality in the three countries we visited. But we were in fact able to identify sources for data to back up almost all of the intermediate indicators and some of the impact indicators. Clearly, some countries are more data rich than others. The availability of good statistics is itself an indicator of development, often the result of donor-sponsored projects. Poor data availability should not, however, be used as a reason to abandon projects which intrinsically involve risk.

A concerted effort to identify data obtained by and for all donors, as well as data routinely gathered by the host government itself for its own purposes must precede or accompany application of the IIIM. In Malawi, this had already been done very competently by Mission staff when preparing the CDSS and Action Plan. In Kenya, a similar effort had successfully been made in the context of designing an M&E system for the Mission's ADO. The Cameroon NCRE Project is designed to yield this kind of data on a routine basis, and is working well so far.

As the guidance for Mission-level strategic planning is followed, data collection and analysis efforts for program-level monitoring will increase. This will provide a good basis for application of the IIIM. Reciprocally, application of the matrix can provide indicators for program performance, thus reducing total data-related costs, and the burden placed on Missions. One suggestion from ANR is that the use of this approach be institutionalized by having Mission staff and their NARS counterparts update it collaboratively, every year or two.

Applying the IIIM in the Field

Our tests of the IIIM in three countries show that it takes about a week of pre-departure reading and team planning to become sufficiently familiar with the country environment and the institutional setting in which research and technology transfer take place. After that, each case can be examined, and the matrix completed in about two to three days. This is based on our experience as teams of outside consultants and A.I.D. staff.

If field staff and local-hire consultants or host government counterparts were used, one could assume that the time necessary to understand the institutional and policy environments of agricultural research in a given country would be shorter. If Level I of the matrix were used as a checklist, to make sure no key features were ignored, then the team could move on directly to Level II, examining particular projects or programs. To facilitate this, a more complete user's guide would have to be developed, perhaps accompanied by a video presentation of the background to the exercise, the IIIM itself, its purposes and its application.

Reporting Results

The following are illustrations of the kind of reporting statements tha can be made using the IIIM:

- the proportion of farmers in Xeland using any new technology went from 0 in 1990 to 40 1993;
- use of purchased inputs by smallholders went from 500 MT/year to 5,000 MT/year between 1990 and 1994;
- operating funds for maize research increased by 15% per scientist, based on a 1 % cess on tobacco sales collected at the auction floor;
- 200,000 children were below the norms for height and weight for age in Xelandin 1990 but only 170,000 in 1995;
- 50 participant trainees returned with Ph.D. degrees in agricultural sciences and were employed by Xeland's NARS;
- maize production prices were increased by 20% at the farm gate, and marketed production increased by 25%;
- the proportion of operating funds allocated to salaries increased from 80% to 85% in 1995, the rest going to research activities.

Some of these kinds of statements can and will be made by Missions in their program and project reporting without the use of the IIIM. However, they are likely to be made in disparate reports, or not made at all because they are not accessible in the documentation available. If the IIIM is improved and used, these sorts of statements could be generated from a single, ordered data set, the links and/or associations among them would be clearer, and they might be used in a more reliably predictive way than before. This is especially true for backward linkages, i.e., those for which agricultural research would get "credit".

Unresolved Issues and Next Steps:

Several issues remain to be resolved before we would recommend wide application of the IIIM to support decisions about funding allocations to agricultural research. Some of them are programmatic but others are substantive or methodological.

How completely the IIIM may be applied will depend on the country setting, the composition of the NARS, Mission staffing, and data availability as well as the Mission's assistance objectives. Different users may emphasize different levels of analysis or stages in the generation-transfer-utilization process. Thus, the matrix can be adapted to particular types of settings. However, it is crucial for comparative purposes that there be a core of common indicators, supported by similar types of data sets for all countries across which impact might be compared. Which of the indicators are

essential cannot be determined until the matrix methodology has been applied to more cases, and the results analyzed.

Limitations of the IIIM

1. The Duration of Technology Generation and Transfer.

Despite our best efforts, we have not been able to integrate time into the matrix satisfactorily. At this point, we are not able to say with certainty that after five or ten or fifteen years, a research system should have generated x number of technologies or sets of cultural practices, adopted by y farmers, leading to z levels of impact on food security, production and productivity. We have made progress by examining the complex process which leads to adoption and impact, rather than stopping when a technology leaves the lab. Yet, we have not been able to identify from the literature or from scientists' experience appropriate norms for the duration of different types of agricultural research and technology transfer. There are some for Latin America and Asia that might be abstracted from the literature on research in those regions, but this would not necessarily mean that they were appropriate norms for research in Africa.

If we compare three cases of research on maize, we find that for Kenya Kitale maize, A.I.D. began funding the program in its fifteenth year, the year before the hybrids were released that had such a significant impact on Kenyan agricultural production. Maize breeding for hybrids and synthetics has been going on in Malawi since 1949, if not before. Research to develop composites started more recently. Despite the fact that in 1990, eight modern varieties are available from the National Seed Company, there is no variety suited to local taste preferences. As we have seen, adoption rates are actually declining, partly because of price factors for fertilizer and marketed grain. In Cameroon, the NCRE project has been in operation since 1982, and in 1990, excellent results have been obtained in adoption, and resulting impact on incomes, production, productivity and food security--thus demonstrating a much shorter time required to develop or adapt and disseminate a new variety and set of agronomic practices before adoption took place. Thus, these three cases do not support a conclusion that five, ten or fifteen years is the norm that should be established for stop/go decisions on further funding.

2. Adoption Rates.

The IIIM is also limited in terms of predicting rates of adoption. There is considerable consensus in the literature that on-station and researcher-managed on-farm research are part of the research process. Similarly, there is consensus that farmer-managed trials, demonstrations and related farmer feedback are typically the domain of extension.

Nevertheless, there appears to be no good, commonly accepted set of indicators to predict adoption of technology in either the research or extension literature. An exception is some of the literature on FSR/E. What our cases tell us is that farmers are more likely to adopt recommendations that are separable--rather than effective only as a total package--and thus present higher and lower-cost options. This makes the task of recording

adoption rates more difficult, since data would have to be gathered about each recommendation, rather than about the package as a whole. As we have seen, there may also be a difficulty in finding unbiased interviewers and observers. This is not impossible, however, and seems to have been done successfully by the Kenya On-Farm Grain Storage Project with relatively little increase in cost or effort.

3. Necessary Versus Sufficient Elements.

We wish to stress again the difference between necessary and sufficient factors incorporated in the IIIM. As we have said, it is easier to specify those factors or elements that are necessary for impact than it is to identify all those that are sufficient for impact to occur. Most of the elements included in the IIIM may be necessary for a research system to be successful in providing outputs that influence welfare if they are adopted. But we are constrained by the state of the art, and thus our indicators probably can at best predict relative success and relative failure.

4. Technology Generation Versus Technology Adaptation.

Another area for further work is the question of the difference between what are called technology generating and technology adapting research systems. All systems in fact borrow from past research. Some, however, are better able to borrow from past and contemporary research than are others. Yet, adaptive research often involves repetition of trials or experiments from other environments in the local one setting. In some instances, it may be difficult to draw the line between original, basic research and adaptive research. Therefore, it is also difficult to say how long one type should take--and how much it should cost--as against the other.

5. Capacity Building.

Our nine cases actually demonstrate that not all of the large number of features included for institutional capacity need be present for impact to be achieved. Some of the cases that involve discrete A.I.D.-funded projects or programs such as On-Farm Grain Storage and the Small Ruminants CRSP in Kenya are operated essentially apart from the host country NARS. Conversely, in Cameroon, the NCRE Project is virtually coterminous with the national research and extension program. All three instances show that training of a critical mass of scientists is probably a precondition for successful technology generation and transfer. They also show that financial incentives rather than job security tend to reduce turnover of trained staff. Further, as the Kenya SR-CRSP shows, scientists will tend to go where there is funding for operational research even if salaries and schemes of service are otherwise the same. Malawi is particularly interesting since career enhancement is easier in the extension branch than in the research branch. Often, the reverse is the case, especially since the credentialing process for scientists is usually longer and more highly rewarded for researchers than for those who opt for careers in extension.

All we are able to confidently say about this based on our limited number of applications of the IIIM is that capacity building--as understood in the extensive work of ISNAR and CGIAR on NARS and their optimal

characteristics--is conducive to successful technology generation, adaptation, transfer and adoption. We cannot demonstrate from these cases that it is either necessary or sufficient, however.

6. How Determining is Agricultural Research?

A final caveat concerns the relative weights to be assigned to agricultural research and to other factors in determining impact. Research and its results are conditioned by too many intervening variables for us to be able to come up with a minimal number of necessary and sufficient characteristics that will lead inevitably to success. This is as true for research in other sectors as it is for agricultural research. This is not a new finding, but it is one that should be stressed lest funding decisions be made on the basis of untenable assumptions either about agricultural research or about impact. This also means that at this point, the state of the art does not allow us to assign proportions of impact to funding from one donor or another. Attribution, though desirable in the DFA reporting system, will have to remain tentative unless A.I.D. has really been the sole or major donor to a program or project.

Next Steps

The IIIM is intended to be user-friendly, and to facilitate data collection and analysis. It is designed to be low-cost in terms of money and level of effort, since a monitoring system should not overwhelm what it is supposed to monitor. Ideally, the IIIM should allow analysis that shows which factors considered are the most predictive of impact. Due to the nature of the data--both qualitative and quantitative, documentary and observational--sophisticated regression techniques are not possible. Simpler methods such as Gutman scaling could be applied if we had enough cases. Using such a method allows us reliably to conclude that an association exists among certain elements included in the matrix and success as defined by impact.

Recommendation

If AFR/TR/ANR decides that the IIIM is likely to meet the need for intermediate indicators of the impact of agricultural research, further testing and revision of its content and use should take place before guidance to Missions is communicated. Testing by another five Missions on three cases each might be possible with little additional effort given the present bureau schedule for preparing program performance monitoring and evaluation plans. Another low-cost alternative would be to integrate application of the IIIM in forthcoming agriculture sector analyses, i.e., in Lesotho.

Nine cases are not enough to allow any reliable analysis or generalizations, but 24 would represent a significant percentage of the universe of African countries with agricultural research programs and A.I.D. Missions. If the sample is large enough, it could be divided into a set of technology generating NARS and one of technology adapting systems. Data from this many cases should allow more reliable conclusions to be made about the utility of the methodology and the accuracy of its results.

If this recommendation is adopted, more work could then be done on building time into the matrix, on coding answers to open-ended questions, such as those posed at level I, and on numerical scoring. The user's guide could be expanded, and the linkages within the matrix tightened up. With more cases, we would be able to say more confidently which factors are likely to be determinants of impact in different settings than we can now.

BIBLIOGRAPHY

Abt, Associates, "The Case for Investing in African Agricultural Research", Appendix E, Report of the Evaluation of the Strengthening African Agricultural Research and Faculties of Agriculture Project (SAARFA), August 1989.

Abt Associates and Univ. of Idaho/Post Harvest Institute. 1989. Privatization of Fertilizer Marketing in Cameroon: A First-Year Assessment of the Fertilizer Subsector Reform Program.

Abt Associates, Univ. of Idaho/Post Harvest Institute, and Deloitte Haskins & Sells. 1989. Fertilizer Utilization Practices and Crop Response Research: Recommendations for the Fertilizer Subsector Reform Program of Cameroon.

A.I.D., Natural Resources Management Support Project, Malawi Natural Resources Management Assessment, September 1989.

Bunderson, W. Trent, "Planning Concerns for Agroforestry Highlighting the Differing but Complementary Roles of Research and Extension," Paper presented at workshop to Improve Agroforestry Linkages Between Research and Extension, Lilongwe Malawi, May 16-19, 1989.

Busch, Lawrence and William B. Lacy. 1983. Science, Agriculture, and the Politics of Research. Boulder, CO; Westview Press.

Centro International de Agricultural Tropical, Annual Report 1987, Bean Program, Working Document No. 39, 1987.

Consortium for International Development, Malawi Agricultural Research and Extension Project, Semi-Annual Technical Report, April 1, 1989 - September 30, 1989, October 1989.

Cusack, T.J. and M. Chihambo, "Promoting Productive Linkages between Research, Extension and the Farmer: The Cassava Research-Extension Project in Salima A.D.D.," Paper presented at the SADCC Cassava Processing and Utilization Workshop, Mzuzu, November 28 - December 2, 1988.

DAI, et. al. 1989, NCRE Mid-term Evaluation.

Dickerman, C.W. and P.C. Bloch, Land Tenure and Agricultural Productivity in Malawi (Draft), University of Wisconsin, Land Tenure Center, October 1989.

Egerton University, Stanford Food Research Institute, University of Arizona, "Increasing Kenyan Agricultural Productivity: Applications of the Policy Analysis Matrix (Interim Project Report, Research and Training in Agricultural Policy Analysis)", November 1989.

Eicher, Carl K. 1989. Building African Scientific Capacity for Agricultural Development. Agricultural Economics, in press.

Frolik, E., and Alcorn, G., 1983. An Evaluation of the National Cereals Research and Extension (NCRE): Project 631-0013.

Government of Malawi, University of Malawi, Bunda College of Agriculture, "Project Proposal: Strengthening the Institutional Capacity of the Faculty of Agriculture, Bunda college (HRID Project), July 1989.

Government of Malawi, University of Malawi, Bunda College of Agriculture, Malawi National Bean Programme, Bunda College of Agriculture and Bean/Cowpea CRSP M.S.U. Malawi Project Progress Report. Proposed Experiments, Bean/Cowpea Project Activities, 1989.

Government of Malawi, Triennial Agricultural Research Review, The World Bank, April 1989.

Heisey, Paul, "Maize Research in Malawi: Comment," CIYMMT, Malawi, n.d.

Himpel, C. and Schultz, M., "Chapter Eight: German Aid to Agriculture in Cameroon, Kenya, Malawi, Senegal and Tanzania," MADIA, February 1989.

Howell, John, "Chapter Seven: British Aid to Agriculture in Malawi, Tanzania and Kenya," MADIA, February 1989.

IADS Operations, Inc. and GOM Department of Agricultural Research: Malawi Agricultural Research Strategy Plan, September 1983.

Institut de la Recherche Agronomique (IRA). 1989. IRA Action Plan. MESRES, Republic of Cameroon.

International Fertilizer Development Center (IFDC). 1986. Cameroon Fertilizer Sector Study. USAID/Cameroon.

International Service for National Agricultural Research (ISNAR). 1988: Analyse de la Structure et de la Gestion de l'Institut de la Recherche Agronomique (IRA) et de l'Institut de Recherches Zootechniques (IRZ) du Cameroun.

ISNAR, A Methodological Framework for ISNAR Reviews of Agricultural Research Systems (NARS) by Mathew Dagg and P.B. Eyzaguirre, April 1989.

-------, Report to the Government of Kenya: Kenya Agricultural Research Strategy and Plan. Volumes 1&2. December 1985.

-------, Organization and Management of Field Activities in On-Farm Research: A Review of Experience in Nine Countries, by Peter Ewell), OFCOR Comparative Study No. 2, The Hague, September 1988.

-------, Linkages Between On-Farm Research and Extension in Nine Countries, by Peter T. Ewell, OFCOR Comparative Study no. 4., The Hague, August 1989.

-------, A Conceptual Framework for Studying the Links Between Agricultural Research and Technology Transfer in Developing Countries, by David Kaimowitz, Monteze Snyder and Paul Engel, The Hague, May 1989.

Government of Kenya, Taskforce Report on the Evaluation of the On-Farm Grain Storage Project, March 1989.

-------, Agricultural Census of Large Farms, 1984. Central Bureau of Statistics, Ministry of Economic Planning and Development, Nairobi, 1985.

-------, Annual Report for 1987, National Agricultural Research Station Kitale, Kitale, September 1989.

-------, Economic Survey, 1989, Central Bureau of Statistics, Ministry of Planning and National Development, Nairobi, May 1989.

-------, Kenya Agricultural Research Institute (An Overview), Task Force on reports and Publications, KARI, Nairobi, July 1989.

-------, Research Achievements, National Research Center Kitale, Ministry of Research Science and Technology, Kitale, June 14, 1989.

-------, Taskforce Final Report on the Crop Post-Harvest Management Program in Kenya, April 1989.

-------, National Agricultural Research Plan (NARP), 1986.

-------, Ministry of Agriculture and Livestock Development, Kenya Agriculture Research Project Preparation Report, Sept. 24, 1986.

Jackson, R., Knauft, D., and McDermott, J.K., 1987. Final Evaluation: National Cereals Research and Extension Phase I, Project No. 631-0013. USAID Yaounde, Cameroon.

Jammeh, S.C., Gbetibouo, M., and Lele, U., 1989. Building Agricultural Research Capacity in Senegal: Analysis of the Evolution of Agricultural research and the Phase I Senegal Agricultural Research Project 1982-1988.

Johnson, V.C., Hill, W.A., and Tchala, F., 1989. Roots and Tuber Food Crops Research in Cameroon. Evaluation Report: Project (631-0058).

Judy, W., 1988. The Impact of Agricultural Research on End-users and Pass-through Users: Cameroon NCRE, ROTEP, and Bean/Cowpea CRSP Project.

Kamanga, Godwin, Y. Agricultural Research: Issues and Experiences; Malawi Ministry of Agriculture, 1988.

Kearl, S. 1987. A New Era for Food Crop Research in Cameroon. In cooperation with: Cameroon Institute for Agronomic research (IRA), International Institute of Tropical Agriculture (IITA), and USAID: Project No. 631-0013.

Khan, O., 1989. From the Ground Up: Interim Report in National Agricultural Research Systems in Five African Countries.

Kydd, Jonathan, "Maize Research in Malawi: Lessons from Failure," Journal of International Development, Vol. 1, No. 1, January, 1989, pp. 112-144.

Lele, U.J., and Goldsmith, A., 1989. The Development of National Agricultural Research Capacity: India's Experience with the Rockefeller Foundation and its Significance for Africa. MADIA Study, World Bank.

Lele, U.J., Kinsey, W.H., and Obeya, A.O., 1989. Building Agricultural Research Capacity in Africa: Policy Lessons from the MADIA Countries. MADIA Studies, World Bank.

McDermott, K.K. and Donald R. Isleib, A Strategy for USAID Support to Agricultural Research in Kenya: Consultant Report, USAID/Kenya, May 1984.

Michigan State University, Culture and Agriculture: Social Contributions to the Maintenance of Genetic Diversity in Beans in Northern Malawi (P.W. Barnes, McConnel), Malawi/MSU Project of the Bean-Cowpea Collaborative Research Support Program (CRSP), March 1989.

Michigan State University, 1988 Annual Report, Technical Summary. The Bean/Cowpea Collaborative Research Support Program (CRSP), n.d.

Ministry of Agriculture, Cameroon. 1988. An Executive Guide to the 1984 Agricultural Census: Part I. Farm and Farmer Characteristics, Farming Methods and Practices. MINAGRI/DEP/DE/AMP-1.

Ministry of Agriculture, Malawi, Department of Agricultural Research, Agricultural Research Master Plan, Draft, 1988.

Mitchnik, D., Quicke, E., Yates, A., Wardie, L. 1989. Cameroon National Extension and Training Project Staff Appraisal Report. World Bank.

Murphy, J., 1983. Strengthening the Agricultural Research Capacity of the Less Developed Countries: Lessons from A.I.D. Experience: Program Evaluation Report No. 10. USAID.

National Cereals Research and Extension Project (NCRE). Annual Work Plan: March 1988 - February 1989. IRA, MESIRES, Republic of Cameroon.

NCRE. 1988. Annual Report. IRA, MESIRES, Republic of Cameroon.

NCRE. 1985. Five Year Work Plan: 1986-1990. IRA, MESIRES, Cameroon.

NCRE. 1982. Project Work Plan: 1981-1985. IRA, MESIRES, Republic of Cameroon.

O'Brien-Place, Patricia, and Timothy R. Frakenburger, "Food Availability and Consumption Indicators", Nutrition in Agriculture Cooperative Agreement, University of Arizona and University of Kentucky, Report no.3, June 1988.

Ochieng, J.A.W., Three Decades of Maize Improvement in Kenya: What Dividends? Kitale Agricultural Research Center, Kitale, October 1988.

On-Farm Grain Storage Project, Maize Conservation on the Farm: Proceedings of a Seminar at Kisumu, Kenya, 21-23 January, 1986.

Phombeya, H.S.K., and Bunderson, W.T., "Agroforestry Commodity Team: An Overview of Strategies, Objectives, and Research Activities," Paper presented at Workshop on Improving Agroforestry Linkages between Research and Extension, Lilongwe, May 16-19, 1989.

Roberts, Nigel, ed., Agricultural Extension in Africa: A World Bank Symposium, Washington D.C. 1989.

Simons, Scott, Research in Kenya: Problems and Solutions, Ministry of Plan and National Development, April 1989.

Simons, S., and Gitu, K.W., 1989. Funding Agricultural Research and Extension: The Implications for Growth. Technical Paper 89-02. Long Range Planning Unit, Kenya Ministry of Planning and National Development.

Small Ruminants CRSP, Techpak Monitoring Schedule, Socio-Economics Project, Maseno, 1989.

-------, Various handouts, received at Maseno, 11/9/89.

-------, Research highlights 1986-88, Nairobi, 1988.

-------, Annual Report for Kenya Program Year Nine 1987-1988, Davis, 1989.

Special Program for African Agricultural Research (SPAAR). 1987. Guidelines for Strengthening National Agricultural Research Systems in Sub-Saharan Africa. World Bank.

Swanson, B.E., C.M. Sands, and W.E. Peterson, "Analyzing Agricultural Technology Systems: Some Methodological Tools" in Echeverria, R.G., ed., Methods for Diagnosing Research System Constraints and for Assessing the Impact of Agricultural Research, Vol. 1. Agricultural Technology Management Workshop, 6-8 July, 1988, Rutgers University New Jersey, The Hague, ISNAR, 1989.

USAID, A.I.D. Evaluation Highlights No. 4., "A Review of A.I.D. Experience: Farming Systems Research and Extension Projects - 1975-1987", Washington, D.C. June 1989.

-------, Kitale Maize: The Limits of Success, A.I.D. Project Impact Evaluation Report No. 2., Washington, D.C., May 1980.

-------, Project Paper, National Agricultural Research USAID/Kenya, 1986.

USAID. 1985. Plan for Supporting Agricultural Research and Faculties of Agriculture in Africa. USAID, Washington, D.C.

USAID/Cameroon. 1989. Country Development Strategy Statement.

USAID/Cameroon. 1989. Program Assistance Initial Document (PIAP): A Program of Reform in the Agricultural Marketing Sector, Phase I (631-0068).

USAID/Cameroon. 1984. NCRE Project paper.

USAID/Cameroon. 1988. Project Data Sheet: Agricultural Policy and Planning (631-0059).

USAID/Cameroon. 1973. Project Identification Document: National Cereals Improvement (later implemented as NCRE).

USAID/Kenya. Situation and Outlook Report for Maize and Wheat as of March 1, 1989.

-------, Report on Agricultural Impact Indicators (by Jennifer Gachagua, Agriculture Economist), January 12, 1989.

-------, An Expanded Maize Research Program in Kenya--Project Proposal Submitted to the Ministry of Agriculture and Livestock Development, October 1984.

-------, Kenya National Agriculture Research Project Analyses, July 8, 1986.

-------, Maize Production in Kenya: A Study of Costs and Technological Constraints Associated with Output Expansion, by C. Okello-Ogutu and M.O. Odhiambo, April 1986.

-------, Institutional and Financial Analyses for Kenya National Agriculture Research Project, Docs. 1&2, Coopers and Lybrand Assoc. Kenya, May 1986.

USAID/Malawi, Country Development Strategy Statement, 1991, December 1989.

USAID/Malawi, Malawi Agriculture and Extension Project, Mid-Term Evaluation Report, (Coffman, et. al.), January 1989.

USAID/Malawi, Background Information on Malawi and the USAID Assistance Program, May 1988.

U.S.D.A., Kenya Agricultural Situation Report, Foreign Agricultural Service, Nairobi, March 28, 1989.

-------, Kenya Grain and Feed Annual Report. Foreign Agricultural Service, Nairobi, April 4, 1989.

World Bank, Joint Kenya/Donor Mission: Kenya National Agricultural Research Project, Working Papers (May 19-June 6, 1986), July 14. 1986.

-------, The Challenge of Hunger in Africa: A Call to Action, Washington, D.C. n.d..

-------, "Kenya National Agricultural Research Program, Joint Donor Mission Evaluation Report," February 4, 1987.

-------, "Kenya National Agricultural Research Project, IDA Review Mission Aide Memoire," (February 17-March 14, 1988).

-------, "Kenya National Agricultural Research Project, Joint Donor Review Mission Aide Memoire," (March 13-31, 1989).

-------, The International Fund for Agricultural Development: Kenya: National Extension Project Mid-Term Review Report, July 1988.

-------, "Kenya's Agricultural Growth Prospects and Strategy Options" (Fraft, October 4, 1989, 2 volumes).

-------, MADIA Agricultural Development and Foreign Assistance: A Review of the World Bank's Experience in Kenya 1963-1986., by Uma Lele and L. Richard Meyers, December 17, 1986.

-------, Malawi National Rural Development Program (NRDP) Technical Issues Review, February 15, 1989.

-------, National Agricultural Research Project (Credit 1549-MAI), Agricultural Extension and Planning Support Project (Credit 1616-MAI), National Rural Development Program - Phase IV Project (Credit 1343-MAI), Aide Memoire Project Review Mission n.d..

ANNEXES

1468-050/2ND

ANNEX A

IIIM COUNTRY TEAM COMPOSITION

IIIM COUNTRY TEAM COMPOSITION

KENYA:

Alice Morton, MSI, Team Leader
Diana McLean, MSI, Agronomist
George Gardner, USDA, Ag. Economist

CAMEROON:

Lawrence Busch, MSI, Team Leader
Timothy Schilling, MSI, Agronomist
Paul Anamosa, AAAS, Agronomist

MALAWI:

Charles Whyte, MSI, Team Leader
John Yohe, MSI, Agronomist
Richard Newberg, A.I.D., Agronomist
Alice Morton, MSI, Anthropologist

ANNEX B

A BRIEF USER'S GUIDE TO THE IMPACT INDICATOR MATRIX

A Brief User's Guide to the Impact Indicator Matrix

After the review of the matrix developed at the October TPM, and applied first by the Kenya team, and thanks to the comments of the Cameroon and Malawi team members, we have worked a bit further to provide an amended version of the matrix as well as this modest user's guide.

Initially, we showed the matrix to the AID Mission personnel with whom we were to work, so that they would understand better what we were going to do and what kind of data we would need to identify and use.

We found it useful to use the matrix as an interview schedule or guide. In some instances, we were able to give copies to the program or project staff we were interviewing--in offices or at research stations--and have them help us to fill in the answers to the questions.

After these visits and interviews, we then checked our filled in matrices and notes and compared answers we had recorded where more than one of us had been present at the meeting, or at related meetings.

Finally, in developing the five-page single-spaced case studies on the programs/projects we assessed, we used the filled in matrices as a guide for the narrative presentation, and appended them as parts of the relevant annexes.

As far as the various scales, weights and measures are concerned, most of them are fairly self-evident. Where we have noted a "Swanson - # " in the margin, this refers to one of the indicators in the Swanson paper published in Echeverria et al, forthcoming. In what follows, we will try to give you the details of what our short-hand indicators mean where we think this will be in doubt at all as you read through the revised matrix.

N.B. We have left in a number of redundancies on purpose, both as methodologically sound, but also so that you can successively test which indicators seem best or most informative to you. Please feel free to add some new ones, especially at levels three and four, where ours are admittedly somewhat thin. For those which you add, please indicate the measurement that goes with the indicators, as appropriate.

Level I:

Question 1.1 - Apply the 0-1-2 weighting.
--Swanson #9 1&2 - indicate whether, for 1, this is actual or projected funding. For personnel (2), get it if you can. Table

10, Swanson p. 20 is real data for Malawi (the Malawi team gets a boost).

1.2 - a) here we suggest absolute %; b) a "batting average--5 starts fitting plan divided by total # of starts.

1.3. highest possible score =4

1.4 - highest possible score = 6
1.5 - list

1.6 - Swanson # 8 - p. 17--60-40% split is the norm. Calculate the per centages and see if they seriously diverge from this norm. Get as much of the other info as possible for the other indicators.

2.1 - yes, no

2.2 - Swanson #17 - bottom of p. 32, table--proximity--the higher the better, and the type of sources.

credit--yes, no--in-kind or in-cash. On a scale of 1-5, 1 being the lowest, rate the availability of input credit to smallholders. E.g., only in-kind from parastatal or gov't-run coop = lowest; free-market multiple sources, cash basis = highest.

High, medium and low potential roughly correspond to isohytes (rainfall zones).

Input supply-- small bags. Recommended use a function of amount of input sold x land covered = area of production.

# of smallest unit of input in question sold divided by # of small farms as an indicator of accessibility.

2.3 - Proportion of farm households within 10 km of a paved road.

2.4 - Effectiveness of extension--use your expert opinion and that of local experts--we know this is subjective, but "tell and vanish" measures aren't much more useful.

Swanson #5 p. 12, farmer organizations, p. 14 Table 7. Measure # two as applied to Ecuador is what we are after.

1.2 - Try to get either personnel by program or by center/station at a minimum. Two technicians for each researcher is the norm. Swanson #7 measures 1&3, p. 17 and Table 9.

1.4 - Career advancement. Promotion--refereed journal publications; advanced degrees are the norm. Salary increases--seniority in service is the norm. There are value questions here; what is the behavior or objective being maximized or reinforced by the promotion and salary system in the case being observed?

1.5 - a) through d) - highest possible score = 4

7,7

1.6 - Cite these and other examples.

Level II.

1.3 - Use of information for a) program design; b) project design, c) evaluation and mid-course correction, d) impact evaluation; maximum possible = 4.

1.4 - Swanson #10 p. 20, Table 12, p. 22. Apply this if possible. Also, add joint planning meetings to determine research design on the basis of identification of researchable problems at the beginning of the table. 1 point each for type of contact, max score = 6. Here again, note that Table 12 is real data for Malawi.

B.

1.0 - Promoted recommendations: all, some, none, %, why?
adapted recommendations: all, some, none, %, why?

2.0 - Swanson # 12 - Time Allotted to Technology Transfer, Table 15, page 25 modified by us. Include - identification of researchable problems and research design as first category under knowledge generation and transfer activities. Here, T&V reports may actually be useful.

Swanson #14, measure 4, p. 26 - figure 9 on p. 28 - give indication of 5.

INTERMEDIATE IMPACT INDICATORS MATRIX

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base	***A. At national/ministerial level***			
Does NARS have institutional structures & management mechanisms which will permit all critical functions of a research system to be effectively carried out?	**Manageable Interests of Parent Ministry and Institute**			
	1.0 Development of national research policy as it relates to national development policy.			
	Questions:			
	Does the country have an agricultural development plan?	Y/N		
	Does the country have a research policy?	Y/N		
	Who monitors the continued concordance of research and development policies?	Name body		
	1.1 NARS priorities articulated according to research policy and resource requirements defined based on iterative planning exercises.			
	Questions:			
	What process exists for setting research priorities and allocating resources? How does this process take into account:	Level of complexity of analysis: 0 = no formal priority setting method; 1 = congruence method; 2 = weighted criteria or other formal method.		
	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 need, distribution of benefits, political considerations, etc.			
Swanson #9:1 and/or 2	The probability and cost of research success, including national use of existing personnel, infrastructure, financial resources, etc. and taking into account past research results, both positive and negative, national and international	Resource allocation to commodities; Index value % research personnel/commodity research program. (state whether planned or actual)		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***1.2*** Effective communication of NARS needs and acquisition of resources.			
	Questions:			
	Does NARS receive an adequate level of funding from Government?	Research budget as % of Ag. GDP.		
	Does NARS receive the types and levels of funding requests from donors?	Funding level/request		
	Does NARS effectively coordinate donor-financed research activities?	Mechanisms: - Formal, timely meetings - New project starts based on NARS priorities - New project starts outside of NARS priorities		
	Does NARS initiate the identification of donor-financed activities?	Y/N		
	1.3 Effective external (international) linkages			
	Questions:			
	Does NARS have formal linkages with IARCs, international private sector research or agri-business? With whom and what type?	List and describe: 1 point each a) technology exchange; b) training; c) networking; d) consultation Maximum: 4 points		
	1.4 Effective internal (national) linkages			
	Questions:			
	Does NARS have formal linkages with MOA/EXT, other relevant ministries, universities, development projects, local agri-business, private sector research organizations? With whom and of what type?	List and describe: 1 point each: a) Priority setting process b) NARS board membership c) Training d) Technology exchange e) Contract research (in & out) f) NARS representation on other boards Maximum: 6 points		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.5*** Monitoring of impact-level indicators by parent ministries			
	Questions:			
	Who is responsible for baseline and time series data collection on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc.?	List by function/data type.		
	What data currently exist?			
	Are data readily exchanged?	Inventory data sets Identify users for each data set.		
	1.6 Human resource management			
	Questions:			
	Does NARS have a personnel database	Y/N		
	Does a NARS manpower training plan exist?	Y/N		
Swanson #8	Is there an adequate career incentive structure to recruit & retain qualified staff?	- Operating budget/researcher - Scheme of service for researchers? Y/N - Annual attrition rate - # of vacancies - Proportion of support staff to research & technical staff		
	2.0 Intervening Variables			
	2.1 Agricultural Policies			
	Questions:			
	Does NARS have a role in input & output price policy development?	Y/N Input policy Output policy		
	Does FX policy favor ag. sector?	- Special rates for ag. export/ import licensing; Y/N - FX readily available for input imports? Y/N		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	*2.2* Extension services			
	Questions:			
	What priority is given to extension? Who carries out extension activities?	% Ag. GDP to extension List		
	Extension salaries comparable to research salaries of equivalent levels?	Y/N		
	How effective is extension?	3 = highly effective; 2 = moderately effective; 1 = marginally effective (subjective observation)		Farmer surveys T&V report Observation Interviews
George?				
	Is there an adequate career incentive structure to recruit and retain qualified staff?	- Operating budget/extension officer - Annual attrition rate - # of vacancies		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***B. At NARS Institute and Program levels***			
	1.0 Research program planning and management			
	1.1 Development of long-term research plan			
	Questions:			
	Does institute have a long-term research plan?	Y/N		
	Do farmer orgs. participate in plan formulation?	Y/N farmer org. index		
	Does the plan articulate priorities and resource allocations by commodities/factors?	Y/N		
Swanson #5, 2	Does it include projections for manpower, infrastructure and operating funds?	Y/N		
	1.2 Development of a program structure			
	Questions:			
	Does institute have a program structure which will effectively carry out the long-term research plan?	- Existence of national programs		NARP
	Are program leaders appointed?	Y/N		
	Are programs adequately staffed?	# researcher/program # technicians/researchers (ratio) # B.S., M.S., Ph.D/program		personnel database NARP ISNAR Indicators Series
Swanson #7 1 and 3				

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ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.3*** Program and budget			
	Questions:			
	Does institute have a short-term program and budget?	Y/N		
	Are farmers involved in determining progams?	Farmer orgs. represented		
	Are programs based on constraints analysis?	Y/N		
	1.4 Monitoring and Evaluation (M&E)			
	Questions			
	How is research performance (efficiency) assessed?	- Active annual review process - # projects revised or cancelled		
	How is research quality assessed?	- Peer or expert review - # projects redesigned		
	Who establishes baseline data for research programs?	- Socio-economic surveys used in divising proposal? - Baseline survey		
	Who collects program-level and institute-level data for evaluation?	Individual scientists, prog. directors; M&E system		
	What are career promotion criteria?	List: Publications, advanced degrees, collaboration with extension.		
	What are criteria for pay increases?	Seniority, degree qualifications, etc.		
	How effective is the flow of information between research and its clients: policy-makers, extension services, farmers and others?	Mechanisms: Board meetings, sessional papers, annual reports, meetings with farmer org., bulletins, mass media messages.		

ANNEX C

SAMPLE INTERMEDIATE IMPACT INDICATORS

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	*1.5* External communication			
	Do institute centers and programs have formal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agri-business organizations for problem identification, program formulation and execution?	List linkages: 1 point each a. problem definition b. investigation c. analysis d. evaluation Maximum: 4 points		
	With whom and of what type?			
	1.6 Internal communication			
	What formal linkages exist within institute, e.g. between programs, disciplines?	Multidisciplinarity: 1 point each a. Problem definition b. Investigation c. Analysis d. Evaluation Maximum: 4 points		Annual reports Interviews with program leaders
	How are multidisciplinary problems approached?			
	Is NR mgt./sustainability incorporated into redesign? (indicate multidisciplinarity)	Cite examples: - Shift from chemical to biological pest control - Agroforestry research - Reduced proportion of inorganic to organic nitrogen sources		Annual reports Policy statements

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	**2.0 Financial Resource Management**			
	2.1 Acquisition of funds			
	Questions:			
	Are funds received by institute headquarters, stations and programs in a timely way and in adequate amounts?	- Date requested, date received; - Programs/projects halted for funding shortfalls (# & proportion) - # of researchers without funded projects		
	2.2 Funds disbursement			
	Questions			
	Do station and/or program heads have the delegation of authority necessary to permit a flexible yet accountable use of funds?	Y/N		
	Can funds be retained and carried over from one year to the next?	Y/N		
	2.3 Accounting			
	Questions			
	Are adequate accounting procedures and staff in place throughout the system?	FM system centralized Y/N No. of clearances required? Trained accountants at each center?		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer	***A. For the Research System***			
	1.0 Intermediate results (outputs)			
	1.1 Training Opportunities			
	Questions			
(What are the quantity, quality and nature of the outputs of the research and extension system?)	What training is available for researchers, collaborators and clients?	# trained ST in-country ST abroad LT abroad (Past 3 years)		Personnel system data-base
	1.2 Progression of experimentation			
	Questions			
	Is research moving from strategic, to applied to adaptive research?	Proportion of research on-station, on-farm, being demonstrated (time series)		Annual reviews extension reports
	How much research is conducted on-farm?	Research reports - # of trials listed		Annual reports
	How much research has moved into the field testing & demonstration stages?	# technologies moved from on-farm trials to demonstration stage/ program		Extension reports
	1.3 Surveys and constraint analysis			
	Questions			
	What studies have been initiated/completed on characteristics and constraints at agro-ecological levels, provincial levels, among cultural groups, etc. for outputs and inputs.	# projects with constraints analysis included # other studies analyzed :		
	How is this information to be used?	List: 1 point each - research project design - research program design - midcourse correction - impact evaluation Maximum: 4 points	1 1 = 4 1 1	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer (cont'd)	***1.4*** Interaction between research & extension			
	How do research & extension collaborate?	Nature, frequency of interaction Liaison officer? Y/N		
	How effective is this collaboration?	# jointly planned/implemented trials.		
(Swanson #10) modified	What research methodologies have been developed/refined to encourage client participation in research planning, execution, and evaluation?	List: - Baseline surveys - Program-level or center-level planning meetings? - Field days - Annual workshops		
	What methods have been developed to monitor and evaluate technology transfer and adoption?	Committees, surveys, reports, on-farm research		
	1.5 Responses to government requests for policy advice	- Sessional papers - Participation in policymaking bodies - Requests for advice		
	2.0 Conclusive results			
	2.1 Technologies developed/released			
	Questions			
	What new varieties have been developed tested, and released to clients? (i.e., extension, farmers, private sector research)?	# varieties released		NARS annual reports Extension reports
	What new technologies have been developed, tested and released to clients?	# of technologies recommended to extension		
	What recommendations have come out of commodity programs?	Proportion of programs that have released varieties or technologies		
	Has a "Menu" of technological choices been developed and offered to accommodate different systems and situations?	# of released varieties responding to low input vs. high input systems; # of techs with positive NR side effects, e.g., alley cropping, cut & carry, fodder, silage, zero-grazing		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	**2.2** Publications ***Questions:*** What scientific, technical and farmer-level publications have been produced?	List internal/external Level scientific technical farm level		Annual reports Extension reports
	2.3 Inputs ***Questions:***			
Swanson #17	Are agricultural inputs (seed, fertilizers, pesticides, tools) available?	Distance from household to input supply point, # of sources of inputs - Credit given for inputs Y/N: in kind or in cash		
	Are there subsectors w/o inputs?	Y/N - high, med, low potential Y/N - areas kg/ha		
	Are there times of the year when inputs are not available, more expensive?	Y/N - timely delivery; seasonal shortages; price fluctuations for fertilizer & seed.		
	How are inputs made available to resource-poor/farmers (e.g. small packaging, etc.)	# smallest units seed or fertilizer sold/# smallholder units		
	2.4 Marketing Infrastructure ***Questions:*** Are markets accessible to all producers?	- regional price variations - status of rural roads (proportion of farm households within 10 km of paved road		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	***B. For the Extension System***			
	1.0 Research results/recommendations accepted and extended			
	Questions:			
Swanson #14.3	To what degree have research results been promoted by the extension service?	All recommendations Some No recommendations Why % recommendation promoted by extension		T&V reports Liaison officer interviews Extension service reports
	To what extent does extension adopt researcher-recommended technologies?	All adopted Some None adopted Why		
Swanson #12	How is adoption of recommendations tracked?	Tracking system exists Y/N Tracking system applied Y/N		Liaison officer interviews Extension service reports
	2.0 Extension methodologies & Effectiveness			
	Questions:			
	What extension methodologies have been developed/refined to improve extension participation in research?	Ranked allocation of extension agent time in tech. generation and transfer activities		T&V agent reports
Swanson #14.4 Swanson #14.5	What extension methodologies have been developed/refined to improve the extension-farmer linkage?	# of program changes based on feedback from extension		T&V on station or on-farm research program descriptions/evaluations
	What publications or other media mechanisms have been produced to inform farmers of research findings?	# of households with direct contact with extension agents (male vs. female-headed) # of new messages by type Actual samples		Extension audio visual department Annual extension reports

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	***C. Intervening Variables***			
	1.0 Markets			
	Questions:			
	1.1 Farm to market roads?	Average distance farm to market? Proportion transport cost of total cost (market prices)?		
		Farmgate vs. market prices		
	1.2 Does a market information system exist for commodities?	Y/N on radio in print media		Observation
	1.3 Are there price constraints for commoditiss?			
	1.4 Are there required marketing channels that must be used?			
	1.5 Are there commodity marketing standards?			
	1.6 Are the recommended inputs available?			
	2.0 Storage and processing considerations			
	2.1 Is value added at household level for commodities examined?	Farm level profit & loss		Farm budgets by type of farm
	2.2 Proportion of post-production losses	Costs & returns at commodity level		
	2.3 Post production processing	Value added to commodities		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (Adoption & Beyond)	1.0 Technology Utilization			
How can the adoption of technologies produced by the NARS be measured, and results used to forecast probable impact on the national economy?	1.1 What % of farmers are using new technologies?	Adoption of technology stratified by farm size high, medium, low; potential; male/female household head.		Project studies Extension service records, e.g. farm management unit. Special Studies
	1.2 Has total production increased in a commodity or region?	Production statistics; yield data; land use data by commodity & region. Production 1 area cultivated.		Central statistics office MOA statistics office Remote sensing data
	Have sales of fertilizer, seed, etc. increased? (Substitute relevant inputs/case study)	Sales records		Cooperative records Import/Export records
	Has there been a tech-related shift in crop mix?	Tech-related shift in crop mix short-term and long-term		National statistics office Remote sensing data
	2.0 Rural agro-industrial transformation			
	2.1 Has agro-industrial transformation occurred?	# of rural-based small enterprises by regions (female vs. male-owned) 10 workers or less? Increased rural savings		MOA
	2.2 Has research/extension resulted in the formation or strengthening of farmer organizations?	- # organizations - # members		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (cont'd)	**3.0** Management of natural resource base			
	Questions:			
	3.1 Has NR management been an element of technology adopted?	Increased land cultivation (intensive vs. extensive) Proportion owned vs. rental land, security of access to land % top soil loss, salinization rate Sedimentation rate		
	4.0 Policy changes at sector level	Price policy; input policy; marketing policy		
V. Impact How has investment in research influenced the economy of the country, in terms of incomes, productivity, production & food security (availability, access & adequacy)?	**1.0** Net farm income	1. Change in net farm income at national aggregate level in real terms. 2. Change in net farm income/ farm in real terms disaggregated by farm size male/female household heads 3. Changes in net farm income per AEPA		FAO yearbook World Bank reports Treasury reports
	2.0 Agricultural productivity			
	2.1 Has agricultural productivity increased by farm size, etc.	1. Change in value of prod/capita. 2. Change in value of production/ farm (EAPA, male/female). 3. Change in value of production/ farm by farm size. 4. Change in value of ag. production per hectare of agricultural land. 5. Change in value of ag. production by unit of ag. investment of credit for agriculture.		Central statistics offices, MOA, Treasury, Credit Bank, FAO nutrition statistics.

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact (cont'd)	***3.0*** Food Security (national level)			
	3.1 What is the impact of ag. research on food security at the national level?	1. Change in per capita food production and consumption. 2. Change in ag. GDP (including non-food crops). 3. Change in % self-sufficiency in basic food commodities. 4. Variability in total annual ag. production. 5. Change in per capita food imports by value. 6. Change in annual carryover stocks of basic food stuffs (buffer stocks)		

ANNEX D

KENYA

CASE NARRATIVES AND COMPLETED INTERMEDIATE IMPACT INDICATOR MATRICES

THE CASE OF KITALE MAIZE IN KENYA

A.I.D. first became involved with hybrid maize research in Kenya in 1963, only a year before the first hybrid maize seeds were released for commercial production. A.I.D. was continuously involved in the maize breeding at Kitale for the next 15 years. In 1964, the first first hybrid seeds were released for commercial production, and they resulted in a remarkable 40 percent increase in yield over local seed and proved appropriate to the environment of the environment of the high potential areas of the nation.

At the time, it was assumed that the African farmers--in contrast to the large commercial European farmers--would continue to use the local inproved variety rather than the hybrid for several reasons. The local variety was less prone to total crop failure, and its seed could be reused year after year whereas hybrid seed had to be purchased each year. But the hybrid maize was clearly superior in yield, enjoyed the status of a crop grown by large prosperous farmers, and the African farmers soon demanded it.

Furthermore, an aggressive private firm--the Kenya Seed Company (KSC)--reproduced the hybrid seed and distributed it widely through an already established private sector network. Extension agents from both the government and KSC demonstrated the use of improved cultivation techniques, while the government-supported official prices and marketing system provided incentives--especially for large commercial farmers. By 1977, the majority of small-holders in the high potential Central, Rift Valley and Western Provinces grew hybrid maize and their total production far surpassed large farmer output.

The final outcome of the Kitale maize breeding success story is that the large number of small farmers who did gain access to the hybrid maize technology have improved their food security as a result. The aggregate results are still being felt in 1989, as Kenya continues in most years to not only be self-sufficient in the country's staple food, but also produces an exportable surplus in most years. The relative success of the spread of hybrid maize technology in Kenya can be seen in the following data tables and graphs depicting the national production, hybrid area harvested, and average yield data during the 1970-88 period.

General Project Description

The Kitale Maize Research Program, throughout its long history, has benefitted from USAID funding at modest levels for most of the years it has been in existence. Because the USAID monies to support maize research at Kitale were expended under various regional and Kenya-specific projects during the 1960s and 1970s, it is impossible to arrive at an exact estimate of the portion of the total monies which were dedicated exclusively to maize research at Kitale. (The chronology of USAID funding and participation is well documented in A.I.D. Project Impact Evaluation Report No. 2, "Kitale Maize: The Limits of Success.") For the purposes of this exercise, Kitale maize research was selected because it is an A.I.D.-supported agricultural research project which has been perceived as successful, and has been around long enough to likely have a measurable impact at the regional and national level.

Applying the Evaluation Framework

Level I: Institutional Base

The Kitale maize improvement program is located at the Kitale National Research Center in western Kenya, and is a component of the Kenya Agricultural Research Institute (KARI). The larger institutional and policy environment surrounding the project, at the national and ministerial levels, is relevant to all technology generation and transfer activities. Thus, the questions of national research and development policy, research priorities, national funding for research, effective external and internal linkages, and intervening variables of macroeconomic policies, input supply, and marketing certainly apply to this activity. They are discussed in detail at the national KARI level in another section of this report, however. In this section, the focus is on the institutional base aspects of the aspects of the Kitale National Research Center maize research story.

For the research program planning and management element of the indicator matrix, Kitale NRC currently ranks quite high. A research plan is developed and formalized annually, although the longer-term strategic plan is less formal. Farmers are involved in the plan formulation process at various stages: they are present on research planning committees, they do on-farm trials, and each researcher visits farmers' fields during the growing season as the trials progress. The Kitale NRC work plan includes projections for manpower, infrastructure and operating funds, although in reality there are sometimes staff turnover and shortages of operating funds.

With respect to a program structure, the Kitale NRC is covered by the National Maize Coordinating Committee which oversees and reviews the long-term research plan. Permanent program leaders are appointed at Kitale, although most are M.S.-level trained researchers. A number of Kitale's staff are currently in Canada for long-term training, and will thus be upgraded to Ph.D.-level scientists.

In terms of program and budget, the Kitale NRC prepares an annual budget. Farmer organizations are not formally or informally represented in the program and budget process. However, the program is based on constraints analysis with limited farmer input in the process.

The Kitale NRC rates positively with respect to monitoring and evaluation of research projects. A special annual review committee operates internally for each project. Furthermore, formal external reviews are also conducted annually. Some projects which do not live up to expectations are actually cancelled.

Information management is handled at Kitale in various ways. The process starts with the research (and extension) staff members overseeing on-farm research and demonstration plots. In addition, more formal demonstrations (i.e. field days) are held on the research station every other year. Publications based on experimental results and farmer trials are published regularly. (See the "Kitale Annual Report: 1987" for details and a list of research publications.)

Other effective flows of research information include annual shows and extensive use of the T&V system with extension personnel. Bulletins for extension staff are published regularly, and maize tours during the growing season are conducted annually.

The question of external linkages addresses the extent to which the research center has formal linkages with clients, such as extension personnel, private sector businessmen, university staff, and provincial-level policy makers. The Kitale NRC has formal linkages in all of these areas. For example, subject-matter specialists sit on all research review committees.

Kitale also ranks well on measures of internal linkages; that is, the degree to which formal linkages exist within the institute between various research programs and disciplines. At Kitale, multidisciplinary linkages are maintained at all stages of the research process -- with special emphasis on the problem definition stage.

Another dimension in which Kitale was evaluated was the area of financial resource management. The idea here is to measure the effectiveness of the particular research station in acquiring funds from KARI headquarters, in a timely way and in adequate amounts. Kitale's performance in this area is mixed, for a number of reasons. Operating expense funds are disbursed from KARI approximately every six months, and this fact creates some budgeting problems -- especially for unanticipated expenses. On the other hand, salaries are paid monthly directly from KARI's headquarters in Nairobi. There have been no particular problems in this area funds are disbursed from the Treasury Ministry to the Ministry of Science and Technology to KARI then to Kitale NRC. Funds which are not expended in the scheduled fiscal year can in theory be carried over to the next year, but in fact they are often apparently lost.

Another measure of financial resource management deals with the adequacy of the accounting system and the degree of flexibility it affords the various research centers within the system. At Kitale, all salary and personnel accounting is highly centralized is done at KARI headquarters in Nairobi. However, there is some flexibility in the operating funds situation. For example, operating expenditures of up to KS 30,000 (about $1,500) can be approved at Kitale NRC by the center's director; but above this amount, approval is needed from KARI headquarters.

Data Sources for Measuring Final Impact of Kitale Maize

The key sources of data on maize (and other basic crops such as beans) are the Ministry of Agriculture (MOA), the Central Bureau of Statistics (CBS), the National Cereals and produce Board (NCPB), and the Kenya Rangeland Ecological Monitoring Unit (KREMU). Thus, there are usually several parallel sets of national maize statistics on area and production, but often significant discrepancies and discontinuities between them exist. These problems are mainly due to the differences in extent of coverage of the estimates and the statistical sampling methods employed. The various data series are described below along with what is known about their respective estimation methodologies:

MOA Estimates: These estimates are based on reports of the provincial director of agriculture who collects the data from the district agriculture officer or crop production officer. A visual estimate of the area is made by the district officer, and then passed on to district or provincial headquarters where statistics are often modified before submission to MOA.

CBS Estimates: CBS has conducted its bi-annual Crop Forecast Survey and Review since 1976 covering maize, beans and potatoes mainly on smallholder farms. In 1980, intermediate and large-scale farms were also included. The surveys provide; estimates of crop area, production, farm retentions from household consumption, and sales by province. The surveys derive production indirectly (from area estimates) and are based on direct interviews with farmers.

NCPB Estimates: The NCPB conducts an annual maize yield survey to estimate biological maize yields. The estimates are then combined with the CBS estimates of acreage planted to derive production estimates for both short and long rain crops. Based on previous surveys, the NCPB also estimates expected maize purchases by the marketing board. In contrast to the MOA, the NCPB bases its estimates on actual physical measurement techniques as opposed to relying solely on interviews with farmers.

INTERMEDIATE IMPACT INDICATORS MATRIX

KENYA—KITALE MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base	***A. At national/ministerial level***		(Level I not completed — see Case Study on SR-CRSP below.)	
Does NARS have institutional structures & management mechanisms which will permit all critical functions of a research system to be effectively carried out?	**Manageable Interests of Parent Ministry and Institute**			
	1.0 Development of national research policy as it relates to national development policy.			
	Questions:			
	Does the country have an agricultural development plan?	Y/N		
	Does the country have a research policy?	Y/N		
	Who monitors the continued concordance of research and development policies?	Name body		
	1.1 NARS priorities articulated according to research policy and resource requirements defined based on iterative planning exercises.			
	Questions:			
	What process exists for setting research priorities and allocating resources? How does this process take into account:	Level of complexity of analysis:		
	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 need, distribution of benefits, political considerations, etc.	0 = no formal priority setting method; 1 = congruence method; 2 = weighted criteria or other formal method.		
Swanson #9:1 and/or 2	The probability and cost of research success, including national use of existing personnel, infrastructure, financial resources, etc. and taking into account past research results, both positive and negative, national and international	Resource allocation to commodities; Index value % research personnel/commodity research program. (state whether planned or actual)		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***1.2*** Effective communication of NARS needs and acquisition of resources.			
	Questions:			
	Does NARS receive an adequate level of funding from Government?	Research budget as % of Ag. GDP.		
	Does NARS receive the types and levels of funding requests from donors?	Funding level/request		
	Does NARS effectively coordinate donor-financed research activities?	Mechanisms: - Formal, timely meetings - New project starts based on NARS priorities - New project starts outside of NARS priorities		
	Does NARS initiate the identification of donor-financed activities?	Y/N		
	1.3 Effective external (international) linkages			
	Questions:			
	Does NARS have formal linkages with IARCs, international private sector research or agri-business? With whom and what type?	List and describe: 1 point each a) technology exchange; b) training; c) networking; d) consultation Maximum: 4 points		
	1.4 Effective internal (national) linkages			
	Questions:			
	Does NARS have formal linkages with MOA/EXT, other relevant ministries, universities, development projects, local agri-business, private sector research organizations? With whom and of what type?	List and describe: 1 point each: a) Priority setting process b) NARS board membership c) Training d) Technology exchange e) Contract research (in & out) f) NARS representation on other boards Maximum: 6 points		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***1.5*** Monitoring of impact-level indicators by parent ministries			
	Questions:			
	Who is responsible for baseline and time series data collection on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc.?	List by function/data type.		
	What data currently exist?			
	Are data readily exchanged?	Inventory data sets Identify users for each data set.		
	1.6 Human resource management			
	Questions:			
	Does NARS have a personnel database	Y/N		
	Does a NARS manpower training plan exist?	Y/N		
Swanson #8	Is there an adequate career incentive structure to recruit & retain qualified staff?	- Operating budget/researcher - Scheme of service for researchers? Y/N - Annual attrition rate - # of vacancies - Proportion of support staff to research & technical staff		
	2.0 Intervening Variables			
	2.1 Agricultural Policies			
	Questions:			
	Does NARS have a role in input & output price policy development?	Y/N Input policy Output policy		
	Does FX policy favor ag. sector?	- Special rates for ag. export/ import licensing; Y/N - FX readily available for input imports? Y/N		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	2.2 Extension services			
	Questions:			
	What priority is given to extension? Who carries out extension activities?	% Ag. GDP to extension List		
	Extension salaries comparable to research salaries of equivalent levels?	Y/N		
George?	How effective is extension?	3 = highly effective; 2 = moderately effective; 1 = marginally effective (subjective observation)		Farmer surveys T&V report Observation Interviews

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	Is there an adequate career incentive structure to recruit and retain qualified staff?	- Operating budget/extension officer - Annual attrition rate - # of vacancies		
	B. At NARS Institute and Program levels			
	1.0 Research program planning and management			
	1.1 Development of long-term research plan			
	Questions:			
	Does institute have a long-term research plan?	Y/N		
Swanson #5, 2	Do farmer orgs. participate in plan formulation?	Y/N farmer org. index		
	Does the plan articulate priorities and resource allocations by commodities/factors?	Y/N		
	Does it include projections for manpower, infrastructure and operating funds?	Y/N		
	1.2 Development of a program structure			
	Questions:			
	Does institute have a program structure which will effectively carry out the long-term research plan?	- Existence of national programs		NARP
Swanson #7 1 and 3	Are program leaders appointed?	Y/N		
	Are programs adequately staffed?	# researcher/program # technicians/researchers (ratio) # B.S., M.S., Ph.D/program		personnel database NARP ISNAR Indicators Series

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.3*** Program and budget			
	Questions:			
	Does institute have a short-term program and budget?	Y/N		
	Are farmers involved in determining progams?	Farmer orgs. represented		
	Are programs based on constraints analysis?	Y/N		
	1.4 Monitoring and Evaluation (M&E)			
	Questions			
	How is research performance (efficiency) assessed?	- Active annual review process - # projects revised or cancelled		
	How is research quality assessed?	- Peer or expert review - # projects redesigned		
	Who establishes baseline data for research programs?	- Socio-economic surveys used in divising proposal? - Baseline survey		
	Who collects program-level and institute-level data for evaluation?	Individual scientists, prog. directors; M&E system		
	What are career promotion criteria?	List: Publications, advanced degrees, collaboration with extension.		
	What are criteria for pay increases?	Seniority, degree qualifications, etc.		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***Questions:***			
	How effective is the flow of information between research and its clients: policy-makers, extension services, farmers and others?	Mechanisms: Board meetings, sessional papers, annual reports, meetings with farmer org., bulletins, mass media messages.		
	1.5 External communication			
	Do institute centers and programs have formal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agri-business organizations for problem identification, program formulation and execution?	List linkages: 1 point each a. problem definition b. investigation c. analysis d. evaluation Maximum: 4 points		
	With whom and of what type?			
	1.6 Internal communication			
	What formal linkages exist within institute, e.g. between programs, disciplines?	Multidisciplinarity: 1 point each a. Problem definition b. Investigation c. Analysis d. Evaluation Maximum: 4 points		Annual reports Interviews with program leaders
	How are multidisciplinary problems approached?			Annual reports Policy statements
	Is NR mgt./sustainability incorporated into redesign? (indicate multidisciplinarity)	Cite examples: - Shift from chemical to biological pest control - Agroforestry research - Reduced proportion of inorganic to organic nitrogen sources		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	2.0 **Financial Resource Management**			
	2.1 Acquisition of funds			
	Questions:			
	Are funds received by institute headquarters, stations and programs in a timely way and in adequate amounts?	- Date requested, date received; - Programs/projects halted for funding shortfalls (# & proportion) - # of researchers without funded projects		
	2.2 Funds disbursement			
	Questions			
	Do station and/or program heads have the delegation of authority necessary to permit a flexible yet accountable use of funds?	Y/N		
	Can funds be retained and carried over from one year to the next?	Y/N		
	2.3 Accounting			
	Questions			
	Are adequate accounting procedures and staff in place throughout the system?	FM system centralized Y/N No. of clearances required? Trained accountants at each center?		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer	***A. For the Research System***			
	1.0 Intermediate results (outputs)			
	1.1 Training Opportunities			
	Questions			
(What are the quantity, quality and nature of the outputs of the research and extension system?)	What training is available for researchers, collaborators and clients?	# trained ST in-country ST abroad LT abroad (Past 3 years)	Most permanent prog leaders are M.S. level trained researchers w/a # currently in Canada — LT abroad to PhD	Personnel system data-base
	1.2 Progression of experimentation			
	Questions			
	Is research moving from strategic, to applied to adaptive research?	Proportion of research on-station, on-farm, being demonstrated (time series)	—mainly on-farm, demonstration plots —one hybrid seed	Annual reviews extension reports
	How much research is conducted on-farm?	Research reports - # of trials listed		Annual reports
	How much research has moved into the field testing & demonstration stages?	# technologies moved from on-farm trials to demonstration stage/ program		Extension reports
	1.3 Surveys and constraint analysis			
	Questions			
	What studies have been initiated/completed on characteristics and constraints at agro-ecological levels, provincial levels, among cultural groups, etc. for outputs and inputs.	# projects with constraints analysis included # other studies analyzed		
	How is this information to be used?	List: 1 point each - research project design - research program design - midcourse correction - impact evaluation Maximum: 4 points	Prog. based on constraints analysis w/limited farmer input 1 1 1 = 4 1	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer (cont'd)	***1.4*** Interaction between research & extension			
(Swanson #10) modified	How do research & extension collaborate?	Nature, frequency of interaction Liaison officer? Y/N	—farmers on research planning committees, on-farm trials —field days	
	How effective is this collaboration?	# jointly planned/implemented trials.		
	What research methodologies have been developed/refined to encourage client participation in research planning, execution, and evaluation?	List: - Baseline surveys - Program-level or center-level planning meetings? - Field days - Annual workshops	—on-farm research, annual review committee, publications, annual shows, T&V, bulletins, tours	
	What methods have been developed to monitor and evaluate technology transfer and adoption?	Committees, surveys, reports, on-farm research		
	1.5 Responses to government requests for policy advice	- Sessional papers - Participation in policymaking bodies - Requests for advice		
	2.0 Conclusive results			
	2.1 Technologies developed/released			
	Questions			
	What new varieties have been developed tested, and released to clients? (i.e., extension, farmers, private sector research)?	# varieties released	—One	NARS annual reports Extension reports
	What new technologies have been developed, tested and released to clients?	# of technologies recommended to extension	—Improved cultivation techniques	
	What recommendations have come out of commodity programs?	Proportion of programs that have released varieties or technologies		
	Has a "Menu" of technological choices been developed and offered to accommodate different systems and situations?	# of released varieties responding to low input vs. high input systems; # of techs with positive NR side effects, e.g., alley cropping, cut & carry, fodder, silage, zero-grazing	—high yield, appropriate to the environment of high potential areas	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	**2.2** Publications ***Questions:*** What scientific, technical and farmer-level publications have been produced?	List internal/external Level scientific technical farm level	Kitali Annual Report: 1987 details a list of research pubs Bulletins for extension stali	Annual reports Extension reports
	2.3 Inputs ***Questions:*** Are agricultural inputs (seed, fertilizers, pesticides, tools) available?	Distance from household to input supply point, # of sources of inputs - Credit given for inputs Y/N: in kind or in cash	One Improved cultivation techniques High yield, appropriate to the environment of high potential areas	
Swanson #17	Are there subsectors w/o inputs?	Y/N - high, med, low potential Y/N - areas kg/ha	One new hybrid seed	
	Are there times of the year when inputs are not available, more expensive?	Y/N - timely delivery; seasonal shortages; price fluctuations for fertilizer & seed.	Seed aggressively distributed through private sector network	
	How are inputs made available to resource-poor/farmers (e.g. small packaging, etc.)	# smallest units seed or fertilizer sold/# smallholder units		
	2.4 Marketing infrastructure ***Questions:*** Are markets accessible to all producers?	- regional price variations - status of rural roads (proportion of farm housholds within 10 km of paved road)	Government supported official prices & marketing system provided (esp. incentives to large commercial farmers)	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	***B. For the Extension System***			
	1.0 Research results/recommendations accepted and extended			
	Questions:			
Swanson #14.3	To what degree have research results been promoted by the extension service?	All recommendations Some No recommendations Why % recommendation promoted by extension	All recommendations All adopted	T&V reports Liaison officer interviews Extension service reports
	To what extent does extension adopt researcher-recommended technologies?	All adopted Some None adopted Why	Annual review committee evaluates each project and annual formal external reviews	
Swanson #12	How is adoption of recommendations tracked?	Tracking system exists Y/N Tracking system applied Y/N		Liaison officer interviews Extension service reports
	2.0 Extension methodologies & Effectiveness			
	Questions:			
	What extension methodologies have been developed/refined to improve extension participation in research?	Ranked allocation of extension agent time in tech. generation and transfer activities	Farmers on research planning committees	T&V agent reports
Swanson #14.4 Swanson #14.5	What extension methodologies have been developed/refined to improve the extension-farmer linkage?	# of program changes based on feedback from extension		T&V on station or on-farm research program descriptions/evaluations
	What publications or other media mechanisms have been produced to inform farmers of research findings?	# of households with direct contact with extension agents (male vs. female-headed) # of new messages by type Actual samples		Extension audio visual department Annual extension reports

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	C. Intervening Variables			
	1.0 Markets			
	Questions:			
	1.1 Farm to market roads?	Average distance farm to market? Proportion transport cost of total cost (market prices)?	Complete infrastructure	
		Farmgate vs. market prices		
	1.2 Does a market information system exist for commodities?	Y/N on radio in print media		Observation
	1.3 Are there price constraints for commodities?		Yes	
	1.4 Are there required marketing channels that must be used?			
	1.5 Are there commodity marketing standards?			
	1.6 Are the recommended inputs available?		Yes	
	2.0 Storage and processing considerations			
	2.1 Is value added at household level for commodities examined?	Farm level profit & loss	Yes	Farm budgets by type of farm
	2.2 Proportion of post-production losses	Costs & returns at commodity level		
	2.3 Post production processing	Value added to commodities	Yes	

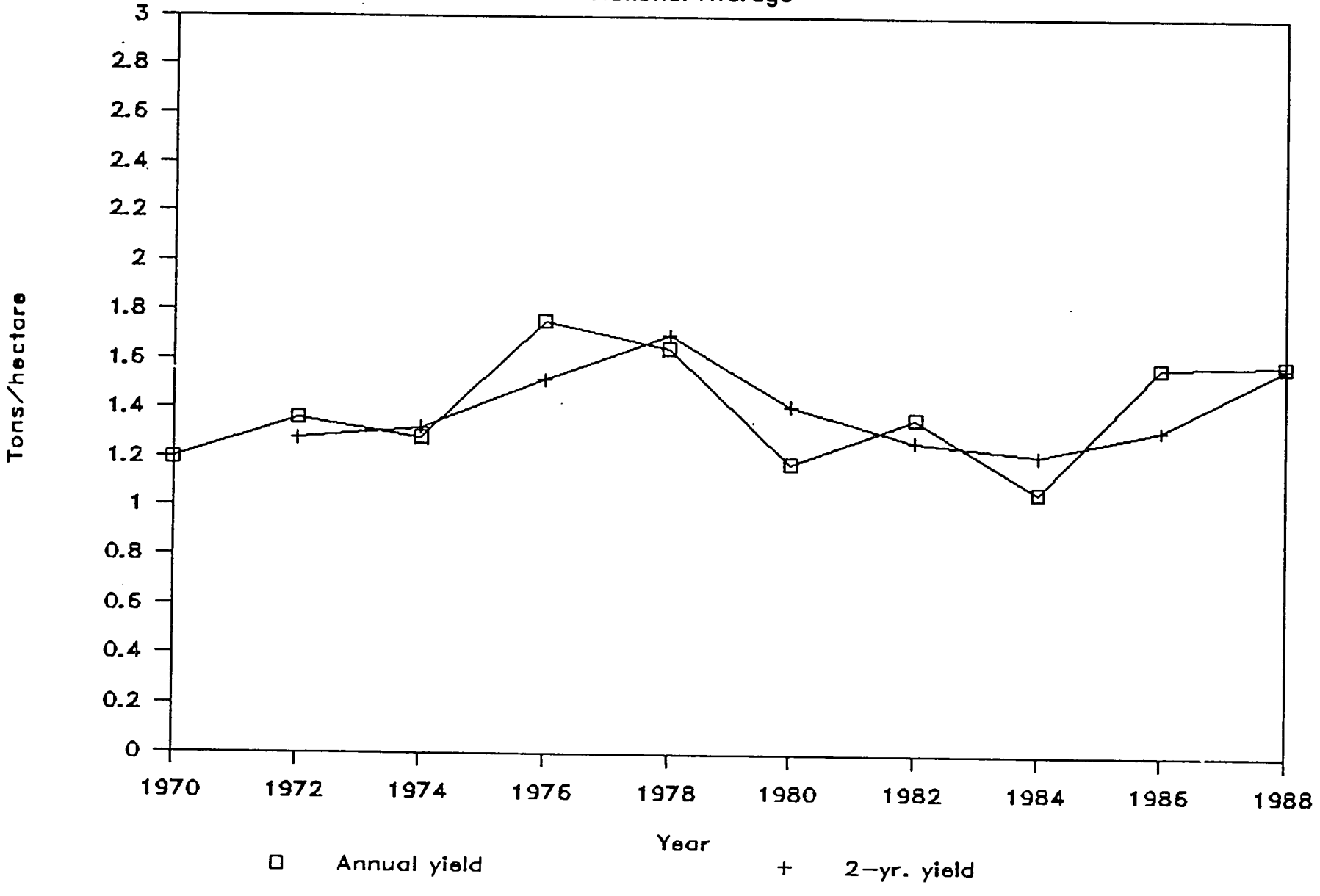
ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (Adoption & Beyond)	**1.0** Technology Utilization			
	1.1 What % of farmers are using new technologies?	Adoption of technology stratified by farm size high, medium, low potential, male/female household head.	High percentage	Project studies Extension service records, e.g. farm management unit. Special Studies
How can the adoption of technologies produced by the NARS be measured, and results used to forecast probable impact on the national economy?	**1.2** Has total production increased in a commodity or region?	Production statistics; yield data; land use data by commodity & region. Production 1 area cultivated.	Yes	Central statistics office MOA statistics office Remote sensing data
	Have sales of fertilizer, seed, etc. increased? (Substitute relevant inputs/case study)	Sales records		Cooperative records Import/Export records
	Has there been a tech-related shift in crop mix?	Tech-related shift in crop mix short-term and long-term		National statistics office Remote sensing data
	2.0 Rural agro-industrial transformation			
	2.1 Has agro-industrial transformation occurred?	# of rural-based small enterprises by regions (female vs. male-owned) 10 workers or less? Increased rural savings		MOA
	2.2 Has research/extension resulted in the formation or strengthening of farmer organizations?	- # organizations - # members		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (cont'd)	**3.0** Management of natural resource base			(See tables above.)
	Questions:			
	3.1 Has NR management been an element of technology adopted?	Increased land cultivation (intensive vs. extensive) Proportion owned vs. rental land, security of access to land % top soil loss, salinization rate Sedimentation rate		
	4.0 Policy changes at sector level	Price policy; input policy; marketing policy		
IV. Impact How has investment in research influenced the economy of the country, in terms of incomes, productivity, production & food security (availability, access & adequacy)?	**1.0** Net farm income	1. Change in net farm income at national aggregate level in real terms. 2. Change in net farm income/ farm in real terms disaggregated by farm size male/female household heads 3. Changes in net farm income per AEPA		FAO yearbook World Bank reports Treasury reports
	2.0 Agricultural productivity			
	2.1 Has agricultural productivity increased by farm size, etc.	1. Change in value of prod/capita. 2. Change in value of production/ farm (EAPA, male/female). 3. Change in value of production/ farm by farm size. 4. Change in value of ag. production per hectare of agricultural land. 5. Change in value of ag. production by unit of ag. investment of credit for agriculture.		Central statistics offices, MOA, Treasury, Credit Bank, FAO nutrition statistics.

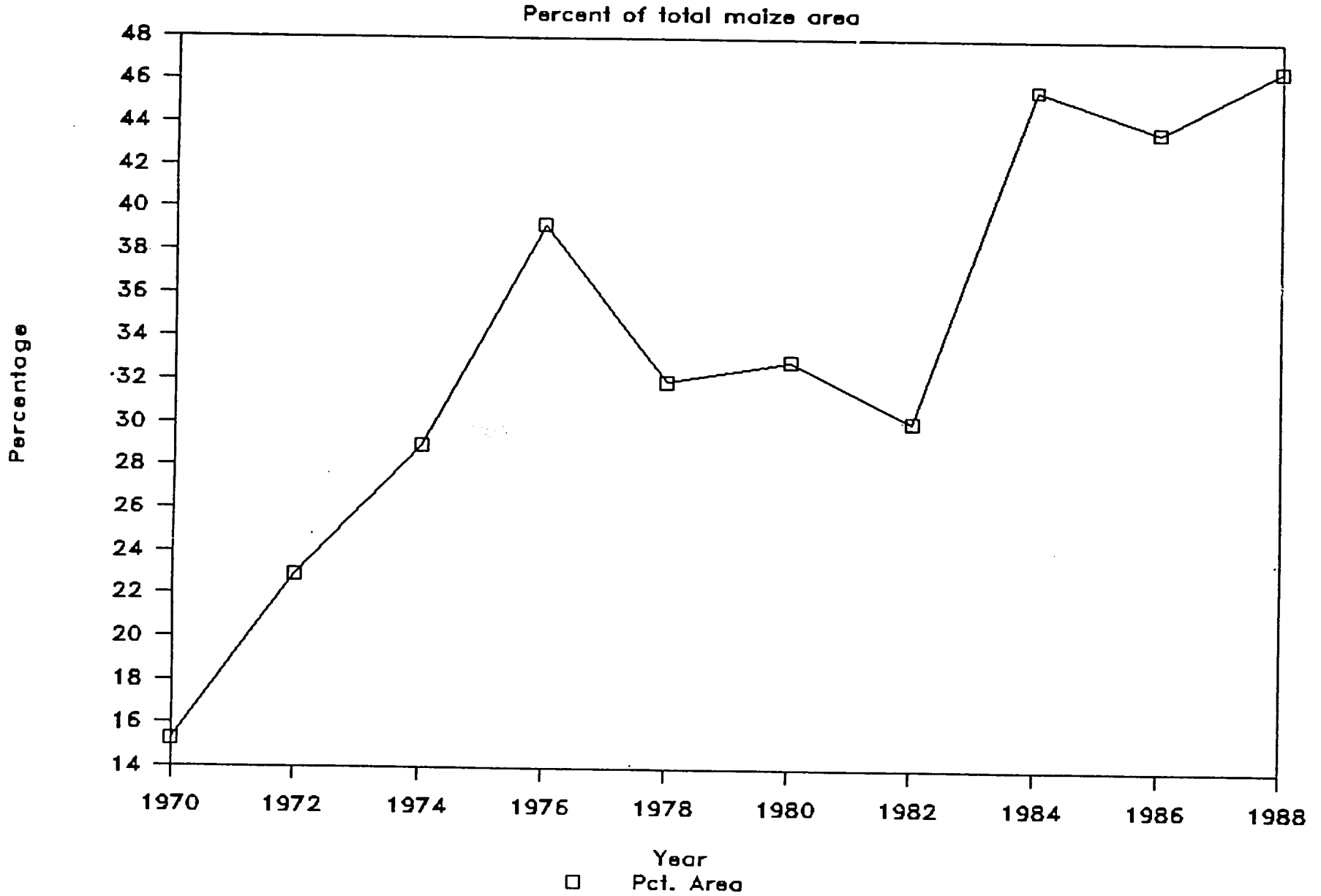
ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. **Impact** (cont'd)	**3.0** Food Security (national level)			
	3.1 What is the impact of ag. research on food security at the national level?	1. Change in per capita food production and consumption. 2. Change in ag. GDP (including non-food crops). 3. Change in % self-sufficiency in basic food commodities. 4. Variability in total annual ag. production. 5. Change in per capita food imports by value. 6. Change in annual carryover stocks of basic food stuffs (buffer stocks)		

Kenya: Maize Yield, 1970–88

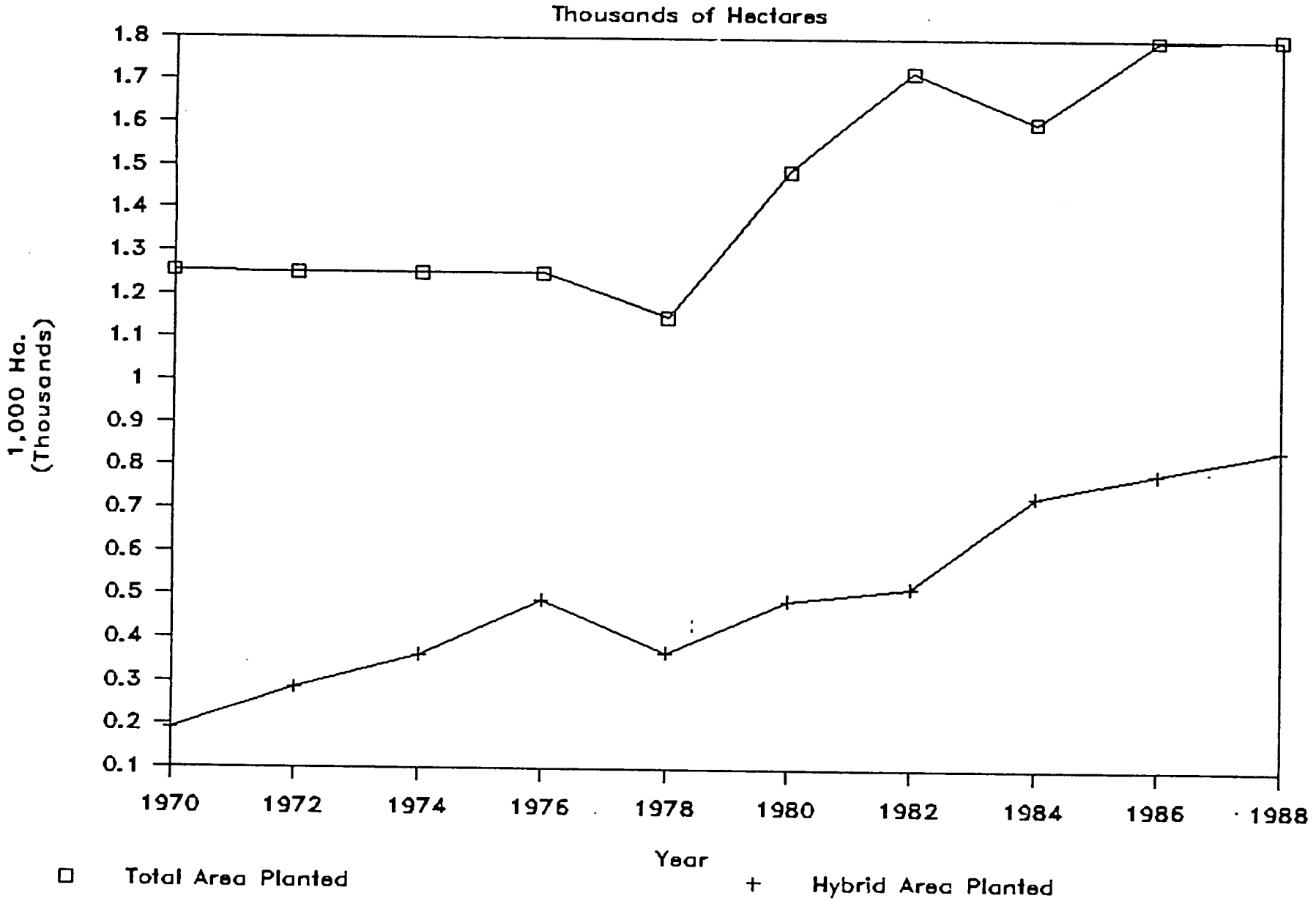
National Average



KENYA: Improved Maize Area, 1970–88

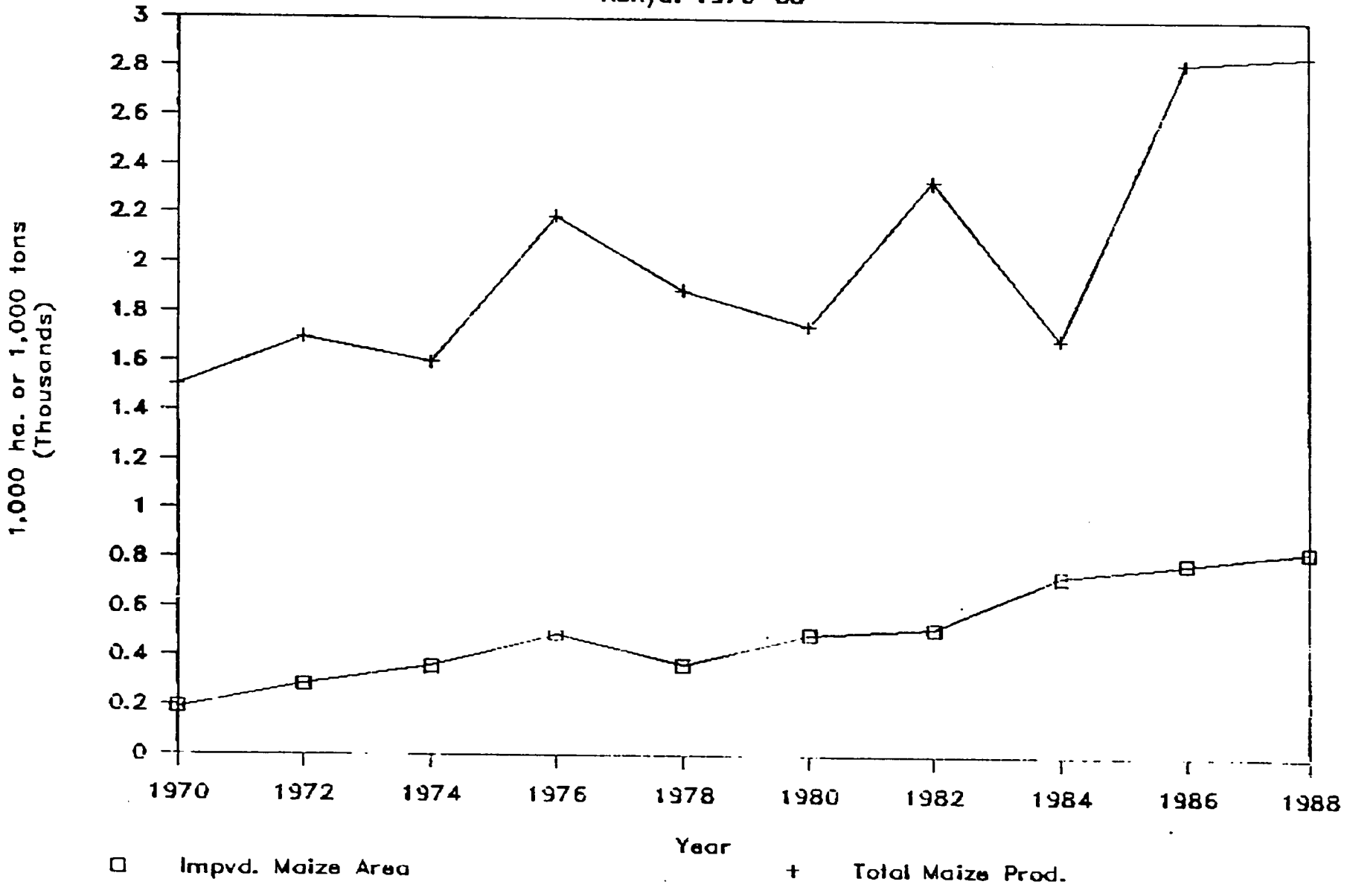


KENYA: Trends in Maize Area, 1970–88



Maize Production & Improved Maize Area

Kenya: 1970–88



EXECUTIVE SUMMARY

THE AGRICULTURAL RESEARCH INTERMEDIATE INDICATORS MATRIX

A SYNTHESIS FOR MANAGERS

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 subsector which requires such indicators is agricultural research. Due to the long duration of most research programs, there is a special need for intermediate indicators by means of which A.I.D. can determine whether continued or additional funding will generate impact over the medium to long term. To meet this need, AFR/TR/ANR contracted with Management Systems International (MSI) to develop a methodology to examine successful 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.

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 with little extra investment in data gathering and analysis. The methodology for using the matrix is discussed, and examples of results presented. If applied to more cases and further refined, these indicators could be used to measure the extent and magnitude of impact which can be attributed to A.I.D.'s agricultural research and extension interventions.

THE AGRICULTURAL RESEARCH INTERMEDIATE IMPACT INDICATORS MATRIX

A SYNTHESIS FOR MANAGERS

Introduction:

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 subsector which requires such indicators is agricultural research. Due to the long duration of most research programs, there is a special need for intermediate indicators by means of which A.I.D. can determine 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 successful 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 present 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. We also summarize the results of nine applications of the methodology in three countries.

In the sections that follow, we discuss 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 conclude with a discussion of unresolved issues and suggested next steps. The complete matrices and narrative summaries for each of nine case studies are presented in the Annexes.

The Problem:

Africa Bureau management must be able to demonstrate 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, as is the research process itself.

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 than is true of other types. Agricultural research results (technologies) can be transported, but usually they must be adapted to the local physical and social environment before they will be appropriate for adoption. 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. How long is legitimate is discussed further below.

Nevertheless, A.I.D. needs to be able 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 has been asked to assess their appropriateness for Africa.

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 USAID 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 focused 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 former 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 existing 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 adapt 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 branch of the MOA, jointly producing a 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, generating a benefit-cost ratio of 2.06 by the year 2001 with a Net Present Value (NPV) of 2 billion Kshs. It would require continued donor support for ten years.

Applying the Evaluation 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 comprise 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

The larger institutional and policy environment surrounding the project, as described for national and ministerial levels, is relevant to all technology generation and transfer activities. Consequently, the questions of national research and development policy, research priorities, national funding for research, effective external and internal linkages for NARS, and intervening variables of policy, input supply, and marketing can be answered for all case studies. Indicators of an adequate national interest in agricultural research and extension provide the backdrop for discussing the

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more specific On-Farm Grain Storage Project activities, and provide some assurances 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 system, 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.

Level II: Technology Generation and Transfer

One of the reasons that the OFGSP was selected for testing the evaluation framework is that it focused more on technology transfer and adoption than some other research projects; this was largely due to the fact that much technology was available for testing from other sources, thereby allowing the project to move more quickly into farmers' fields. Level II was relatively easy to document from the numerous studies and surveys that had been carried out by the project. At this level of analysis, some questions have been answered both retrospectively and prospectively, since a proposal for future project activities on a national scale has been prepared which modifies some of the existing procedures and linkages with other orgarizations.

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 of 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 activities and the responsiveness of the project to develop lower-cost technologies when it appeared that farmers could not assume the more sophisticated ones resulted in a very encouraging uptake of recommendations.

Level III: Intermediate Impact Indicators (Adoption and Beyond)

Technology utilization: From extensive surveys using various sampling methodologies, there is an 80-85% awareness level in the project area of recommended technologies. 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.

Rural agro-industrial transformation: In addition, another indicator of intermediate impact is the creation of rural agro-industries. The OFGSP has trained 1500 artisans to fabricate for profit improved grain structures and simple maize shellers. The demand for these services far exceeds the supply, and an expansion of these industries is expected.

Management of natural resource base: The OFGSP had no direct affect on natural resource management, though the reduction of grain losses through improved harvesting and storage could reduce production pressures on land.

Policy changes at the sector level: Though the project has potential, particularly through its 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 consumers for higher quality grain.

Level IV: Impact

The MOA established a Task Force to analyze the benefits to be gained from expanding the OFGSP to one of national dimension on several important staple crops. Extrapolating from the well-documented project area, the Task Force recommended that returns to investment would be high, even under a modest adoption rate. 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, with a corresponding Net Present Value (NPV) of Kshs. 2 billion. These data are available in the "Crop Post-Harvest Management Programme in Kenya Final Report" (April 1989) and "National Economic Savings Through Adoption of Improved Storage Grain Structures and Storage Management" by Felix Kariungi (February 1989).

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***1.2*** Effective communication of NARS needs and acquisition of resources.			
	Questions:			
	Does NARS receive an adequate level of funding from Government?	Research budget as % of Ag. GDP.	._1% Ag & DP - no flexibility investment to recurrent budget	Simons Paper
	Does NARS receive the types and levels of funding requests from donors?	Funding level/request	Much donor funding but certain programs not covered, e.g. ag. econ.	Annex 2, Joint Donor Review 89
	Does NARS effectively coordinate donor-financed research activities?	Mechanisms: - Formal, timely meetings - New project starts based on NARS priorities - New project starts outside of NARS priorities	Priorities meetings every 2 months Near coverage of all programs Some new starts (e.g. macadamia nuts) not considered priorities	
	Does NARS initiate the identification of donor-financed activities?	Y/N		
	1.3 Effective external (international) linkages			
	Questions:			
	Does NARS have formal linkages with IARCs, international private sector research or agri-business? With whom and what type?	List and describe: 1 point each a) technology exchange; b) training; c) networking; d) consultation Maximum: 4 points	4 points - many linkages described	CIMMYT; Baird, CGIAR Joint Review '88; '89 ISNAR Priv. Sec. Res. Report, A.I.D./MIAC, NARP
	1.4 Effective internal (national) linkages			
	Questions:			
	Does NARS have formal linkages with MOA/EXT, other relevant ministries, universities, development projects, local agri-business, private sector research organizations? With whom and of what type?	List and describe: 1 point each: a) Priority setting process b) NARS board membership c) Training d) Technology exchange e) Contract research (in & out) f) NARS representation on other boards Maximum: 6 points	High - board membership, broadly composed, including agribusiness contract research with UNW and/or pyrethrum board beginning	Private sector (Agric. Res. Found.) MIAC/KARI, Kenya Seed Co. Pyrethrum Board, Nrb. Univ., Egerton Univ. MOLD, CIMMYT FSR/E; PAM; SR-CRSP

INTERMEDIATE IMPACT INDICATORS MATRIX

KENYA — ON-FARM GRAIN STORAGE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base	***A. At national/ministerial level***			
Does NARS have institutional structures & management mechanisms which will permit all critical functions of a research system to be effectively carried out?	**Manageable Interests of Parent Ministry and Institute**			
	1.0 Development of national research policy as it relates to national development policy.			
	Questions:			
	Does the country have an agricultural development plan?	Y/N	Yes	Food Security Policy
	Does the country have a research policy?	Y/N		
	Who monitors the continued concordance of research and development policies?	Name body		
	1.1 NARS priorities articulated according to research policy and resource requirements defined based on iterative planning exercises.			
	Questions:			
	What process exists for setting research priorities and allocating resources? How does this process take into account:	Level of complexity of analysis:	Commodity & factor analysis	Sessional Paper #1, 86 NARP 1986
	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 need, distribution of benefits, political considerations, etc.	0 = no formal priority setting method; 1 = congruence method, 2 = weighted criteria or other formal method.	Total projected costs by center & commodity/factor Projected staffing by center not programs Detailed center/program staff inventors in program	Table 4, Joint Donor Mission Eval. Report, 86 NARP 1986 Interview with KARL
Swanson #9:1 and/or 2	The probability and cost of research success, including national use of existing personnel, infrastructure, financial resources, etc. and taking into account past research results, both positive and negative, national and international	Resource allocation to commodities; Index value % research personnel/commodity research program. (state whether planned or actual)		NARP 1986

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.5*** Monitoring of impact-level indicators by parent ministries			
	Questions:			
	Who is responsible for baseline and time series data collection on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc.?	List by function/data type.		
	What data currently exist?			
	Are data readily exchanged?	Inventory data sets Identify users for each data set.		PAM, USAID memo
	1.6 Human resource management			
	Questions:			
	Does NARS have a personnel database	Y/N	Yes	PW personnel system
	Does a NARS manpower training plan exist?	Y/N	Yes	KARI training plan
Swanson #8	Is there an adequate career incentive structure to recruit & retain qualified staff?	- Operating budget/researcher - Scheme of service for researchers? Y/N - Annual attrition rate - # of vacancies - Proportion of support staff to research & technical staff	Improved scheme service inadequate operating funds	Simons paper
	2.0 Intervening Variables			
	2.1 Agricultural Policies			
	Questions:			
	Does NARS have a role in input & output price policy development?	Y/N Input policy Output policy	Yes, advisory	sessional papers
	Does FX policy favor ag. sector?	- Special rates for ag. export/ import licensing; Y/N - FX readily available for input imports? Y/N		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	**2.2** Extension services			
	Questions:			
	What priority is given to extension? Who carries out extension activities?	% Ag. GDP to extension List	MOA, MOLD, private companies	MOA, MOLD, MoPlan
	Extension salaries comparable to research salaries of equivalent levels?	Y/N	No	
	How effective is extension?	3 = highly effective; 2 = moderately effective; 1 = marginally effective (subjective observation)	2	Farmer surveys T&V report Observation Interviews
George?	Is there an adequate career incentive structure to recruit and retain qualified staff?	- Operating budget/extension officer - Annual attrition rate - # of vacancies		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***B. At NARS Institute and Program levels***			
	1.0 Research program planning and management			
	1.1 Development of long-term research plan			
	Questions:			
	Does institute have a long-term research plan?	Y/N	Yes - preliminary 1999	Crop Post-Harvest Mgt. Progr_____ Final report
	Do farmer orgs. participate in plan formulation?	Y/N farmer org. index	No	
Swanson #5, 2	Does the plan articulate priorities and resource allocations by commodities/factors?	Y/N	Yes - methodology proposed review by multidisciplinary team based on baseline surveys	Crop Post-Harvest Mgt. Progr_____ Final report
	Does it include projections for manpower, infrastructure and operating funds?	Y/N	Yes - however salaries:operating funds poor (80:20) recurrent funds 50% of total	Crop Post-Harvest Mgt. Progr_____ Final report
	1.2 Development of a program structure			
	Questions:			
	Does institute have a program structure which will effectively carry out the long-term research plan?	- Existence of national programs	Defined organization structure & methodology For post-harves = fragmented:	CPHMP final report KARI, RTPC, NAL, OMU
	Are program leaders appointed?	Y/N	No	
Swanson #7 1 and 3	Are programs adequately staffed?	# researcher/program # technicians/researchers (ratio) # B.S., M.S., Ph.D/program	Staffing & training plan proposed based on OFGSP & rural structures project experiences	CPHMP final report

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.3*** Program and budget			
	Questions:			
	Does institute have a short-term program and budget?	Y/N	Yes	CPHMP final report
	Are farmers involved in determining progams?	Farmer orgs. represented	None	RRC minutes; CPHMP final report
	Are programs based on constraints analysis?	Y/N	Y - based on baseline studies & constraints analysis; farmer input in identifying constraints	CPHMP final report
	1.4 Monitoring and Evaluation (M&E)			
	Questions			
	How is research performance (efficiency) assessed?	- Active annual review process - # projects revised or cancelled	quarterly progress reports	CPHMP final report project evaluation
	How is research quality assessed?	- Peer or expert review - # projects redesigned	multidisciplinary review: change in emphasis from large structures to low cost management	interviews project evaluation
	Who establishes baseline data for research programs?	- Socio-economic surveys used in divising proposal? - Baseline survey	multidisciplinary teams '84 baseline survey proposed in '89 final, report for expansion of program.	CPHM branch OFGSP
	Who collects program-level and institute-level data for evaluation?	Individual scientists, prog. directors; M&E system	baseline, midterm, final	interviews CPHMP final report
	What are career promotion criteria?	List: Publications, advanced degrees, collaboration with extension.	MON personnel evaluation system criteria	MOA
	What are criteria for pay increases?	Seniority, degree qualifications, etc.		
	How effective is the flow of information between research and its clients: policy-makers, extension services, farmers and others?	Mechanisms: Board meetings, sessional papers, annual reports, meetings with farmer org., bulletins, mass media messages.	—good with extension & farmers —proposal - increased extension & policymaker linkages —less emphasis w/KARI	OFGSP interviews project evaluation

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***1.5*** External communication			
	Do institute centers and programs have formal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agri-business organizations for problem identification, program formulation and execution?	List linkages: 1 point each a. problem definition b. investigation c. analysis d. evaluation Maximum: 4 points	Extension 1,2,3,4 Farmers 1,2,3,4 Policymakers 4	OFGSP interviews project final evaluation
	With whom and of what type?			
	1.6 Internal communication			
	What formal linkages exist within institute, e.g. between programs, disciplines?	Multidisciplinarity: 1 point each a. Problem definition b. Investigation c. Analysis d. Evaluation Maximum: 4 points	1 0 1	84 baseline survey interviews - OFGSP
	How are multidisciplinary problems approached?		—baseline surveys —tech packages identified by multidisciplinary team (entonologist engineer, ___, extension specialist)	CPHMP final report
	Is NR mgt./sustainability incorporated into redesign? (indicate multidisciplinarity)	Cite examples: - Shift from chemical to biological pest control - Agroforestry research - Reduced proportion of inorganic to organic nitrogen sources	—relatively benign chemical use —rodent guards —timely harvest — pest risk	final project eval. interviews

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	**2.0 Financial Resource Management**			
	2.1 Acquisition of funds			
	Questions:			
	Are funds received by institute headquarters, stations and programs in a timely way and in adequate amounts?	- Date requested, date received; - Programs/projects halted for funding shortfalls (# & proportion) - # of researchers without funded projects	No - MOA funds tardy, esp. for equipment & travel A.I.D. funds used to "float" activities when national contribution late	OFGSP eval.
	2.2 Funds disbursement			
	Questions			
	Do station and/or program heads have the delegation of authority necessary to permit a flexible yet accountable use of funds?	Y/N		Simons, Baird, Joint Review, PW FM systems
	Can funds be retained and carried over from one year to the next?	Y/N		
	2.3 Accounting			
	Questions			
	Are adequate accounting procedures and staff in place throughout the system?	FM system centralized Y/N No. of clearances required? Trained accountants at each center?		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer	***A. For the Research System***			
	1.0 Intermediate results (outputs)			
	1.1 Training Opportunities			
	Questions			
(What are the quantity, quality and nature of the outputs of the research and extension system?)	What training is available for researchers, collaborators and clients?	# trained ST in-country ST abroad LT abroad (Past 3 years)	1,800 30 6	OFGSP final evaluation A.I.D. PP; PW Personnel system database ISNAR training project
	1.2 Progression of experimentation			
	Questions			
	Is research moving from strategic, to applied to adaptive research?	Proportion of research on-station, on-farm, being demonstrated (time series)	1984 - 54 test units (stage 3) 1986 - entirely onfarm (demon.) some testing should have continued (stage 3) to incorporate feedback	OFGSP final evaluation interviews
	How much research is conducted on-farm?	Research reports - # of trials listed	All trials - using cluster approach	OFGSP evaluation
	How much research has moved into the field testing & demonstration stages?	# technologies moved from on-farm trials to demonstration stage/ program	1754 improved structures for drying & storage 100% in field testing/demon. by 1987	Liaison Officer reports, SR-CRSP, Maize, OFGS Final report 3/89 Interviews OFGSP
	1.3 Surveys and constraint analysis			
	Questions			
	What studies have been initiated/completed on characteristics and constraints at agro-ecological levels, provincial levels, among cultural groups, etc. for outputs and inputs.	# projects with constraints analysis included # other studies analyzed	1979-81: preliminary survey 1984: baseline survey 1986: seminar: maize conservation on the Farm	SR-CRSP, FSR/E reports, CIMMYT, PAM KARI, Farm Mgt. Unit, CBS, T&V, universities CBS OFGSP Proceedings
	How is this information to be used?		Technology development: some key points ignored - lost project time & money. Eventually project moved to lower cost methods.	interviews

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer (cont'd)	**1.4** Interaction between research & extension			
	How do research & extension collaborate?	Nature, frequency of interaction Liaison officer? Y/N	At least monthly at division & locatio level every 2 weeks - frontline extension (T&V)	final report
(Swanson #10) modified	How effective is this collaboration?	# jointly planned/implemented trials.	1,764 mini cluster trials implemented jointly 1,300 TA trained 500 TD trained district-level briefings of local leaders	CPHMP final report; project evaluation OFGSP; interviews
	What research methodologies have been developed/refined to encourage client participation in research planning, execution, and evaluation?	List: - Baseline surveys - Program-level or center-level planning meetings? - Field days - Annual workshops	On internal M&E system, baseline survey 1984 District Development Committee approves all projects Work with proposed RECs	interview OFGSP
	What methods have been developed to monitor and evaluate technology transfer and adoption?	Committees, surveys, reports, on-farm research	1989 - Kurungi study of farm level cash flows 1989 - "straight line" adoption survey 1989 - DPRA questionnaire through T&V	CPHMP report interviews
	1.5 Responses to government requests for policy advice	- Sessional papers - Participation in policymaking bodies - Requests for advice		
	2.0 Conclusive results			
	2.1 Technologies developed/released			
	Questions			
	What new varieties have been developed tested, and released to clients? (i.e., extension, farmers, private sector research)?	# varieties released		OFGSP evaluation
	What new technologies have been developed, tested and released to clients?	# of technologies recommended to extension	—Crib & improved basket storage structures —tray drying —alternative structures —in-house storage —post production mgt. system	
	What recommendations have come out of commodity programs?	Proportion of programs that have released varieties or technologies	Benign pesticide recommendations Non-chemical recommendation	OFGSP evaluation

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. **Technology Generation and Transfer** (cont'd)	Has a "Menu" of technological choices been developed and offered to accommodate different systems and situations?	# of released varieties responding to low input vs. high input systems; # of techs with positive NR side effects, e.g., alley cropping, cut & carry, fodder, silage, zero-grazing	Yes, development delayed but occurred	OFGSP interviews Final project eval.
	2.2 Publications ***Questions:*** What scientific technical and farmer-level publications have been produced?	List internal/external Level scientific technical farm level	Numerous Proceedings Training materials; brochures in English & local languages; posters	Annual reports Extension reports OFGSP interviews Final eval.
Swanson #17	***2.3*** Inputs ***Questions:*** Are agricultural inputs (seed, fertilizers, pesticides, tools) available?	Distance from household to input supply point, # of sources of inputs - Credit given for inputs Y/N: in kind or in cash	Functions well in most places for most inputs —disruptions in fert. supply, late arrival —localized shortages —delayed [illegible] to farmers —limited farm credit	Kenya Seed Co. Fertilizer Suppliers PAM; KMDP analysis Annex 7, Kenya National Extension Project Midterm Review 1988 WB & IFAD
	Are there subsectors w/o inputs?	Y/N - high, med, low potential Y/N - areas kg/ha	Yes	
	Are there times of the year when inputs are not available, more expensive?	Y/N - timely delivery; seasonal shortages; price fluctuations for fertilizer & seed.	Yes	Credit agency; Annex 7, Kenya Nat'l Ext. Proj. Midterm Review '88 WB/IFAD
	How are inputs made available to resource-poor/farmers (e.g. small packaging, etc.)	# smallest units seed or fertilizer sold/# smallholder units	forced cooperatives	
	2.4 Marketing infrastructure ***Questions:*** Are markets accessible to all producers?	- regional price variations - status of rural roads (proportion of farm housholds within 10 km of paved road	Yes - cooperative outlets package in small quantities, Main source smallholder credit is AFC & CBK	KGGCU KSC

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	***B. For the Extension System***			
	1.0 Research results/recommendations accepted and extended			
	Questions:			
Swanson #14.3	To what degree have research results been promoted by the extension service?	All recommendations Some No recommendations Why % recommendation promoted by extension		T&V reports Liaison officer interviews Extension service reports
	To what extent does extension adopt researcher-recommended technologies?	All adopted Some None adopted Why		
Swanson #12	How is adoption of recommendations tracked?	Tracking system exists Y/N Tracking system applied Y/N	Yes Yes Special surveys System not specifically proposed in CPHMP proposal	Interviews T&V reports; OFGSP report; Mbula 88; CPNMP report Quarterly reports; District Post-Harvest officers; Annual reports
	2.0 Extension methodolcgies & Effectiveness			
	Questions:			
	What extension methodologies have been developed/refined to improve extension participation in research?	Ranked allocation of extension agent time in tech. generation and transfer activities	Participation in baseline & adoption surveys	T&V agent reports interviews OFGSP eval.
Swanson #14.4 Swanson #14.5	What extension methodologies have been developed/refined to improve the extension-farmer linkage?	# of program changes based on feedback from extension	Miniclusters for demonstration 3 types of field days Single focus field days Change in focus from large structures to low cost systems.	OFGSP final eval. interviews
	What publications or other media mechanisms have been produced to inform farmers of research findings?	# of households with direct contact with extension agents (male vs. female-headed) # of new messages by type Actual samples	posters & brochures, songs, 16 mm film, videos, radio, training centers equipped	samples of documents interviews OFGS

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	***C. Intervening Variables***			
	1.0 Markets			
	Questions:			
	1.1 Farm to market roads?	Average distance farm to market? Proportion transport cost of total cost (market prices)?		farmgate vs. market prices; PAM, Farm Mgt Unit, A.I.D. Market Dev. analysed
		Farmgate vs. market prices		
	1.2 Does a market information system exist for commodities?	Y/N on radio in print media		Observation
	1.3 Are there price constraints for commodities?			
	1.4 Are there required marketing channels that must be used?			
	1.5 Are there commodity marketing standards?			
	1.6 Are the recommended inputs available?			
	2.0 Storage and processing considerations			
	2.1 Is value added at household level for commodities examined?	Farm level profit & loss	Grain quality increased - increased nutritional value	Farm budgets by type of farm
	2.2 Proportion of post-production losses	Costs & returns at commodity level	If full package adopted: losses decreased from 25-35% to 4%; if partial packages adopted: 35% to 18%	RSU (88) surveys DPRA (80) survey _____ (86) _____ (88) surveys
	2.3 Post production processing	Value added to commodities		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (Adoption & Beyond)	**1.0** Technology Utilization			
How can the adoption of technologies produced by the NARS be measured, and results used to forecast probable impact on the national economy?	**1.1** What % of farmers are using new technologies?	Adoption of technology stratified by farm size high, medium, low potential, male/female household head.	Of random population: 24.3% have adopted storage hygiene & dusting; 220 structures built (.25% dispersion (most costly recommendation) 80-85% awareness level among farmers in project area.	Project studies Extension service records, e.g. farm management unit. Special Studies Kaininga survey (89)
	1.2 Has total production increased in a commodity or region?	Production statistics; yield data; land use data by commodity & region. Production 1 area cultivated.		Central statistics office MOA statistics office Remote sensing data
	Have sales of fertilizer, seed, etc. increased? (Substitute relevant inputs/case study)	Sales records	Demand exceeds supply Chemical sales records	OFGSP final eval. (89); interviews Cooperative records Import/Export records
	Has there been a tech-related shift in crop mix?	Tech-related shift in crop mix short-term and long-term	No	National statistics office Remote sensing data
	2.0 Rural agro-industrial transformation			
	2.1 Has agro-industrial transformation occurred?	# of rural-based small enterprises by regions (female vs. male-owned) 10 workers or less? Increased rural savings	1,500 artisans trained to make improved structures; demand exceeds supply	interviews
	2.2 Has research/extension resulted in the formation or strengthening of farmer organizations?	- # organizations - # members		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (cont'd)	**3.0** Management of natural resource base			
	Questions:			
	3.1 Has NR management been an element of technology adopted?	Increased land cultivation (intensive vs. extensive) Proportion owned vs. rental land, security of access to land % top soil loss, salinization rate Sedimentation rate		Simons
	4.0 Policy changes at sector level	Price policy; input policy; marketing policy	None yet	policy documents, sessional papers
IV. Impact How has investment in research influenced the economy of the country, in terms of incomes, productivity, production & food security (availability, access & adequacy)?	**1.0** Net farm income	1. Change in net farm income at national aggregate level in real terms. 2. Change in net farm income/ farm in real terms disaggregated by farm size male/female household heads 3. Changes in net farm income per AEPA	Appendix D&E OFGSP final evaluation; benefit-cost analysis for Western Kenya	Karimga study
	2.0 Agricultural productivity			
	2.1 Has agricultural productivity increased by farm size, etc.	1. Change in value of prod/capita. 2. Change in value of production/ farm (EAPA, male/female). 3. Change in value of production/ farm by farm size. 4. Change in value of ag. production per hectare of agricultural land. 5. Change in value of ag. production by unit of ag. investment of credit for agriculture.	Estimated reduction of maize losses 10-20% of total production; Secondary benefits: increased fodder value, value of early planting, etc. Increased nutritional value	CPHMP final report Karminga report GMW

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact (cont'd)	**3.0** Food Security (national level)			
	3.1 What is the impact of ag. research on food security at the national level?	1. Change in per capita food production and consumption. 2. Change in ag. GDP (including non-food crops). 3. Change in % self-sufficiency in basic food commodities. 4. Variability in total annual ag. production. 5. Change in per capita food imports by value. 6. Change in annual carryover stocks of basic food stuffs (buffer stocks)	Projected maize savings by 2001 is 483,000 MT or N10% of production. Storage structures used for other crops	CPHMP final report CPHMP final report

THE SMALL RUMINANTS COLLABORATIVE RESEARCH SUPPORT PROGRAM

The series of commodity-oriented Collaborative Research Support Programs (CRSPs) funded by AID's Science and Technology Bureau were developed as world-wide projects to foster collaborative research on particularly important food crops (and animals) for lower-resource farmers in a series of developing countries. The accent was both on collaborative research with host country researchers--associated with U.S.-based training for a number of counterparts from each country program--and on achieving research results that could increase food production and meet food needs in a more sustained manner than was often achieved by discrete bilateral projects. As part of the broader Title XII program to increase the capacity of U.S. land grant universities to contribute to solving food problems in LDCs, the scientific interchange represented by the CRSPs was anticipated to benefit both the U.S. institutions and their LDC collaborating institutions.

The Small Ruminants CRSP (SR-CRSP) was initially made up of ten separate projects involving 13 U.S. Title XII entities, under the overall management of the University of California at Davis. Key programs were in animal health, animal breeding and systems analysis, animal nutrition and management, agricultural economics, rural sociology, and feed resources. While each project, with its respective Principle Investigator(s) (P.I.) at the U.S. institutions involved had a specific set of goals and objectives, the overall intention was that together, sets of these projects could enhance local research systems and provide research results that would substantially improve production and productivity of small ruminants in the collaborating countries.

The two objectives for the Kenya program under the SR-CRSP were 1) to carry out research on dual purpose goat (DPG) production systems which would contribute to increased production of milk and meat and improve cash flow through marketable goats and goat products in small-scale farms in Kenya and 2) to provide training which would enhance the long-term capability for research and development on sheep and goats in Kenya. Initially, the collaborating GOK agency was the Ministry of Agriculture and Livesock Development (MOALD), but in 1986, when the new Kenya Agricultural Research Institute (KARI) was founded, it became the primary collaborating agency, with the Deputy Director for Livestock as the Kenyan Principle Investigator. Collaborating U.S. institutions are Winrock International, Texas A&M, University of Missouri, and Washington State University.

A recent internal review of the Kenya SR-CRSP, plus an external review of the SR-CRSP as a whole have both indicated that the utility and progress of the Kenya program are very commendable. Our own review indicates that a great deal of progress has been made in the ten years the program has been in implementation, of which key elements are the U.S.-based training of research scientists, the farming systems orientation of almost all of the research, considerable collaboration among researchers although they are still primarily responsible for attaining goals of individual projects which have been developed with the relevant U.S. institution. From what we were able to observe, there has been a good deal of collaboration at the station level in Maseno among projects, which has perhaps been enhanced by the presence of the Ph.D. sociologist who recently returned from Missouri. The economist is still completing Ph.D. work, but is scheduled to return this year, which should also

help ensure further integration of research activities and findings and recommendations.

Key accomplishments of the program, which are derived from a review of all the projects, are as follows: development of a new breed of DPG, moving from the F1 to a four-way cross; a breeding program for resistance to Haemonchus; development and testing of a vaccine against CCPP, the most significant disease among goats in Kenya from an economic point of view; development of a composite variety of double-cob maize in conjunction with research on production systems and feed and nutrition; development of two new sweet potato cultivars which provide improved human and animal nutrition, through both tubers and vines; experiments with improved low-cost storage techniques for fodder, including ensilage; socio-economic resaerch on constraints of the mixed farming system of small-holders in six agro-ecological zones which has yielded a great deal of needed data that can be used to the advantage of other programs, and development of a model which simulates the production system, although there are some reservations about the user-friendliness of the current version.

The program has operated at several sites, which to some extent may have militated against cross- and interdisciplinarity in the definition and implementation of individual projects. The projects represented by the team at Maseno, however, appear to have benefitted from considerable collaboration, at least recently. This has continued despite potentially serious problems caused by the continuing uncertainty about continuation of funding of the CRSP, and the emergence of KARI separate from the Ministry of Livestock Development. This has meant that a number of trained researchers have left the project, while those who have remained risk being remunerated in terms of at least three schemes of service--those of KARI and the MOLD, as well as those of the U.S. institutions which provide higher salaries to the Ph.D.-level resident scientists who have replaced expatriate researchers over the past several years. The goal is that the entire program be staffed by Kenyans by the end of the current extension in 1993.

Applying the Impact Indicator Framework:

Level I--The Institutional Base. Initially, the worldwide SR-CRSP had a set of overall internal goals and objectives, as well as specific goals and objectives for each project. Each U.S. institution, although responding to overall guidelines from the Management Entity (ME) and the Board, wished to maintain independence and integrity for its program, and this caused considerable dissention at the beginning of the program, when initial country selections were being made. Kenya was regarded as a very desirable country with which to collaborate, based on prior experience, and there was considerable competition among the P.I.s to place their projects in Kenya. The result is that seven of the projects are now represented in the Kenya program. When the program began, the Ministry of Agriculture and Livestock Development (MOALD) was the collaborating institution. Fortunately, when KARI took over agricultural research from the MOALD in 1986, the same Kenyan P.I. remained in charge of the program from the GOK side. This continuity has been important for the overall success and extension of the Kenyan program, particularly as there has been a good deal of turnover among the U.S. and Kenyan researchers over the ten years of implementation.

If we examine the SR-CRSP today, as a loosely-related part of KARI, but being implemented in collaboration with the MOLD, the MOA and the University of Nairobi, the level I questions in the framework are relevant. Although its objectives were formulated before the KARI mandate, it fits quite closely with the objectives stated in national development and national research plans and policies. In fact, on the farming systems research and socio-economic dimensions, the CRSP might well serve as a model for other KARI and Ministry programs. Research priorities for the Kenyan program were based on socio-economic baseline studies in collaboration with C.B.S. in the Ministry of Planning and National Development (MOPND), and the objective throughout has been to meet the needs of low-resource farmers on small farms with mixed animal-crop farming systems, large family size, high rates of out-migration and off-farm employment (40%), and a preponderance of women-headed households.

Regarding the probability of success and the cost of the research program--as well as the critical mass of scientific personnel involved with it--the SR-CRSP scores quite high. The priority setting method has been developed over time, and modified for the inclusion of an additional set of clusters this year. The two BSc., 23 M.S., and seven Ph.D. researchers trained under the program constitute a significant proportion of researchers at their respective levels in KARI, counting those trained who have transferred to other institutions, including the University of Nairobi.[1]

There are difficulties with the receipt at the field level of KARI counterpart funds, as is the case with other programs and centers, but the U.S. funding has, in the past, allowed research to continue during KARI funding gaps.

Data gathering, analysis and utilization have been largely internal to the CRSP program in the first two phases of the program, but now in phase 3, researchers are generating technical recommendations (techpaks) as well as publishing refereed articles and presenting information at conferences and workshops. Their main concern is that recommendations be technically sound before they are turned into extension materials.

Work with farmers has been carried out in eight clusters (defined by the C.B.S. national cluster sample). Inputs have been provided free to farmers who are willing to participate on the basis of an agreement that the researchers will be able to continue to do on-station and on-farm research on the animals and related production system components. Given the slow nature of animal breeding, only 400 DPGs are currently placed with farmers. These serve both for researcher-managed trials, farmer-managed trials and demonstrations and field days, depending on the status of the individual projects involved. The program-hired field assistants are the main link with the farmer at the farm level. Researchers, however, go in a team to hold "workshops" with farmers at which they answer questions and provide information to their collaborating farmers, extension agents and other interested participants. All farmers included in the program have registered land, and might thus be eligible eventually for formal

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[1] It was not possible to determine per centages of degree holders in particular fields represented by those trained under the CRSP, as total numbers by field were not available. Various donor documents and the NARP indicate projected numbers, and numbers to be trained, but were were not able to acquire a listing of actual numbers by field.

small farmer credit as and when goats will no longer be provided free. While these farmers are exposed to all the vacissitudes of small-holders in Kenya, they are, however, in what is generally regarded as "high-potential" areas, and thus are assumed to have a better resource base than those on more marginal lands. However, like other Kenyan small-holders, they are faced by a severe labor constraint.

Relations between the CRSP and the National Extension Service (MOA) are fairly close at the field level, but not as close as for the On-Farm Grain Storage Project. SR-CRSP researchers and field agents interact with extension personnel on the farm and at demonstrations and field days. Four workshops have been held to train extension agents on some of the technical recommendations of the CRSP projects. At the higher level of institutional collaboration, the uncertainty about KARI-MOA relations and the recent retirement of the Kenyan P.I. have meant that collaboration with extension is not particularly close. If the proposed development of the Regional Research Centers (RRC's) and their local advisory committees actually takes place, the CRSP researchers will be in a good position to concretize and formalize their relationship with extension at the district and regional levels. This will, perhaps, also allow them to extend their successful farming systems approach, based on detailed socio-economic analysis, to other development practitioners in MOA and MOLD.

Natural resource considerations have ranked high in the SR-CRSP projects. Work on feed and fodder resources, as well as production systems and animal health and nutrition have taken into account natural resource base constraints and conservation. These include alley cropping, improved fodder production, treatment and storage, maize and sweet potato varietal improvement to enhance food and feed production in existing systems, testing of relative performance of goat manure and chemical fertilizers on maize and other crops, and zero-grazing improvements, including supplemenal feeds and improved tethers.

Moving to Level II, Technology Generation and Transfer, we see that we have already addressed a number of these questions at Level I. A significant number of technologies (breeds, varieties) have been generated by the program, and in general, basic, and applied research projects are now moving to the stage of adaptive research. There are over 40 scientific recommendations available in techpaks, all of which have been tested on-farm either by researchers or by farmers themselves. Breeding work will continue, particularly in disease resistance and increased milk production. Two hundred and fifty households have been part of the program sample from eight clusters. Each cluster is composed of 100-150 households. So, we can assume that the CRSP directly transfers technology to 1/30 of the households of the national cluster sample which is taken as representative of the Kenyan population as a whole. (C.B.S. usually samples only 10% of the households in each cluster.)

Collaboration with external and Kenyan institutions is good under the CRSP and is in fact built into the design of the overall program. There was perhaps closer collaboration with U.S. "parent" institutions at the beginning of the CRSP program than with local institutions. However, in stage three, the CRSP is collaborating with ICRAF, CIMMYT, IITA, and University of Nairobi, Egerton University, and the Ministries of Agriculture and Livestock. If vaccine production is carried out in the private sector, there will be an additional linkage there.

Level III - Intermediate Indicators of Impact. To the extent that the CRSP program has so far been cautious about extending recommendations through the extension service, intermediate indicators as presented in our framework are harder to apply than, say, for On-Farm Grain Storage. If, for example, we assume a demonstration effect to only one-half of the households in each cluster in which the CRSP has done on-farm trials and field days, we could say that there has been adoption of at least one theme or component among 1,250 households, which seems on the low side. Through on-station and on-farm visits and demonstrations, it is likely that awareness is quite high in the Maseno and Kakamega areas, as well as in Naivasha and Ol'Magogo. However, we are unable at this point to generate a prediction given x rate of awareness to y rate of adoption. We can, however, assert that for each goat sold, the household gets between 500-1000 Kshs. Meat offtake is still being investigated. The average milk production for human consumption is from 5. to 1 kg per day, and the twinning rate of DPGs is quite high. If the breeding and multiplication projects had received anticipated funding over the past three years, it is likely that our assumed intermediate impact measures would have indicated higher awareness and adoption rates.

There is great potential for positive natural resource impacts from this program, as well as significant impacts on net farm income, and nutritional status and food security at the household level. The vaccine for CCPP and haemonchus resistance breeding efforts should, together, have considerable national level impact on milk, meat and goat by-product production as well as increased productivity. Similarly, the improved varieties of sweet potatoes, double-cob maize, and extensive work on fodder including on sesbania and other leguminous trees suitable for alley cropping, fodder and fuel, is likely to have a significant national-level impact. Unfortunately, with the data currently available to the team, we are unable to calculate that potential or extrapolated national-level impact with any reliability. However, it is possible that with data available and projections by the SR-CRSP ME at Davis, we will be able to improve our estimations after our return to the U.S.

INTERMEDIATE IMPACT INDICATORS MATRIX

KENYA — SR-CRSP

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base	***A. At national/ministerial level***			
Does NARS have institutional structures & management mechanisms which will permit all critical functions of a research system to be effectively carried out?	**Manageable Interests of Parent Ministry and Institute**			
	1.0 Development of national research policy as it relates to national development policy.			
	Questions:			
	Does the country have an agricultural development plan?	Y/N	Yes	Session Paper 1, 1986, 1986-91 D Plan NARP
	Does the country have a research policy?	Y/N	Yes	
	Who monitors the continued concordance of research and development policies?	Name body		
	1.1 NARS priorities articulated according to research policy and resource requirements defined based on iterative planning exercises.			
	Questions:			
	What process exists for setting research priorities and allocating resources? How does this process take into account:	Level of complexity of analysis: 0 = no formal priority setting method; 1 = congruence method; 2 = weighted criteria or other formal method.	Baseline surveys, socioeconomic research, FSR approach, low-cost, low input criteria	
	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 need, distribution of benefits, political considerations, etc.			
Swanson #9:1 and/or 2	The probability and cost of research success, including national use of existing personnel, infrastructure, financial resources, etc. and taking into account past research results, both positive and negative, national and international	Resource allocation to commodities; Index value % research personnel/commodity research program. (state whether planned or actual)		SR-CRSP global agenda based on international & national review of existing research results. PP developed by RTI 1977.

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.2*** Effective communication of NARS needs and acquisition of resources.			
	Questions:			
	Does NARS receive an adequate level of funding from Government?	Research budget as % of Ag. GDP.	Problems of GOK contribution reaching SR-CRSP in timely manner - borrow from US funds & payback later.	Simons paper
	Does NARS receive the types and levels of funding requests from donors?	Funding level/request		
	Does NARS effectively coordinate donor-financed research activities?	Mechanisms: - Formal, timely meetings - New project starts based on NARS priorities - New project starts outside of NARS priorities		
	Does NARS initiate the identification of donor-financed activities?	Y/N		
	1.3 Effective external (international) linkages			
	Questions:			
	Does NARS have formal linkages with IARCs, international private sector research or agri-business? With whom and what type?	List and describe: 1 point each a) technology exchange; b) training; c) networking; d) consultation Maximum: 4 points		
	1.4 Effective internal (national) linkages			
	Questions:			
	Does NARS have formal linkages with MOA/EXT, other relevant ministries, universities, development projects, local agri-business, private sector research organizations? With whom and of what type?	List and describe: 1 point each: a) Priority setting process b) NARS board membership c) Training d) Technology exchange e) Contract research (in & out) f) NARS representation on other boards Maximum: 6 points		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.5*** Monitoring of impact-level indicators by parent ministries			
	Questions:			
	Who is responsible for baseline and time series data collection on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc.?	List by function/data type.	SR-CRSP resident & collaborating scientists collaborate with CBS	Baseline survey initial cluster Baseline survey 1989 2nd cluster Economic & sociology projects, production systems project collaborate with KEFRI, ICAAF, CIMMYT, KARI, MLD, EGERTON, U. Nairobi, PANESA, CARE/Kenya
	What data currently exist?	Inventory data sets	SEC annual reports, master questionnaire	
	Are data readily exchanged?	Identify users for each data set.	resident & collaborating scientists, 2 year household consumption study of sample households with DPGs	
	1.6 Human resource management			
	Questions:			
	Does NARS have a personnel database	Y/N	Yes - new	PW personal system
Swanson #8	Does a NARS manpower training plan exist?	Y/N	Yes 1982-92	Prepared with ISNAR scheme of service 1989
	Is there an adequate career incentive structure to recruit & retain qualified staff?	- Operating budget/researcher - Scheme of service for researchers? Y/N	Yes, may be training too many overseas at one time; problem of incorporation of socioeconomics researchers and of CRSP staff formerly in MDA & MOLD	
		- Annual attrition rate - # of vacancies - Proportion of support staff to research & technical staff	Low turnover on CRSP - substitution of US trained Kenyan scientists for US scientists.	Price Waterhouse personnel system database

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	**2.0 Intervening Variables**			
	2.1 Agricultural Policies			
	Questions:			
	Does NARS have a role in input & output price policy development?	Y/N Input policy Output policy	For CRSP, inputs are provided free to encourage demonstration & on-farm testing.	
	Does FX policy favor ag. sector?	- Special rates for ag. export/ import licensing; Y/N - FX readily available for input imports? Y/N		
George?	**2.2** Extension services			
	Questions:			
	What priority is given to extension? Who carries out extension activities?	% Ag. GDP to extension List	CRSP - beginning to have results - 9 _____ - to provide through extension; have trained ext. personnel. Many field days with extension	
	Extension salaries comparable to research salaries of equivalent levels?	Y/N		
	How effective is extension?	3 = highly effective; 2 = moderately effective; 1 = marginally effective (subjective observation)	Probably between 1 & 2 for CRSP farmers	Farmer surveys T&V report Observation Interviews
	Is there an adequate career incentive structure to recruit and retain qualified staff?	- Operating budget/extension officer - Annual attrition rate - # of vacancies		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***B. At NARS Institute and Program levels***			
	1.0 Research program planning and management			
	1.1 Development of long-term research plan			
	Questions:			
	Does institute have a long-term research plan?	Y/N	CRSP - yes, determined first in US, then in Kenya	NARP
	Do farmer orgs. participate in plan formulation?	Y/N farmer org. index	CRSP - no	
	Does the plan articulate priorities and resource allocations by commodities/factors?	Y/N	emphasizes inputs to low-resource farmers needing improved nutrition & some increased cash income with problem deficits	
Swanson #5, 2	Does it include projections for manpower, infrastructure and operating funds?	Y/N	CRSP budgets were probably for 5 year increments	David ME records Check McFarland
	1.2 Development of a program structure			
	Questions:			
	Does institute have a program structure which will effectively carry out the long-term research plan?	- Existence of national programs	CRSP - coordinated with MOALD, KARI	NARP, Baird, Jt. Reviews KARI interviews
	Are program leaders appointed?	Y/N	Yes	
	Are programs adequately staffed?	# researcher/program # technicians/researchers (ratio) # B.S., M.S., Ph.D/program	Increased over time Kenyan PhDs replace US profs, MS training provided also. FAs trained. See chart 1988 report	PW personnel database ISNAR Indicators Series
Swanson #7 1 and 3				

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.3*** Program and budget			
	Questions:			
	Does institute have a short-term program and budget?	Y/N	Yes	Joint reviews, annual budget submission Simons papers
	Are farmers involved in determining progams?	Farmer orgs. represented	CRSP - not in budget process per se - probably their KARI Board for KARI funds, MOLD?	
	Are programs based on constraints analysis?	Y/N	Yes - quite thorough Stage 1 & Stage 3	
	1.4 Monitoring and Evaluation (M&E)			
	Questions			
	How is research performance (efficiency) assessed?	- Active annual review process - # projects revised or cancelled	Active annual review; external CRSP-wide review. Differential extension of activities over time with additional funding.	A.I.D.
	How is research quality assessed?	- Peer or expert review - # projects redesigned		
	Who establishes baseline data for research programs?	- Socio-economic surveys used in divising proposal? - Baseline survey	Yes - SRCRSP researchers	
	Who collects program-level and institute-level data for evaluation?	Individual scientists, prog. directors; M&E system	Incl. sci; F.A.S., special surveys	
	What are career promotion criteria?	List: Publications, advanced degrees, collaboration with extension.	All of these	
	What are criteria for pay increases?	Seniority, degree qualifications, etc.		
	How effective is the flow of information between research and its clients: policy-makers, extension services, farmers and others?	Mechanisms: Board meetings, sessional papers, annual reports, meetings with farmer org., bulletins, mass media messages.	Now extending 9 + 11 FR tehpaks, training extension agents direct contact with station and farmer managed on-farm trials with goats, fodder, cropping systems, animal health, organic fertilizer; teckpak on soil fertility & conservation, etc. (1988, p. 21)	KARI interviews KARI library annual reports CRSP interviews and documents

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***1.5*** External communication			
	Do institute centers and programs have formal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agri-business organizations for problem identification, program formulation and execution?	List linkages: 1 point each a. problem definition b. investigation c. analysis d. evaluation Maximum: 4 points	CRSP has "contractual" agreements with farmers who accept goats to be able to do any beneficial research farmers held harmless firm gumplasm to other countries, breed, vaccine & variety dev. results exchanged. loss of goats	
	With whom and of what type?			
	1.6 Internal communication			
	What formal linkages exist within institute, e.g. between programs, disciplines?	Multidisciplinarity: 1 point each a. Problem definition b. Investigation c. Analysis d. Evaluation Maximum: 4 points	Yes in all	Annual reports Interviews with program leaders
	How are multidisciplinary problems approached?		All projects & activities based on multidisciplinary premise and actually operated largely this way.	Annual reports Policy statements
	Is NR mgt./sustainability incorporated into redesign? (indicate multidisciplinarity)	Cite examples: - Shift from chemical to biological pest control - Agroforestry research - Reduced proportion of inorganic to organic nitrogen sources	Yes, shift to organic fertilizer; agroforestry research, concern with maintaining soil fertility through improved agronomic practices.	CRSP interviews, station & on-farm visits, KEFRI/ICRAF interviews

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	2.0 **Financial Resource Management**			
	2.1 Acquisition of funds			
	Questions:			
	Are funds received by institute headquarters, stations and programs in a timely way and in adequate amounts?	- Date requested, date received; - Programs/projects halted for funding shortfalls (# & proportion) - # of researchers without funded projects	Semi-annual KARI allotments always late - tide themselves over wih CRSP funds	Ass. Dis. Admin. & Fin. Simons papers Price Waterhouse
	2.2 Funds disbursement			
	Questions			
	Do station and/or program heads have the delegation of authority necessary to permit a flexible yet accountable use of funds?	Y/N	Apparently, vet station director seems to give CRSP staff autonomy	Simons, Baird, Joint Review, PW FM systems
	Can funds be retained and carried over from one year to the next?	Y/N	Yes for CRSP funds. ? for KARI/mold funds	Check MOLD, KARI
	2.3 Accounting			
	Questions			
	Are adequate accounting procedures and staff in place throughout the system?	FM system centralized Y/N No. of clearances required? Trained accountants at each center?	Yes for salaries KARI & MOLD	Price Waterhouse & A.I.D.

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer	***A. For the Research System***			
	1.0 Intermediate results (outputs)			
	1.1 Training Opportunities			
	Questions			
(What are the quantity, quality and nature of the outputs of the research and extension system?)	What training is available for researchers, collaborators and clients?	# trained ST in-country ST abroad LT abroad (Past 3 years)	4 workshops for extension 3 PhD students in US & returned 40 publications 1988 6 conferences attended Visits of private & sec. school classes & teachers	Personnel system data-base
	1.2 Progression of experimentation			
	Questions			
	Is research moving from strategic, to applied to adaptive research?	Proportion of research on-station, on-farm, being demonstrated (time series)	Yes, 40 recommendations near adaptive research components, expansion of project area to 4 new clusters (120 households)	Annual reviews extension reports
	How much research is conducted on-farm?	Research reports - # of trials listed	numerous - photocopy	Annual reports 1986-88 & 1987-88 reports
	How much research has moved into the field testing & demonstration stages?	# technologies moved from on-farm trials to demonstration stage/ program	9 teckpacks breed dev. & release FI & 4 cross new feeds developed and recommended - varieties tested	Liaison Officer reports, SR-CRSP, Maize, CFGS
	1.3 Surveys and constraint analysis			
	Questions			
	What studies have been initiated/completed on characteristics and constraints at agro-ecological levels, provincial levels, among cultural groups, etc. for outputs and inputs.	# projects with constraints analysis included # other studies analyzed	All, corroborate with CBS, U. Nairobi, other stations - international centers	SR-CRSP, FSR/E reports, CIMMYT, PAM KARI, Farm Mgt. Unit, CDBS, T&V, universities
	How is this information to be used?	List: 1 point each - research project design - research program design - midcourse correction - impact evaluation Maximum: 4 points		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer (cont'd)	**1.4** Interaction between research & extension	Liaison officers at RRCs - not officially appointed work informally & train at this level	Extension at all field days, FA's & extension interat on farm (?); at district level collaborate. Whether formally jointly planned trials with extension unclear. Do have trials national KARI progs & international & regional centers outside Kenya.	
(Swanson #10) modified	How do research & extension collaborate?	Nature, frequency of interaction Liaison officer? Y/N		
	How effective is this collaboration?	# jointly planned/implemented trials.		
	What research methodologies have been developed/refined to encourage client participation in research planning, execution, and evaluation?	List: - Baseline surveys - Program-level or center-level planning meetings? - Field days - Annual workshops	Surveys, special studies, internal M&E system CRSP level (see questionnaire) socioeconomics project - economic model with 50 constraints & 44 activities.	CRSP interviews & documents
	What methods have been developed to monitor and evaluate technology transfer and adoption?	Committees, surveys, reports, on-farm research	Surveys, on-farm research, recs for extension, field days for politicians, officials & students, presentations at national & international conferences, short courses at universities & institutes.	KARI manager interview annual report, minutes from Board
	1.5 Responses to government requests for policy advice	- Sessional papers - Participation in policymaking bodies - Requests for advice		
	2.0 Conclusive results			
	2.1 Technologies developed/released			
	Questions			
	What new varieties have been developed tested, and released to clients? (i.e., extension, farmers, private sector research)?	# varieties released	2 sweet potato - humans x sweet potato - river for goats 1 maize variety	NARS annual reports Extension reports
	What new technologies have been developed, tested and released to clients?	# of technologies recommended to extension	Scabania varietal testing & _____. Vaccine, breeding for resistances - all respond to low input systems.	KARI annual reports; program annual reports, extension
	What recommendat. ıs have come out of commodity programs?	Proportion of programs that have released varieties or technologies	Sileage, cut & carry, alt. fodder sources, alley cropping (with ICRAF) organic manure, zero-grazing.	
	Has a "Menu" of technological choices been developed and offered to accommodate different systems and situations?	# of released varieties responding to low input vs. high input systems; # of techs with positive NR side effects, e.g., alley cropping, cut & carry, fodder, silage, zero-grazing	Primarily geared toward ___ resource systems most prevalent in the area. Technologies adaptable to higher resource farmers, eng. composition of funds, minimal blocks, etc.	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	**2.2** Publications ***Questions:*** What scientific, technical and farmer-level publications have been produced?	List internal/external Level scientific technical farm level	see CRSP annual reports	KARI, Extension T&V reports, KARI program reports, extension Annual reports
	2.3 Inputs ***Questions:***			
Swanson #17	Are agricultural inputs (seed, fertilizers, pesticides, tools) available?	Distance from household to input supply point, # of sources of inputs - Credit given for inputs Y/N: in kind or in cash	Supplies from CRSP; extension provides some veterinary services	Kenya Seed Co. Fertilizer Suppliers PAM; KMDP analysis
	Are there subsectors w/o inputs?	Y/N - high, med, low potential Y/N - areas kg/ha	This highly densely populated small farm sector has trouble with input availability per COB ag. growth report.	
	Are there times of the year when inputs are not available, more expensive?	Y/N - timely delivery; seasonal shortages; price fluctuations for fertilizer & seed.	timely delivery, seasonal shortages price fluctuations for fertilizer & seed	Credit agency
	How are inputs made available to resource-poor/farmers (e.g. small packaging, etc.)	# smallest units seed or fertilizer sold/# smallholder units	CRSP - careful about sizes; costs, low to zero input recommendations	
	2.4 Marketing infrastructure ***Questions:***			
	Are markets accessible to all producers?	- regional price variations - status of rural roads (proportion of farm housholds within 10 km of paved road	Goats if sold are fetching good prices	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	***B. For the Extension System***			
	1.0 Research results/recommendations accepted and extended			
	Questions:			
Swanson #14.3	To what degree have research results been promoted by the extension service?	All recommendations Some No recommendations Why % recommendation promoted by extension		Interviews T&V reports T&V reports Liaison officer interviews Extension service reports
	To what extent does extension adopt researcher-recommended technologies?	All adopted Some None adopted Why		
Swanson #12	How is adoption of recommendations tracked?	Tracking system exists Y/N Tracking system applied Y/N		Liaison officer interviews Extension service reports
	2.0 Extension methodologies & Effectiveness			
	Questions:			
	What extension methodologies have been developed/refined to improve extension participation in research?	Ranked allocation of extension agent time in tech. generation and transfer activities		T&V agent reports
Swanson #14.4 Swanson #14.5	What extension methodologies have been developed/refined to improve the extension-farmer linkage?	# of program changes based on feedback from extension	Field days, including extension, provide impact to ongoing & new research.	T&V on station or on-farm research program descriptions/evaluations
	What publications or other media mechanisms have been produced to inform farmers of research findings?	# of households with direct contact with extension agents (male vs. female-headed) # of new messages by type Actual samples		Extension audio visual department Annual extension reports

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	***C. Intervening Variables***			
	1.0 Markets			
	Questions:			
	1.1 Farm to market roads?	Average distance farm to market? Proportion transport cost of total cost (market prices)?		farmgate vs. market prices PAM, Farm Mgt. Unit, A.I.D. Market Dev. analysed
		Farmgate vs. market prices		
	1.2 Does a market information system exist for commodities?	Y/N on radio in print media		Observation
	1.3 Are there price constraints for commodities?			Observation
	1.4 Are there required marketing channels that must be used?			
	1.5 Are there commodity marketing standards?			
	1.6 Are the recommended inputs available?			
	2.0 Storage and processing considerations			
	2.1 Is value added at household level for commodities examined?	Farm level profit & loss	cheese, milk, meat	CFGS, PAM commodity budgets Farm Mgt Unit farm budgets by type of farm CRSP reports
	2.2 Proportion of post-production losses	Costs & returns at commodity level	Improved dual purpose storage structure, baling, fodder drying, early harvesting _____	
	2.3 Post production processing	Value added to commodities		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (Adoption & Beyond)	**1.0** Technology Utilization			
How can the adoption of technologies produced by the NARS be measured, and results used to forecast probable impact on the national economy?	**1.1** What % of farmers are using new technologies?	Adoption of technology stratified by farm size high, medium, low potential, male/female household head.	Random sample 120 new farms for phase 3 from 4 clusters, considerable atention to 7-headed households; all 3 potential areas, but all small farms.	Project studies Extension service records, e.g. farm management unit. Special Studies
	1.2 Has total production increased in a commodity or region?	Production statistics; yield data; land use data by commodity & region. Production 1 area cultivated.	Milk production has increased; fodder production increased; maize & sweet potatoes (& meats) & cowpeas from tested varieties probably increased in W. Kenya & Nyazza. Cheese production began in Naivasha.	Central statistics office MOA statistics office Remote sensing data
	Have sales of fertilizer, seed, etc. increased? (Substitute relevant inputs/case study)	Sales records	ST may be changes in intercropping patterns with maize	Cooperative records Import/Export records
	Has there been a tech-related shift in crop mix?	Tech-related shift in crop mix short-term and long-term		National statictics office Remote sensing data
	2.0 Rural agro-industrial transformation			
	2.1 Has agro-industrial transformation occurred?	# of rural-based small enterprises by regions (female vs. male-owned) 10 workers or less? Increased rural savings		KREMU MOA Soil conservation Charles North
	2.2 Has research/extension resulted in the formation or strengthening of farmer organizations?	- # organizations - # members		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (cont'd)	**3.0** Management of natural resource base ***Questions:***			
	3.1 Has NR management been an element of technology adopted?	Increased land cultivation (intensive vs. extensive) Proportion owned vs. rental land, security of access to land % top soil loss, salinization rate Sedimentation rate	Yes, all owned, registered land before goats given.	
	4.0 Policy changes at sector level	Price policy; input policy; marketing policy	Not yet, animal health policy impacts likely	Policy makes endeavours; Simons
IV. Impact How has investment in research influenced the economy of the country, in terms of incomes, productivity, production & food security (availability, access & adequacy)?	**1.0** Net farm income	1. Change in net farm income at national aggregate level in real terms. 2. Change in net farm income/ farm in real terms disaggregated by farm size male/female household heads 3. Changes in net farm income per AEPA		FAO yearbook World Bank reports Treasury reports
	2.0 Agricultural productivity			
	2.1 Has agricultural productivity increased by farm size, etc.	1. Change in value of prod/capita. 2. Change in value of production/ farm (EAPA, male/female). 3. Change in value of production/ farm by farm size. 4. Change in value of ag. production per hectare of agricultural land. 5. Change in value of ag. production by unit of ag. investment of credit for agriculture.		Central statistics offices, MOA, Treasury, Credit Bank, FAO nutrition statistics.

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. **Impact** (cont'd)	**3.0** Food Security (national level)			
	3.1 What is the impact of ag. research on food security at the national level?	1. Change in per capita food production and consumption. 2. Change in ag. GDP (including non-food crops). 3. Change in % self-sufficiency in basic food commodities. 4. Variability in total annual ag. production. 5. Change in per capita food imports by value. 6. Change in annual carryover stocks of basic food stuffs (buffer stocks)		

ANNEX E

CAMEROON

CASE NARRATIVES AND COMPLETED INTERMEDIATE IMPACT INDICATOR MATRICES

THE NATIONAL CEREALS RESEARCH AND EXTENSION PROJECT DESCRIPTION

The National Cereals Research and Extension (NCRE) Project expands the USAID/Cameroon investment in applied cereals and cropping systems research, technology transfer, and institution building that began in Phase I, from 1979 to 1985 (Project 631-0013). Phase II began with project authorization, on October 10, 1984, of a grant of $35.4 million and a loan of $3.6 million. Phase II has a project assistance completion date (PACD) of December 12, 1994. (In this report, the current contract period from 1984 to December 1990 is called Phase II. The period from January 1991 through December 1994 is called Phase III.) The basic problem identified by the project was the lack of agricultural production technology adapted to Cameroon's diverse agroclimatic zones and the needs of rural smallholders.

The long-term goal of the project is to increase agricultural production and rural development by building Cameroonian institutional capacity for applied agricultural research. The purpose of Phase II is to provide additional assistance to develop the capacity of the Institute of Agronomic Research (IRA) to provide high-quality research on maize, rice, sorghum, and millet and to facilitate utilization of research results by farmers. Four liaison structures for research and extension, known as testing and liaison units (TLUs), are supported in Phase II to integrate cereals research into the cropping systems of the country's major agroecological zones in a way that focuses on the problems farmers face in food production.

The five major objectives of the project are:

Cereals Research

The principal objective is to develop the capacity of IRA's Cereals Program. This research will lead to improved varieties and development of appropriate cultural practices. Before the project ends the research will encompass intercropping systems and research on other food and perennial crops to develop suitable systems for each agro-climatic zone.

Cereals Program Staff Improvement

The second objective is to augment IRA's cereals program staff through long-term academic training, on-the-job training, and short-term training at international research centers.

Testing and Liaison Units

The third objective is to establish four TLUs under IRA's Farming Systems Program, each in a different agro-climatic zone. The principal TLU activities are: (a) short-course training in methods of farming systems research and extension, (b) on-farm trials and demonstrations and (c) diagnostic farming systems surveys. The key components in addition to technology testing are farming systems description, identification and analysis of constraints, and

active involvement in strengthening extension.

Research Linkages

The fourth objective is to establish and maintain linkages and information exchange with international, African and Cameroonian research institutions.

Physical Facilities Improvement

The fifth objective is to provide adequate physical facilities and equipment for carrying out IRA's cereals research program.

To accomplish the above objectives, USAID and IITA have signed a contract under which IITA provides technical assistance to strengthen IRA's cereals breeding and agronomy program and establish four TLUs. IITA technical assistants are also expected to carry out in-service training and coordinate short-course training, help develop research linkages, and identify and procure research equipment and supplies.

NCRE personnel operate from 6 provinces of Cameroon: Center (Nkolbisson), Northwest (Bambui), West (Dschang), Southwest (Ekona), North (Garoua) and Extreme North (Maroua). Actual work locations are on IRA experiment stations and in numerous farmer's fields throughout each province. A total of 18 IITA staff cooperate with 43 Cameroonian researchers as counterparts.

At this time, the following varieties have been released or are ready for release:

Lowland Maize:	CMS-8501, CMS-8503, CMS-8602, CMS-8704, DRM-EST0-Y, CMS-8710, NDOCK-8701
Highland Maize:	Shaba, Kasai, COCA-SR, BACOA-SR
Rice:	IR-7167, CICA-8, BKN-3033, ITA-222
Sorghum:	S-35, CS-54, CS-95, CS-61, S-34

The use of zero and minimum tillage has been recommended and adopted by farmers resulting in a significant reduction in soil erosion. The use of "Marshall" insecticide as a seed treatment for maize and sorghum has resulted in significantly higher yields than other seed treatments. Large numbers of mini-kits have been distributed by the TLUs as a means of both testing and introducing new practices. Several diagnostic surveys have been conducted to characterize the production systems in different zones and identify constraints to increased production. Eight counterparts are now studying for advanced degrees in the USA. Fifteen have finished their degrees and have returned to their positions in IRA. During the second phase of the project twelve in-country training courses have been conducted on subjects ranging from research techniques and intensive maize production through surveys and computers.

NATIONAL CEREALS RESEARCH AND EXTENSION PROJECT

THE SORGHUM IMPROVEMENT PROGRAM

General Project Description

Background:

Sorghum is the major staple cereal in North Cameroon and is produced almost entirely for human consumption. The crop is indigenous to the region and is grown on over 500,000 hectares. In an attempt to improve overall cereal production in Cameroon, sorghum was chosen as one of the four cereals that the National Cereals Research and Extension Project (NCRE) would include for intensive research efforts.

The sorghum breeding component of the NCRE was initiated in 1981 following a research hiatus of three years when the Institut de Recherche Agronomique Tropicale (IRAT) terminated their activity in sorghum in 1978. The program is funded by USAID under a contractual arrangement with the International Institute of Tropical Agriculture (IITA) and technical backstopping is provided by the International Center for Research in the Semi Arid Tropics (ICRISAT) through a Memorandum of Understanding (MOU) with IITA. The program is an integral part of the National Agricultural Research System (NARS), the Institut de Recherches Agronomique (IRA), and is based at the IRA/Maroua Research Station. Current program staff include an expatriate sorghum breeder as project leader, two national sorghum breeders, an entomologist, a part time pathologist, and several research technicians. Other technical support includes the expatriate NCRE agronomist and his staff for agronomic input and the NCRE Testing and Liaison Unit (TLU) which includes an expatriate agronomist, economist and national staff for on-farm testing and monitoring.

Goal and Objectives:

The major goal of the project is to increase sorghum production in North Cameroon through improved variety development. Objectives designed to meet the project goal were defined through discussions with the SAFGRAD ACPO, who had worked as an on-farm sorghum agronomist prior to the NCRE project, and former IRA sorghum researchers, who had been transferred to other sections. In addition to research input, the project also sought the advice of the Societe pour le Developpement de Coton (SODECOTON) which is the major agency for extension and rural development in North Cameroon. IRAT reports on previous sorghum work were also consulted. Through this process, the project oriented the bulk of its effort to create high-yielding, stable, early maturing, food-type sorghums

with disease and insect resistance for the Extreme North Province.

Program Evolution:

Phase I:

The first phase of the program introduced and tested sorghum germplasm from ICRISAT, ICAR, INTSORMIL, and neighboring countries. From this screening technique the program identified several promising varieties to meet its short to mid-term objectives while simultaneously implementing a more intensive hybridization program with exotic and local material for its long-term objectives. By 1983 the Nigerian bred variety, S35, had been adequately tested on-station with positive results and was proposed for a series of on-farm tests. The decision to test the variety in comparison to local varieties on-farm was reached through consensus by the IRA/Maroua NCRE TLU and SODECOTON at the annual Northern IRA-SODECOTON meetings. The tests were conducted in complete collaboration with SODECOTON on approximately 65 farms in the Extreme North Province. SODECOTON extension agents were trained by the TLU in their respective zones of operation and selected the farmers who would manage the trials. The agents were also responsible for monitoring the evolution of the trials throughout the growing season. Periodic visits by the TLU staff were conducted with the agents at key stages in the growth cycle.

Results from the on-farm trials were presented at the next annual IRA-SODECOTON meeting. These results indicated that S35 was superior in yield to the local varieties by approximately 50%. It is important to note, however, that the testing year was 1984, the year in which North Cameroon, like most of the Sahel, suffered its worst drought in almost 40 years. In addition, the variety S35 was significantly shorter in maturity cycle than local varieties and therefore had a distinct advantage in drought years. In any case, it was decided that S35 be tested again on-farm in 1985 while the breeder multiplied sufficient quantities of foundation seed for the seed multiplication service.

Phase II:

Phase II of the NCRE project was marked by the increase in TLU staff and better relations with both SODECOTON and the Provincial Delegation of Agriculture. In addition, the World Bank initiated an extensive rural development project, Projet Centre Nord, in North Cameroon which encompassed experiment station development and strengthening. These factors were instrumental in creating a well coordinated, institutionalized critical mass in both the research and extension sectors of North Cameroon.

The second series of on-farm tests with the variety S35 were conducted under more favorable climatic conditions in the Extreme North. Nevertheless, results from these trials indicated that the variety S35 maintained its high yield but was no longer significantly different in yield than the local varieties. These results suggested that S35 may be an ideal variety which could provide good yield in drought years and average yields in better years, thus significantly increasing food security in the adverse Sahelian environments of North Cameroon.

In 1986, SODECOTON extended the variety to farmers. Again, 1986 proved to be an exceptionally wet year and feedback from farmers indicated that S35 had some agronomic problems under these conditions:

namely, grain mold and bird damage, due to the short cycle of the variety which matured before the end of the rainy season. In retrospect, these problems should have been detected at the on-farm testing stage but may have been "hidden" through the manner in which these trials were conducted. In this respect, the on-farm trials may have been overly researcher managed, following a rigid protocol which called for late planting, which runs contrary to traditional sorghum planting, and a quick harvest which also is not traditionally done.

Despite these problems in the wet zones and/or years, S35 was adopted by farmers in those areas which typically have a shorter growing season and there are indications that the variety is well accepted in those regions. In 1987, the TLU followed up on the adoption of S35 in North Cameroon by conducting a survey among farmers who had grown S35. It was found that approximately 30% of the farmers retained seed to plant approximately 30% of their sorghum fields in S35 for the following year.

More important is the way in which the system allowed feedback from the farmer through SODECOTON and the TLU to the breeder who then reoriented the program to solve the problems of bird damage and grain mold and has made significant progress in this respect. These interactions were crucial to the overall success of the sorghum program and have been well institutionalized to insure future success and impact.

Applying the Framework:

Since the Sorghum Program is well integrated into the NARS, the framework developed by ISNAR and modified by the MSI Kenya team was found to be appropriate and relatively successful at predicting the impact of the program.

Level I: Institutional Base

The overall institutional and policy environment surrounding the sorghum program is very relevant. Institutional structures and management mechanisms which permit critical functions of a research system to be effectively carried out exist for the sorghum program. As stated in the above program description and evolution, the sorghum research program was only one piece of a very effective, dynamic, institutional development scheme which itself was in the early stages of formation. In this respect, the initiation of the research program was well timed with the formation and development of other critical elements necessary for the achievement of impact at the farmer level.

Another key factor that led to the overall success of the sorghum program, as well as the whole NCRE project, was the input received during the design phase of the project by the Director of IRA and the Coordinator of IRA's cereals program. Their input considerably enhanced the overall project design and approach not only in technical and institutional ways but through the basic underlying commitment to the project's success by the GRC. It should also be added that both of the above persons are respected in their fields as strong national and international leaders. In addition, development agencies, such as SODECOTON, were also contacted which further engendered a broader institutional commitment by other relevant development agencies for mutual benefit and success.

In terms of the sorghum program, the above factors led to the development of an effective system of feedback from development agencies, who represent farmers, to the NARS. As stated in the program description, this was crucial to the success of the sorghum program and since the process is dynamic, these linkages have become formal and should continue to add to the future success of this program. In addition, these linkages have facilitated an effective communication system among all IRA stations and within specific target zones. The NCRE project installed short wave radios at all project sites which simplified and expedited research implementation and coordination. SODECOTON also made available their extensive short wave radio link to all their sectors which allowed the TLU to efficiently conduct their training, implementation and monitoring of the on-farm trial program.

Another indicator of sustainable success was the program's training component. Four national ingenieurs agronomes were identified for advanced degree training to the M.S. level for the sorghum improvement program and two for the Maroua TLU. Mere numbers of the trained personnel are probably less important than the selection and follow-up process for those individuals. The team was informed on several occasions that the advanced degree training program was relatively slow (only 2 of the above six have returned) and input from the researchers who work day-to-day with the candidates was negligible and had little effect on final decisions. As a result, it may be useful to include some indicators on the selection process and the location and performance of the returned trainees. On the other hand, short-term and on-the-job training for technical staff seems to have been more through nomination by the researchers themselves and has had considerable impact at the technical and general motivational level.

In general terms our team felt that the institutional indicators in the evaluation matrix were relevant, appropriate and easy to gather the necessary data.

Level II: Technology Generation and Transfer

A relatively unique component to the NCRE Project was the inclusion of a Testing and Liaison Unit (technology transfer program) at the outset of the project. More important has been the evolution of the TLU program throughout the life of the project. At the beginning of the project in 1982, only one TLU was being implemented and it was located in the densely populated Northwest Province and focused on maize and rice research. In 1984, a TLU was formed for the Extreme North Province to service sorghum, millet, cowpea, and peanut research programs. In 1985, another TLU was placed in the South Province to service maize, root and tuber research programs. Finally a fourth TLU was formed for the Center South Province to service the lowland maize research program. In addition to the full ecological coverage the new TLUs provided, the TLUs were gradually strengthened through the addition of TA staff which usually includes an agronomist and an economist.

In terms of the sorghum program, technology was generated in the absence of a functional TLU program but nevertheless in collaboration with former IRA sorghum researchers, the SAFGRAD project, and input from SODECOTON. The major

technological product of the program was the release of a high-yielding, short cycle, food-type sorghum variety, S35. The complement of the TLU for the transfer of this variety did not occur until 1984 with the arrival of an on-farm, extension agronomist, and has only recently been fully completed with the arrival of an economist in 1988. As stated earlier, the first activity of the Maroua TLU was the extensive on-farm testing of the variety in collaboration with SODECOTON. As a result, there were no baseline surveys conducted on farmer varietal preference and traditional sorghum culture. This was probably of critical importance for the generation of an indigenous crop like sorghum, where the population has been selecting and refining sorghum varieties for thousands of years. The problems this variety has experienced since its release in the long wet seasons, such as grain mold and bird damage would probably been avoided if the TLU had been in place at the outset of the program.

Despite those problems, the variety has had a high level of success in those zones where rainfall is limited and poorly distributed. Its success diminishes as you move geographically from the northern Extreme North Province, around Mora, southward. In addition and probably most important, the TLU and SODECOTON have effectively reoriented the breeding program to address the shortcomings of the variety in the wetter zones through debate and discussion in the annual IRA/SODECOTON meetings. Nevertheless, the quality, quantity, and nature of the outputs of the sorghum program are easily verifiable and available.

Level III: Intermediate Impact Indicators (Adoption and Beyond)

Technology Utilization:

The adoption and spread of the variety S35 can be verified through two reliable sources. Namely, SODECOTON trimester reports and TLU surveys. In the first case, cultivated area of S35 by the SODECOTON farmers can be documented for any given year and shows a modest demand for the variety since its release in 1986. In no year, however, has the demand been greater than 1000 hectares. This of course does not include other development projects and large farmers who buy the seed directly through the seed multiplication project. Those figures should be available at the seed multiplication agency, but time was too short to verify their availability and the quantity. Also, SODECOTON has significantly reduced their activity in the Extreme North which further complicates an accurate assessment of adoption.

In the second case, the TLU has followed the adoption of the variety by surveys conducted in 1987 and 1988 where farmers who tested the variety in earlier years were interviewed about the success and/or failure of the variety in those years following the trials. These data generally suggest that a third of the farmers who tested the variety saved its seed and planted at least a third of their next year's sorghum crop to S35. These are very encouraging results and also reflect the knowledge and speculation of the farmer in terms of food security at a family and village level. These farmers were by and large those who grew the variety in 1984 and saw the enormous advantage of the

high-yielding early variety in that drought year. As a result, these farmers have kept the variety to ensure a certain level of production stability over several years.

Rural Agro-industrial Transformation:

In this respect, the sorghum program has not achieved the relative success of the maize program for several reasons. First, sorghum is almost entirely consumed for food and beer by the farm family/village. Surpluses are generally sold in larger markets at low prices due the lack of efficient grain storage facilities. Despite this deficiency, the team was told by the provincial cereal office that there is a great demand for food-type sorghums, such as S35 in their storage and marketing project. This should probably be investigated by the TLU economist. Secondly, there does not appear to be interest by agro-industry which could utilize sorghum through transformation into flour substitutes or beer. Nevertheless, the sorghum program has branched out to investigate these possibilities in collaboration with scientists at the Food Technology Center in Ngoundere. Also, the French-financed Projet Garoua will be working in this area in the near future.

Management of Natural Resources:

The sorghum program has addressed some of these issues through the agronomy component which is investigating rotations, agro-forestry, and intercropping schemes and their effect on the natural soil resource base which is very important on many of the marginal North Cameroon lands.

Policy changes at the Sector Level:

The project has not evolved sufficiently to have had an effect at this level nor was it the intention of the project. Instead, the USAID portfolio includes an Agricultural Policy project whose mandate is to monitor, analyze, and make recommendations for policy changes at the Ministry level. If successful, the effect on sorghum production and marketing could be great.

Level IV: Impact

Once again, the project has not been in existence long enough to accurately assess impact in terms of the economy of Cameroon, incomes, productivity, production and food security. It can be said, however, that Cameroon is food self-sufficient and that the NCRE project holds promise to sustain that sufficiency and increase production.

Summary:

The Sorghum Improvement Program of the NCRE project was begun in 1982 and has evolved into an effective technology-generating program. Four years after its initiation the program released a short cycle, high-yielding, food-type sorghum which has been partially adopted in its target zone. The extent of adoption and the key factors that led to its adoption are available and verifiable. Paramount among the key factors were the establishment and gradual maturity of an effective, dynamic, feedback system or forum where all relevant and appropriate institutions provided significant input into the research process at each step in its progression.

INTERMEDIATE IMPACT INDICATORS MATRIX

CAMEROON — SORGHUM

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base Does NARS have institutional structures & management mechanisms which will permit all critical functions of a research system to be effectively carried out?	***A. At national/ministerial level*** **Manageable Interests of Parent Ministry and Institute**		(Answers for Level I are given in the next matrix.)	
	1.0 Development of national research policy as it relates to national development policy. ***Questions:***			
	Does the country have an agricultural development plan?	Y/N		
	Does the country have a research policy?	Y/N		
	Who monitors the continued concordance of research and development policies?	Name body		
	1.1 NARS priorities articulated according to research policy and resource requirements defined based on iterative planning exercises. ***Questions:***			
	What process exists for setting research priorities and allocating resources? How does this process take into account:	Level of complexity of analysis: 0 = no formal priority setting method; 1 = congruence method; 2 = weighted criteria or other formal method.		
	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 need, distribution of benefits, political considerations, etc.			
Swanson #9:1 and/or 2	The probability and cost of research success, including national use of existing personnel, infrastructure, financial resources, etc. and taking into account past research results, both positive and negative, national and international	Resource allocation to commodities; Index value % research personnel/commodity research program. (state whether planned or actual)		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.2*** Effective communication of NARS needs and acquisition of resources.			
	Questions:			
	Does NARS receive an adequate level of funding from Government?	Research budget as % of Ag. GDP.		
	Does NARS receive the types and levels of funding requests from donors?	Funding level/request		
	Does NARS effectively coordinate donor-financed research activities?	Mechanisms: - Formal, timely meetings - New project starts based on NARS priorities - New project starts outside of NARS priorities		
	Does NARS initiate the identification of donor-financed activities?	Y/N		
	1.3 Effective external (international) linkages			
	Questions:			
	Does NARS have formal linkages with IARCs, international private sector research or agri-business? With whom and what type?	List and describe: 1 point each a) technology exchange; b) training; c) networking; d) consultation Maximum: 4 points		
	1.4 Effective internal (national) linkages			
	Questions:			
	Does NARS have formal linkages with MOA/EXT, other relevant ministries, universities, development projects, local agri-business, private sector research organizations? With whom and of what type?	List and describe: 1 point each: a) Priority setting process b) NARS board membership c) Training d) Technology exchange e) Contract research (in & out) f) NARS representation on other boards Maximum: 6 points		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.5*** Monitoring of impact-level indicators by parent ministries			
	Questions:			
	Who is responsible for baseline and time series data collection on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc.?	List by function/data type.		
	What data currently exist?			
	Are data readily exchanged?	Inventory data sets Identify users for each data set.		
	1.6 Human resource management			
	Questions:			
	Does NARS have a personnel database	Y/N		
	Does a NARS manpower training plan exist?	Y/N		
Swanson #8	Is there an adequate career incentive structure to recruit & retain qualified staff?	- Operating budget/researcher - Scheme of service for researchers? Y/N - Annual attrition rate - # of vacancies - Proportion of support staff to research & technical staff		
	2.0 Intervening Variables			
	2.1 Agricultural Policies			
	Questions:			
	Does NARS have a role in input & output price policy development?	Y/N Input policy Output policy		
	Does FX policy favor ag. sector?	- Special rates for ag. export/ import licensing; Y/N - FX readily available for input imports? Y/N		

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ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	2.2 Extension services			
	Questions:			
	What priority is given to extension? Who carries out extension activities?	% Ag. GDP to extension List		
	Extension salaries comparable to research salaries of equivalent levels?	Y/N		
George?	How effective is extension?	3 = highly effective; 2 = moderately effective; 1 = marginally effective (subjective observation)		Farmer surveys T&V report Observation Interviews

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	Is there an adequate career. incentive structure to recruit and retain qualified staff?	- Operating budget/extension officer - Annual attrition rate - # of vacancies		
	B. At NARS Institute and Program levels			
	1.0 Research program planning and management			
	1.1 Development of long-term research plan			
	Questions:			
	Does institute have a long-term research plan?	Y/N		
Swanson #5, 2	Do farmer orgs. participate in plan formulation?	Y/N farmer org. index		
	Does the plan articulate priorities and resource allocations by commodities/factors?	Y/N		
	Does it include projections for manpower, infrastructure and operating funds?	Y/N		
	1.2 Development of a program structure			
	Questions:			
	Does institute have a program structure which will effectively carry out the long-term research plan?	- Existence of national programs		NARP
Swanson #7 1 and 3	Are program leaders appointed?	Y/N		
	Are programs adequately staffed?	# researcher/program # technicians/researchers (ratio) # B.S., M.S., Ph.D/program		personnel database NARP ISNAR Indicators Series

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.3*** Program and budget			
	Questions:			
	Does institute have a short-term program and budget?	Y/N		
	Are farmers involved in determining progams?	Farmer orgs. represented		
	Are programs based on constraints analysis?	Y/N		
	1.4 Monitoring and Evaluation (M&E)			
	Questions			
	How is research performance (efficiency) assessed?	- Active annual review process - # projects revised or cancelled		
	How is research quality assessed?	- Peer or expert review - # projects redesigned		
	Who establishes baseline data for research programs?	- Socio-economic surveys used in divising proposal? - Baseline survey		
	Who collects program-level and institute-level data for evaluation?	Individual scientists, prog. directors; M&E system		
	What are career promotion criteria?	List: Publications, advanced degrees, collaboration with extension.		
	What are criteria for pay increases?	Seniority, degree qualifications, etc.		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***Questions:***			
	How effective is the flow of information between research and its clients: policy-makers, extension services, farmers and others?	Mechanisms: Board meetings, sessional papers, annual reports, meetings with farmer org., bulletins, mass media messages.		
	1.5 External communication			
	Do institute centers and programs have formal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agri-business organizations for problem identification, program formulation and execution?	List linkages: 1 point each a. problem definition b. investigation c. analysis d. evaluation Maximum: 4 points		
	With whom and of what type?			
	1.6 Internal communication			
	What formal linkages exist within institute, e.g. between programs, disciplines?	Multidisciplinarity: 1 point each a. Problem definition b. Investigation c. Analysis d. Evaluation Maximum: 4 points		Annual reports Interviews with program leaders
	How are multidisciplinary problems approached?			Annual reports Policy statements
	Is NR mgt./sustainability incorporated into redesign? (indicate multidisciplinarity)	Cite examples: - Shift from chemical to biological pest control - Agroforestry research - Reduced proportion of inorganic to organic nitrogen sources		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	**2.0 Financial Resource Management**			
	2.1 Acquisition of funds			
	Questions:			
	Are funds received by institute headquarters, stations and programs in a timely way and in adequate amounts?	- Date requested, date received; - Programs/projects halted for funding shortfalls (# & proportion) - # of researchers without funded projects		
	2.2 Funds disbursement			
	Questions			
	Do station and/or program heads have the delegation of authority necessary to permit a flexible yet accountable use of funds?	Y/N		
	Can funds be retained and carried over from one year to the next?	Y/N		
	2.3 Accounting			
	Questions			
	Are adequate accounting procedures and staff in place throughout the system?	FM system centralized Y/N No. of clearances required? Trained accountants at each center?		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer	***A. For the Research System***			
	1.0 Intermediate results (outputs)			
	1.1 Training Opportunities			
	Questions			
(What are the quantity, quality and nature of the outputs of the research and extension system?)	What training is available for researchers, collaborators and clients?	# trained ST in-country ST abroad LT abroad (Past 3 years)	LT abroad - 6:4/MS 2/Maroua TLV Yes, how much?	Personnel system data-base
	1.2 Progression of experimentation			
	Questions			
	Is research moving from strategic, to applied to adaptive research?	Proportion of research on-station, on-farm, being demonstrated (time series)	—Extensive on-farm trials - from 1984 —an on-farm extension agronomist —Testing and Liaison Unit (TLV) established 1984 —One new variety - 535	Annual reviews extension reports
	How much research is conducted on-farm?	Research reports - # of trials listed		Annual reports
	How much research has moved into the field testing & demonstration stages?	# technologies moved from on-farm trials to demonstration stage/ program		Extension reports
	1.3 Surveys and constraint analysis			
	Questions			
	What studies have been initiated/completed on characteristics and constraints at agro-ecological levels, provincial levels, among cultural groups, etc. for outputs and inputs.	# projects with constraints analysis included # other studies analyzed	No baseline surveys on farmer varietal preference or traditional sorghum culture	
	How is this information to be used?	List: 1 point each - research project design - research program design - midcourse correction - impact evaluation Maximum: 4 points	1 ? 1 1	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer (cont'd)	***1.4*** Interaction between research & extension			
(Swanson #10) modified	How do research & extension collaborate?	Nature, frequency of interaction Liaison officer? Y/N	TLV - tech. transfer program established 1984 - could have avoided problems with new variety if established earlier.	
	How effective is this collaboration?	# jointly planned/implemented trials.		
	What research methodologies have been developed/refined to encourage client participation in research planning, execution, and evaluation?	List: - Baseline surveys - Program-level or center-level planning meetings? - Field days - Annual workshops		
	What methods have been developed to monitor and evaluate technology transfer and adoption?	Committees, surveys, reports, on-farm research		
	1.5 Responses to government requests for policy advice	- Sessional papers - Participation in policymaking bodies - Requests for advice		
	2.0 Conclusive results			
	2.1 Technologies developed/released			
	Questions			
	What new varieties have been developed tested, and released to clients? (i.e., extension, farmers, private sector research)?	# varieties released	—One variety released, agronomic work also — —	NARS annual reports Extension reports
	What new technologies have been developed, tested and released to clients?	# of technologies recommended to extension	—investigating rotations, agro-forestry, and intercropping schemes	
	What recommendations have come out of commodity programs?	Proportion of programs that have released varieties or technologies		
	Has a "Menu" of technological choices been developed and offered to accommodate different systems and situations?	# of released varieties responding to low input vs. high input systems; # of techs with positive NR side effects, e.g., alley cropping, cut & carry, fodder, silage, zero-grazing		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	**2.2** Publications ***Questions:*** What scientific, technical and farmer-level publications have been produced?	List internal/external Level scientific technical farm level	1984 one new variety released	Annual reports Extension reports
	2.3 Inputs ***Questions:***			
Swanson #17	Are agricultural inputs (seed, fertilizers, pesticides, tools) available?	Distance from household to input supply point, # of sources of inputs - Credit given for inputs Y/N: in kind or in cash		
	Are there subsectors w/o inputs?	Y/N - high, med, low potential Y/N - areas kg/ha		
	Are there times of the year when inputs are not available, more expensive?	Y/N - timely delivery; seasonal shortages; price fluctuations for fertilizer & seed.		
	How are inputs made available to resource-poor/farmers (e.g. small packaging, etc.)	# smallest units seed or fertilizer sold/# smallholder units		
	2.4 Marketing infrastructure ***Questions:***			
	Are markets accessible to all producers?	- regional price variations - status of rural roads (proportion of farm housholds within 10 km of paved road		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	***B. For the Extension System***			
	1.0 Research results/recommendations accepted and extended			
	Questions:			
Swanson #14.3	To what degree have research results been promoted by the extension service?	All recommendations Some No recommendations Why % recommendation promoted by extension	—Probably all recommendations —Probably all adopted —TLV staff & SODECOON agents monitor farm trials	T&V reports Liaison officer interviews Extension service reports
	To what extent does extension adopt researcher-recommended technologies?	All adopted Some None adopted Why		
Swanson #12	How is adoption of recommendations tracked?	Tracking system exists Y/N Tracking system applied Y/N		Liaison officer interviews Extension service reports
	2.0 Extension methodologies & Effectiveness			
	Questions:			
	What extension methodologies have been developed/refined to improve extension participation in research?	Ranked allocation of extension agent time in tech. generation and transfer activities		T&V agent reports
Swanson #14.4 Swanson #14.5	What extension methodologies have been developed/refined to improve the extension-farmer linkage?	# of program changes based on feedback from extension	Results from trials presented at meetings w/researchers previous on farm trials overly researcher managed.	T&V on station or on-farm research program descriptions/evaluations
	What publications or other media mechanisms have been produced to inform farmers of research findings?	# of households with direct contact with extension agents (male vs. female-headed) # of new messages by type Actual samples	Surveys among farmers led to reorientation of program Good interaction between farmer and SODECTION & the TLV	Extension audio visual department Annual extension reports

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. **Technology Generation and Transfer** (cont'd)	C. ***Intervening Variables***			
	1.0 Markets			
	Questions:			
	1.1 Farm to market roads?	Average distance farm to market? Proportion transport cost of total cost (market prices)?		
		Farmgate vs. market prices		
	1.2 Does a market information system exist for commodities?	Y/N on radio in print media		Observation
	1.3 Are there price constraints for commodities?			
	1.4 Are there required marketing channels that must be used?			
	1.5 Are there commodity marketing standards?			
	1.6 Are the recommended inputs available?			
	2.0 Storage and processing considerations		Important considerations - lack of efficient storage facilities	
	2.1 Is value added at household level for commodities examined?	Farm level profit & loss		Farm budgets by type of farm
	2.2 Proportion of post-production losses	Costs & returns at commodity level		
	2.3 Post production processing	Value added to commodities		

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ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (Adoption & Beyond)	**1.0** Technology Utilization			
How can the adoption of technologies produced by the NARS be measured, and results used to forecast probable impact on the national economy?	**1.1** What % of farmers are using new technologies?	Adoption of technology stratified by farm size high, medium, low potential, male/female household head.	30% of farmers who tested new variety planted it as 30% of their next years crop.	Project studies Extension service records, e.g. farm management unit. Special Studies
	1.2 Has total production increased in a commodity or region?	Production statistics; yield data; land use data by commodity & region. Production 1 area cultivated.	—North Cameroon - new variety including produc. during drought and average yield in better conditions —Modest demand for new variety	Central statistics office MOA statistics office Remote sensing data
	Have sales of fertilizer, seed, etc. increased? (Substitute relevant inputs/case study)	Sales records		Cooperative records Import/Export records
	Has there been a tech-related shift in crop mix?	Tech-related shift in crop mix short-term and long-term		National statistics office Remote sensing data
	2.0 Rural agro-industrial transformation			
	2.1 Has agro-industrial transformation occurred?	# of rural-based small enterprises by regions (female vs. male-owned) 10 workers or less? Increased rural savings		MOA
	2.2 Has research/extension resulted in the formation or strengthening of farmer organizations?	- # organizations - # members		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (cont'd)	**3.0** Management of natural resource base			
	Questions:			
	3.1 Has NR management been an element of technology adopted?	Increased land cultivation (intensive vs. extensive) Proportion owned vs. rental land, security of access to land % top soil loss, salinization rate Sedimentation rate		
	4.0 Policy changes at sector level	Price policy; input policy; marketing policy		
IV. Impact How has investment in research influenced the economy of the country, in terms of incomes, productivity, production & food security (availability, access & adequacy)?	**1.0** Net farm income	1. Change in net farm income at national aggregate level in real terms. 2. Change in net farm income/ farm in real terms disaggregated by farm size male/female household heads 3. Changes in net farm income per AEPA		FAO yearbook World Bank reports Treasury reports
	2.0 Agricultural productivity			
	2.1 Has agricultural productivity increased by farm size, etc.	1. Change in value of prod/capita. 2. Change in value of production/ farm (EAPA, male/female). 3. Change in value of production/ farm by farm size. 4. Change in value of ag. production per hectare of agricultural land. 5. Change in value of ag. production by unit of ag. investment of credit for agriculture.		Central statistics offices, MOA, Treasury, Credit Bank, FAO nutrition statistics.

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. **Impact** (cont'd)	3.0 Food Security (national level)			
	3.1 What is the impact of ag. research on food security at the national level?	1. Change in per capita food production and consumption. 2. Change in ag. GDP (including non-food crops). 3. Change in % self-sufficiency in basic food commodities. 4. Variability in total annual ag. production. 5. Change in per capita food imports by value. 6. Change in annual carryover stocks of basic food stuffs (buffer stocks)		

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

2 Currently, the only fertilizer used is 20-10-10. It is apparently optimal for coffee but not for maize. USAID's newly-created fertilizer project has as its goals the privatization of the fertilizer industry and the diversification of fertilizers available through in-country mixing. This should also tend to lower the cost of fertilizer (and presumably increase the usage) in the future. Credit for fertilizer purchases is provided in some areas by a network of small credit unions.

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.

PEM REPORTS

Those marked P are planning studies, those marked C have been undertaken by external agencies. Baseline surveys have been included under planning studies because they were intended to have significant inputs to the implementation of Phase I.

P Baseline Socio-Economic Survey, 1984.
Extension Survey, Report No. 1: Socio-Economic Background of Maize Contact Farmers, 1984.
Extension Service Survey, Report No. 2: Maize Package Adoption, 1984.
Extension Service Survey, Report No. 3: Yields of Second Cycle Improved Maize, 1984.

PC Baseline Survey of Protein-Energy Malnutrition in Donga Mantung Division, 1984.
Internal Mid-Term Evaluation Report, 1985.

PC Study of Oil Production and Processing in Momo Division.

P A Guide to the MIDENO/FONADER Credit Component.
Arabica Coffee (Re)planting 1984 - Farmer's Practices.
Report on the Training Workshop for Members of the Provincial Technical Committee of MIDENO.
Report on the Evaluation of the Campaign Against Bush Fires, 1984.

PC NWCA Transport Study.

PC Coffee Processing Study.

P Water Supply Study.
Uncompleted Water Supply Schemes.

P Palm Oil Production in Momo Division.
Credit Service Study, 1985/86, Report No. 1: Analysis of Applications and Grants — Social and Economic Characteristics of Loan Recipients.
Credit Service Study, 1985/86, Report No. 2: Coffee Credit Survey.
Credit Service Study, 1985/86, Report No. 3: Food Crop Credit Survey.
The MIDENO/PDA Central Coffee Nursery Programme.
Coffee Production Survey, 1988.
Village Extension Worker Performance Study, 1987.
Agricultural Production Programme Evaluation Study.

PC PAFSAT/MIDENO Marketing Study.

PC NWCA/COOPMIFOCC Evaluation Study.
Maize Farming Systems Study, 1987.

P Assessment of the Resources, Constraints and Level of Production of the Livestock Sector, Northwest Province 1987.

PC Input Supply Study, 1988.

P Maize Storage Investigation, 1985.
Report on the Meeting of the Provincial Technical Committee, May 1987.
Report on the Meeting of the Provincial Technical Committee, January 1989.
Coffee Nursery Study, 1987.
Review of Central Nurseries, 1989.

PC Management and Organization Study, 1989.

PC Extension and Adaptive Research Evaluation and Restructuring Study, 1989.

P RDF Proposals, 1989.
Technical Description of Project Components, 1987.
MIS Report, 1989.

P Cassava Grater Credit Line Feasibility Study, 1989.

INTERMEDIATE IMPACT INDICATORS MATRIX

CAMEROON — HIGHLAND MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base	***A. At national/ministerial level***			
Does NARS have institutional structures & management mechanisms which will permit all critical functions of a research system to be effectively carried out?	**Manageable Interests of Parent Ministry and Institute**			
	1.0 Development of national research policy as it relates to national development policy.			
	Questions:			
	Does the country have an agricultural development plan?	Y/N	Yes	MINAGRI
	Does the country have a research policy?	Y/N	Yes	
	Who monitors the continued concordance of research and development policies?	Name body	MESRES	MESRES
	1.1 NARS priorities articulated according to research policy and resource requirements defined based on iterative planning exercises.			
	Questions:			
	What process exists for setting research priorities and allocating resources? How does this process take into account:	Level of complexity of analysis:		
	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 need. distribution of benefits, political considerations, etc.	0 = no formal priority setting method; 1 = congruence method; 2 = weighted criteria or other formal method.	0	
Swanson #9:1 and/or 2	The probability and cost of research success, including national use of existing personnel, infrastructure, financial resources, etc. and taking into account past research results, both positive and negative, national and international	Resource allocation to commodities; Index value % research personnel/commodity research program. (state whether planned or actual)	Yes	

CAMEROON — HIGHLAND MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***1.2*** Effective communication of NARS needs and acquisition of resources.			
	Questions:			
	Does NARS receive an adequate level of funding from Government?	Research budget as % of Ag. GDP.	No .34%	CDSS/ISNAR Report
	Does NARS receive the types and levels of funding requests from donors?	Funding level/request		CDSS
	Does NARS effectively coordinate donor-financed research activities?	Mechanisms: - Formal, timely meetings - New project starts based on NARS priorities - New project starts outside of NARS priorities	 Yes Yes	
	Does NARS initiate the identification of donor-financed activities?	Y/N	Yes	
	1.3 Effective external (international) linkages			
	Questions:			
	Does NARS have formal linkages with IARCs, international private sector research or agri-business? With whom and what type?	List and describe: 1 point each a) technology exchange; b) training; c) networking; d) consultation Maximum: 4 points	4	
	1.4 Effective internal (national) linkages			
	Questions:			
	Does NARS have formal linkages with MOA/EXT, other relevant ministries, universities, development projects, local agri-business, private sector research organizations? With whom and of what type?	List and describe: 1 point each: a) Priority setting process b) NARS board membership c) Training d) Technology exchange e) Contract research (in & out) f) NARS representation on other boards Maximum: 6 points		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.5*** Monitoring of impact-level indicators by parent ministries			
	Questions:			
	Who is responsible for baseline and time series data collection on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc.?	List by function/data type.		MINAGRI, Development Agencies
	What data currently exist?			
	Are data readily exchanged?	Inventory data sets		
		Identify users for each data set.		
	1.6 Human resource management			
	Questions:			
	Does NARS have a personnel database	Y/N	Yes	
	Does a NARS manpower training plan exist?	Y/N	Yes	
Swanson #8	Is there an adequate career incentive structure to recruit & retain qualified staff?	- Operating budget/researcher		
		- Scheme of service for researchers? Y/N	Yes	
		- Annual attrition rate	Low	
		- # of vacancies	Low	
		- Proportion of support staff to research & technical staff	20:1	ISNAR (questionable)
	2.0 Intervening Variables			
	2.1 Agricultural Policies			
	Questions:			
	Does NARS have a role in input & output price policy development?	Y/N Input policy Output policy		
	Does FX policy favor ag. sector?	- Special rates for ag. export/ import licensing; Y/N	No	
		- FX readily available for input imports? Y/N	Yes	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	2.2 Extension services			
	Questions:			
	What priority is given to extension? Who carries out extension activities?	% Ag. GDP to extension List		World Bank Sector Study
	Extension salaries comparable to research salaries of equivalent levels?	Y/N	Yes	
	How effective is extension?	3 = highly effective; 2 = moderately effective; 1 = marginally effective (subjective observation)	2 = Dev. Agencies 1 = MINAGRI	Farmer surveys T&V report Observation Interviews
George?	Is there an adequate career incentive structure to recruit and retain qualified staff?	- Operating budget/extension officer - Annual attrition rate - # of vacancies		

CAMEROON — HIGHLAND MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***B. At NARS Institute and Program levels***			
	1.0 Research program planning and management			
	1.1 Development of long-term research plan			
	Questions:			
	Does institute have a long-term research plan?	Y/N	Yes	IRA Action Plan
	Do farmer orgs. participate in plan formulation?	Y/N farmer org. index	No	
Swanson #5, 2	Does the plan articulate priorities and resource allocations by commodities/factors?	Y/N	Yes	
	Does it include projections for manpower, infrastructure and operating funds?	Y/N	Yes	
	1.2 Development of a program structure			
	Questions:			
	Does institute have a program structure which will effectively carry out the long-term research plan?	- Existence of national programs	Yes	NARP
	Are program leaders appointed?	Y/N	Yes	
Swanson #7 1 and 3	Are programs adequately staffed?	# researcher/program # technicians/researchers (ratio) # B.S., M.S., Ph.D/program	10 2 0, 8, 2 estimated	personnel database NARP ISNAR Indicators Series

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***1.3*** Program and budget			
	Questions:			
	Does institute have a short-term program and budget?	Y/N	Yes	
	Are farmers involved in determining progams?	Farmer orgs. represented	Yes	
	Are programs based on constraints analysis?	Y/N	Yes	
	1.4 Monitoring and Evaluation (M&E)			
	Questions			
	How is research performance (efficiency) assessed?	- Active annual review process - # projects revised or cancelled	Yes, but ineffective No project system	
	How is research quality assessed?	- Peer or expert review - # projects redesigned	Poor	
	Who establishes baseline data for research programs?	- Socio-economic surveys used in divising proposal? - Baseline survey		
	Who collects program-level and institute-level data for evaluation?	Individual scientists, prog. directors; M&E system		
	What are career promotion criteria?	List: Publications, advanced degrees, collaboration with extension.	Publications, advanced degrees	
	What are criteria for pay increases?	Seniority, degree qualifications, etc.	Personnel evaluation	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***Questions:***			
	How effective is the flow of information between research and its clients: policy-makers, extension services, farmers and others?	Mechanisms: Board meetings, sessional papers, annual reports, meetings with farmer org., bulletins, mass media messages.		
	1.5 External communication			
	Do institute centers and programs have formal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agri-business organizations for problem identification, program formulation and execution?	List linkages: 1 point each a. problem definition b. investigation c. analysis d. evaluation Maximum: 4 points	Yes	
	With whom and of what type?			
	1.6 Internal communication			
	What formal linkages exist within institute, e.g. between programs, disciplines?	Multidisciplinarity: 1 point each a. Problem definition b. Investigation c. Analysis d. Evaluation Maximum: 4 points		Annual reports Interviews with program leaders
	How are multidisciplinary problems approached?		Through commodity progs.	
	Is NR mgt./sustainability incorporated into redesign? (indicate multidisciplinarity)	Cite examples: - Shift from chemical to biological pest control - Agroforestry research - Reduced proportion of inorganic to organic nitrogen sources	No but moving in that direction Yes	Annual reports Policy statements

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	**2.0 Financial Resource Management**			
	2.1 Acquisition of funds			
	Questions:			
	Are funds received by institute headquarters, stations and programs (1) in a timely way and (2) in adequate amounts?	- Date requested, date received; - Programs/projects halted for funding shortfalls (# & proportion) - # of researchers without funded projects	(1) No, not anymore (2) No	
	2.2 Funds disbursement			
	Questions			
	Do station and/or program heads have the delegation of authority necessary to permit a flexible yet accountable use of funds?	Y/N	Yes	
	Can funds be retained and carried over from one year to the next?	Y/N		
	2.3 Accounting			
	Questions			
	Are adequate accounting procedures and staff in place throughout the system?	FM system centralized Y/N No. of clearances required? Trained accountants at each center?	Yes Yes	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer	***A. For the Research System***	Confusion of levels here. Need to talk about A.I.D. project sources.		
	1.0 Intermediate results (outputs)			
	1.1 Training Opportunities			
	Questions			
(What are the quantity, quality and nature of the outputs of the research and extension system?)	What training is available for researchers, collaborators and clients?	# trained ST in-country ST abroad LT abroad (Past 3 years)	Yes	Personnel system data-base
	1.2 Progression of experimentation			
	Questions			
	Is research moving from strategic, to applied to adaptive research?	Proportion of research on-station, on-farm, being demonstrated (time series)	Not doable at NARS level	Annual reviews extension reports
	How much research is conducted on-farm?	Research reports - # of trials listed		Annual reports
	How much research has moved into the field testing & demonstration stages?	# technologies moved from on-farm trials to demonstration stage/ program		Extension reports
	1.3 Surveys and constraint analysis			
	Questions			
	What studies have been initiated/completed on characteristics and constraints at agro-ecological levels, provincial levels, among cultural groups, etc. for outputs and inputs.	# projects with constraints analysis included # other studies analyzed	All, but varies in qual. ?	
	How is this information to be used?	List: 1 point each - research project design - research program design - midcourse correction - impact evaluation Maximum: 4 points	 1 1 1 = 4 1	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. **Technology Generation & Transfer** (cont'd)	***1.4*** Interaction between research & extension			
(Swanson #10) modified	How do research & extension collaborate?	Nature, frequency of interaction Liaison officer? Y/N	Formally, annually Yes	
	How effective is this collaboration?	# jointly planned/implemented trials.	High, but at prog. level	
	What research methodologies have been developed/refined to encourage client participation in research planning, execution, and evaluation?	List: - Baseline surveys - Program-level or center-level planning meetings? - Field days - Annual workshops		
	What methods have been developed to monitor and evaluate technology transfer and adoption?	Committees, surveys, reports, on-farm research	Dev. Agencies do it in some areas	
	1.5 Responses to government requests for policy advice	- Sessional papers - Participation in policymaking bodies - Requests for advice	None	
	2.0 Conclusive results			
	2.1 Technologies developed/released			
	Questions			
	What new varieties have been developed tested, and released to clients? (i.e., extension, farmers, private sector research)?	# varieties released		NARS annual reports Extension reports
	What new technologies have been developed, tested and released to clients?	# of technologies recommended to extension	Agronomic tech. pkgs.	
	What recommendations have come out of commodity programs?	Proportion of programs that have released varieties or technologies		
	Has a "Menu" of technological choices been developed and offered to accommodate different systems and situations?	# of released varieties responding to low input vs. high input systems; # of techs with positive NR side effects, e.g., alley cropping, cut & carry, fodder, silage, zero-grazing	Yes	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	**2.2** Publications			
	Questions:			
	What scientific, technical and farmer-level publications have been produced?	List internal/external Level scientific technical farm level	 Few Many reports - not formal pubs Few	Annual reports Extension reports
	2.3 Inputs			
	Questions:			
Swanson #17	Are agricultural inputs (seed, fertilizers, pesticides, tools) available?	Distance from household to input supply point, # of sources of inputs - Credit given for inputs Y/N: in kind or in cash	 Yes - for some people	
	Are there subsectors w/o inputs?	Y/N - high, med, low potential Y/N - areas kg/ha	Yes Unclear	
	Are there times of the year when inputs are not available, more expensive?	Y/N - timely delivery; seasonal shortages; price fluctuations for fertilizer & seed.		
	How are inputs made available to resource-poor/farmers (e.g. small packaging, etc.)	# smallest units seed or fertilizer sold/# smallholder units	50 kg fertilizer small pesticides	
	2.4 Marketing infrastructure			
	Questions:			
	Are markets accessible to all producers? No	- regional price variations - status of rural roads (proportion of farm housholds within 10 km of paved road	Yes - high Poor Very low	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	***B. For the Extension System***			
	1.0 Research results/recommendations accepted and extended			
	Questions:			
Swanson #14.3	To what degree have research results been promoted by the extension service?	All recommendations Some No recommendations Why % recommendation promoted by extension	Some	T&V reports Liaison officer interviews Extension service reports
	To what extent does extension adopt researcher-recommended technologies?	All adopted Some None adopted Why	Some	
Swanson #12	How is adoption of recommendations tracked?	Tracking system exists Y/N Tracking system applied Y/N	Yes Yes	Liaison officer interviews Extension service reports
	2.0 Extension methodologies & Effectiveness			
	Questions:			
	What extension methodologies have been developed/refined to improve extension participation in research?	Ranked allocation of extension agent time in tech. generation and transfer activities	TLUs	T&V agent reports
Swanson #14.4 Swanson #14.5	What extension methodologies have been developed/refined to improve the extension-farmer linkage?	# of program changes based on feedback from extension	T&V	T&V on station or on-farm research program descriptions/evaluations
	What publications or other media mechanisms have been produced to inform farmers of research findings?	# of households with direct contact with extension agents (male vs. female-headed) # of new messages by type Actual samples	minikits, bulletins, radio, field days, memos	Extension audio visual department Annual extension reports

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	***C. Intervening Variables***			
	1.0 Markets			
	Questions:			
	1.1 Farm to market roads?	Average distance farm to market? Proportion transport cost of total cost (market prices)?	Meaning?	
		Farmgate vs. market prices		
	1.2 Does a market information system exist for commodities?	Y/N on radio in print media	No, not timely	Observation
	1.3 Are there price constraints for commodities?		Ceilings? Yes for some	
	1.4 Are there required marketing channels that must be used?		Not for food	
	1.5 Are there commodity marketing standards?		No	
	1.6 Are the recommended inputs available?		Sometimes	
	2.0 Storage and processing considerations		Vague	
	2.1 Is value added at household level for commodities examined?	Farm level profit & loss	Yes	Farm budgets by type of farm
	2.2 Proportion of post-harvest losses	Costs & returns at commodity level		
	2.3 Post harvest processing	Value added to commodities		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (Adoption & Beyond)	**1.0** Technology Utilization			
How can the adoption of technologies produced by the NARS be measured, and results used to forecast probable impact on the national economy?	**1.1** What % of farmers are using new technologies?	Adoption of technology stratified by farm size high, medium, low potential, male/female household head.	Tech specific	Project studies Extension service records, e.g. farm management unit. Special Studies
	1.2 Has total production increased in a commodity or region?	Production statistics; yield data; land use data by commodity & region. Production 1 area cultivated.		Central statistics office MOA statistics office Remote sensing data
	Have sales of fertilizer, seed, etc. increased? (Substitute relevant inputs/case study)	Sales records		Cooperative records Import/Export records
	Has there been a tech-related shift in crop mix?	Tech-related shift in crop mix short-term and long-term		National statistics office Remote sensing data
	2.0 Rural agro-industrial transformation			
	2.1 Has agro-industrial transformation occurred?	# of rural-based small enterprises by regions (female vs. male-owned) 10 workers or less? Unavailable Increased rural savings	Also include large industry e.g., MAIZECAM	MOA
	2.2 Has research/extension resulted in the formation or strengthening of farmer organizations?	- # organizations - # members	No	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (cont'd)	**3.0** Management of natural resource base			
	Questions:			
	3.1 Has NR management been an element of technology adopted?	Increased land cultivation (intensive vs. extensive) Proportion owned vs. rental land, security of access to land % top soil loss, salinization rate Sedimentation rate	No	
	4.0 Policy changes at sector level	Price policy; input policy; marketing policy	None	
IV. Impact How has investment in research influenced the economy of the country, in terms of incomes, productivity, production & food security (availability, access & adequacy)?	**1.0** Net farm income	1. Change in net farm income at national aggregate level in real terms. 2. Change in net farm income/ farm in real terms disaggregated by farm size male/female household heads 3. Changes in net farm income per AEPA	Not available	FAO yearbook World Bank reports Treasury reports
	2.0 Agricultural productivity **2.1** Has agricultural productivity increased by farm size, etc.	1. Change in value of prod/capita. 2. Change in value of production/ farm (EAPA, male/female). 3. Change in value of production/ farm by farm size. 4. Change in value of ag. production per hectare of agricultural land. 5. Change in value of ag. production by unit of ag. investment of credit for agriculture.		Central statistics offices, MOA, Treasury, Credit Bank, FAO nutrition statistics.

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact (cont'd)	**3.0** Food Security (national level)			
	3.1 What is the impact of ag. research on food security at the national level?	1. Change in per capita food production and consumption. 2. Change in ag. GDP (including non-food crops). 3. Change in % self-sufficiency in basic food commodities. 4. Variability in total annual ag. production. 5. Change in per capita food imports by value. 6. Change in annual carryover stocks of basic food stuffs (buffer stocks)	Not available	

MAIZE AGRONOMY/GAROUA

I. General Project Description

The maize agronomy research program is a component of the Cereals Agronomy Unit, based in Garoua, and is part of the National Cereals Research and Extension Project within the Ministry of Higher Education (MESRES). The Unit devotes most of its resources (70%) to maize, and places secondary emphasis on sorghum and millet.

The objectives of the maize agronomy research program are to: (a) develop improved and adaptable packages of agricultural practices for maize in the context of the different cropping systems used in the main maize-growing zones of North Cameroon; (b) evaluate the impact and interaction of the main climatic, soil, biotic, and management constraints on the production of maize and associated cropping systems and alleviate them; (c) participate in the extension of the improved agro-technologies in close cooperation with the agencies in charge of rural development; and (d) train national counterparts and technicians in agronomic field research. The research effort of the program has focused on the conservation and management of soil, water and fertilizer, cropping schemes, social and economic constraints to production (product palatability, credit, inputs, markets etc.), and the adaptability of technological packages generated in conjunction with the regional development agency and farmers.

The program has been in existence since 1982, and was developed to support crop diversification, improve food security and increase production of maize in a region traditionally dominated by cotton. The program is integrated with the development agency, SODECOTON, the cotton marketing parastatal which provides inputs (fertilizers, pesticides and seeds) and extension services to farmers. The maize agronomy program conducts on-station and on-farm agronomic research, demonstrations with farmers, and training of SODECOTON extension staff.

Due to the provision of inputs and markets, SODECOTON wields considerable power in the local economy. SODECOTON provides agricultural inputs on a credit basis, extracts promises of a percentage of land area planted to cotton (around 66%), and then subtracts loan balances from value of the cotton, maize, and peanuts it then buys from the farmer at harvest. Only farmers under contract with SODECOTON have access to their inputs, but these inputs are also utilized on maize and other crops. A consequence of the decline in world cotton prices and reduced GRZ subsidies on cotton supports has been a decline in land area planted in cotton and an increase in area in maize.

The maize agronomy program, although administratively independent of SODECOTON, is somewhat under its tutelage. The program develops its research workplan with considerable input from SODECOTON management in conjunction

with feedback from the SODECOTON extension agents. The maize agronomy program management concedes that this process requires considerable jawboning, but results in identifying specific technological needs and has worked well to date. The program also identifies farmer and extension agent training programs through participant input and perceived needs. The program invites review of on-station experiments by SODECOTON extension agents and requires that SODECOTON agents help in identifying locations, conducting, and analyzing on-farm experiments.

The maize agronomy program does not have an associated Testing and Liaison Unit (TLU) as do most of the other NCRE programs. However, with the extension capacity of SODECOTON and the strong leadership and integration of the maize agronomy program and SODECOTON, many aspects of the TLU model are essentially there. SODECOTON develops and provides to its extension agents, extension kits which are based on the agronomy program's results and recommmendations, which utilize both diagrammatical and written instructions of cultural practices including plant spacing, fertilizer amounts and placement, pesticide usage and optimal harvest maturity. The program identified the need for, and has extended, a very short season (60 days) corn variety, developed by the NCRE lowland maize breeding unit, to help farmers overcome the "hunger period" from April to August (the growing season for the cotton and majority of other food crops.) This has helped to improve labor efficiency on the remaining food and cotton crops.

The success of the maize agronomy program and its parent, the Cereals Agronomy Unit, has had benificial effects on SODECOTON. Diversification of the production area has increased the sale of seeds, fertilizers, herbicides, farm tools, and related equipment (small mills and shellers). The increase in area under maize production has also increased the effeciency of SODECOTON's extension effort and its mechanized industrial capacity.

II. Applying the Evaluation Framework

A. Introduction

The maize agronomy program is nestled within the Cereals Agronomy Unit (Garoua) in the NCRE project, which itself is in the structure of IRA and MESRES. The program workplan and activities are generally expected to fall within the national development strategy and the agricultural development plan. IITA, the implementing technical assistance contractor, has developed an increasingly supplementary role in the project as the educational and managerial level of Cameroonian staff has improved. Additionally, the transfer of a previously key player in the national program, Jacques Eckebil, to the IITA staff at Ibadan has further helped to augment the conceptual and managerial maturity of the national staff through the vested interest of this IITA relationship.

B. Level I Institutional Base

The initial development and success of the maize agronomy program has been dependent on the institutional base established at the national and ministerial levels. The answers to questions regarding the presence of agricultural development plans and research policy with periodic

review at the national level are all affirmative. The national government played a leading role in the conceptual development of the project design and has maintained an active role in both project implementation policy and modification of priorities as economic conditions have changed and research results have provided information concerning the cost-effectiveness of research on certain commodities (i.e. rice).

C. Level II Technology Generation

Information concerning Level II indicators is readily available. The Cereals Agronomy Unit chief at Garoua, Dr. Henri Talleyrand, requested and received training in communication skills following a rather grilling interview from an A.I.D. officer early on in the project. Since that time, documentation of technology generation, inter- and intra-institutional collaboration, training, on-farm trials, farmer feedback and farmer adoption rates has been made, compiled, and graphically displayed with bulletin boards of figures and photographs, brochures, Cameroon Television interviews, experiment reports and inclusions in NCRE annual reports. In addition to the above-mentioned public relations-oriented approach, technically oriented data is available that covers the wide range of the programs activities which is disaggregated by crops (and crop mix), varietal trials, cultural practices, geographical regions, collaborators, training programs, technologies recommended, technologies actually extended, and farmer feedback surveys.

The collaborative nature and integration of the program with SODECOTON, provides continual informal appraisal of the technology generation and transfer process. Research objectives, training activities and extension techniques concerning the technology generation and extension process may also be reviewed more formally at a semi-annual work-plan review the Cereals Agronomy Unit conducts with SODECOTON.

D. Level III Intermediate Impact Indicators

Indicators of technology adoption are only marginally within the mandate of the maize agronomy program or the Cereals Agronomy Unit. The Cereals Agronomy Unit does document results of on-farm trials, but documentation of adoption and diffusion is considered to fall with the extension service of SODECOTON. SODECOTON has detailed information on cultural practices, fertilizer usage, and yield data that can be disaggregated by year, age, gender, and farm size, due to its need to forecast yields and monitor repayments of input credits. Farmers outside of the SODECOTON program may still (and probably do) use seeds, fertilizers (resold by participating members), and the associated technologies developed in conjunction with the maize agronomy program; however, documentation is not available.

Management of the natural resource base has not been an overriding issue in the development of technology outside of the general awareness of the necessity for sustainable agricultural technology. The agronomic sustainability of the natural resource base generally requires more time to evaluate than economic sustainability, because additive effects of a degenerating process may not become agronomically apparent until after numerous cropping cycles (soil fertility and structure degradation). Due to the nature of the environment (the amount and distribution of rainfall), and the marketing structure of SODECOTON, crop

rotations on a large portion of the cultivated land are generally limited to cotton, a cereal grain (maize, sorghum or millet), cowpeas and peanuts. Awareness and attention to the problems associated with natural resource base management are being made in the design of Phase III of the NCRE project.

E. Level IV Impact

Impact in the region covered by the maize program and SODECOTON is documented. SODECOTON has reported increases in the number of maize farmers, total maize area (132%), total maize production (394%), total income from maize (394%), yield per hectare (113%), increase in farmer income (113%) and better nutrition for the farm family. Additionally the price of maize in the North Province has not collapsed (although prices do fluctuate seasonally) following these large increases in production, indicating that the maize is moving into other regions of the country.

INTERMEDIATE IMPACT INDICATORS MATRIX

CAMEROON — MAIZE/GAROUA

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base	***A. At national/ministerial level***			
Does NARS have institutional structures & management mechanisms which will permit all critical functions of a research system to be effectively carried out?	**Manageable interests of Parent Ministry and Institute**			
	1.0 Development of national research policy as it relates to national development policy.			
	Questions:			
	Does the country have an agricultural development plan?	Y/N	Yes	Minagi (Ministry of Ag.)
	Does the country have a research policy?	Y/N	Yes	Meares (Ministry of Scientific Research and Higher Education)
	Who monitors the continued concordance of research and development policies?	Name body		
	1.1 NARS priorities articulated according to research policy and resource requirements defined based on iterative planning exercises.			
	Questions:			
	What process exists for setting research priorities and allocating resources? How does this process take into account:	Level of complexity of analysis: 0 = no formal priority setting method; 1 = congruence method; 2 = weighted criteria or other formal method.	0	
	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 need, distribution of benefits, political considerations, etc.			
Swanson #9:1 and/or 2	The probability and cost of research success, including national use of existing personnel, infrastructure, financial resources, etc. and taking into account past research results, both positive and negative, national and international	Resource allocation to commodities; Index value % research personnel/commodity research program. (state whether planned or actual)		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	**1.2** Effective communication of NARS needs and acquisition of resources.			
	Questions:			
	Does NARS receive an adequate level of funding from Government?	Research budget as % of Ag. GDP.	0.34%	CDSS
	Does NARS receive the types and levels of funding requests from donors?	Funding level/request		ISNAR IRA Report CDSS
	Does NARS effectively coordinate donor-financed research activities?	Mechanisms: - Formal, timely meetings - New project starts based on NARS priorities - New project starts outside of NARS priorities	 Yes Yes No	
	Does NARS initiate the identification of donor-financed activities?	Y/N	Yes	
	1.3 Effective external (international) linkages			
	Questions:			
	Does NARS have formal linkages with IARCs, international private sector research or agri-business? With whom: and what type?	List and describe: 1 point each a) technology exchange; b) training; c) networking; d) consultation Maximum: 4 points	All 4	
	1.4 Effective internal (national) linkages			
	Questions:			
	Does NARS have formal linkages with MOA/EXT, other relevant ministries, universities, development projects, local agri-business, private sector research organizations? With whom and of what type?	List and describe: 1 point each: a) Priority setting process b) NARS board membership c) Training d) Technology exchange e) Contract research (in & out) f) NARS representation on other boards Maximum: 6 points	 Yes Yes Yes Yes Yes Yes 6 points	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***1.5*** Monitoring of impact-level indicators by parent ministries			
	Questions:			
	Who is responsible for baseline and time series data collection on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc.?	List by function/data type.	Ag. Census	Minagi Government Development Agencies
	What data currently exist?			
	Are data readily exchanged?	Inventory data sets Identify users for each data set.		
	1.6 Human resource management			
	Questions:			
	Does NARS have a personnel database	Y/N	Yes	
	Does a NARS manpower training plan exist?	Y/N	No	
Swanson #8	Is there an adequate career incentive structure to recruit & retain qualified staff?	- Operating budget/researcher - Scheme of service for researchers? Y/N - Annual attrition rate - # of vacancies - Proportion of support staff to research & technical staff	Yes Low Low 0.55%	Questionable Data
	2.0 Intervening Variables			
	2.1 Agricultural Policies			
	Questions:			
	Does NARS have a role in input & output price policy development?	Y/N Input policy Output policy	No No	
	Does FX policy favor ag. sector?	- Special rates for ag. export/ import licensing; Y/N - FX readily available for input imports? Y/N	Yes Yes	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	2.2 Extension services			
	Questions:			
	What priority is given to extension? Who carries out extension activities?	% Ag. GDP to extension List		World Bank Ag. Ext. Sector Study
	Extension salaries comparable to research salaries of equivalent levels?	Y/N	Yes	
	How effective is extension?	3 = highly effective; 2 = moderately effective; 1 = marginally effective (subjective observation)		Farmer surveys1. Minagi T&V report Observation2. Dev. Agency Interviews
George?	Is there an adequate career incentive structure to recruit and retain qualified staff?	- Operating budget/extension officer - Annual attrition rate - # of vacancies	Unavailable	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***B. At NARS Institute and Program levels***			
	1.0 Research program planning and management		Yes	
	1.1 Development of long-term research plan			
	Questions:			
	Does institute have a long-term research plan?	Y/N	Yes	IRA Action Plan
	Do farmer orgs. participate in plan formulation?	Y/N farmer org. index	No	
	Does the plan articulate priorities and resource allocations by commodities/factors?	Y/N	Yes	
Swanson #5, 2	Does it include projections for manpower, infrastructure and operating funds?	Y/N	Yes	
	1.2 Development of a program structure			
	Questions:			
	Does institute have a program structure which will effectively carry out the long-term research plan?	- Existence of national programs	Yes	NARP
	Are program leaders appointed?	Y/N	Yes	
	Are programs adequately staffed?	# researcher/program # technicians/researchers (ratio) # B.S., M.S., Ph.D/program	10 2/11 (after training completed)	personnel database NARP ISNAR Indicators Series
Swanson #7 1 and 3				

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
i. **Institutional Base** (cont'd)	***1.3*** Program and budget			
	Questions:			
	Does institute have a short-term program and budget?	Y/N		
	Are farmers involved in determining progams?	Farmer orga. represented		
	Are programs based on constraints analysis?	Y/N	Yes	
	1.4 Monitoring and Evaluation (M&E)			
	Questions			
	How is research performance (efficiency) assessed?	- Active annual review process - # projects revised or cancelled	Poorly	
	How is research quality assessed?	- Peer or expert review - # projects redesigned	Poorly	
	Who establishes baseline data for research programs?	- Socio-economic surveys used in divising proposal? - Baseline survey	evelopment Agencies	Development Agencies
	Who collects program-level and institute-level data for evaluation?	Individual scientists, prog. directors; M&E system		
	What are career promotion criteria?	List: Publications, advanced degrees, collaboration with extension.	Personnel evaluation	
	What are criteria for pay increases?	Seniority, degree qualifications, etc.	Pub personnel	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***Questions:***			
	How effective is the flow of information between research and its clients: policy-makers, extension services, farmers and others?	Mechanisms: Board meetings, sessional papers, annual reports, meetings with farmer org., bulletins, mass media messages.		
	1.5 External communication			
	Do institute centers and programs have formal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agri-business organizations for problem identification, program formulation and execution?	List linkages: 1 point each a. problem definition b. investigation c. analysis d. evaluation Maximum: 4 points	Yes 4	
	With whom and of what type?			
	1.6 Internal communication			
	What formal linkages exist within institute, e.g. between programs, disciplines?	Multidisciplinarity: 1 point each a. Problem definition b. Investigation c. Analysis d. Evaluation Maximum: 4 points	4	Annual reports Interviews with program leaders
	How are multidisciplinary problems approached?		By commodity	Annual reports Policy statements
	Is NR mgt./sustainability incorporated into redesign? (indicate multidisciplinarity)	Cite examples: - Shift from chemical to biological pest control - Agroforestry research - Reduced proportion of inorganic to organic nitrogen sources	Yes Yes Not relevant	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	**2.0 Financial Resource Management**			
	2.1 Acquisition of funds			
	Questions:			
	Are funds received by institute headquarters, stations and programs in a timely way and in adequate amounts?	- Date requested, date received; - Programs/projects halted for funding shortfalls (# & proportion) - # of researchers without funded projects	No	
	2.2 Funds disbursement			
	Questions			
	Do station and/or program heads have the delegation of authority necessary to permit a flexible yet accountable use of funds?	Y/N	Yes	
	Can funds be retained and carried over from one year to the next?		Don't know	
	2.3 Accounting	Y/N		
	Questions			
	Are adequate accounting procedures and staff in place throughout the system?	FM system centralized Y/N No. of clearances required? Trained accountants at each center?	Yes Chief of Center Yes	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer	***A. For the Research System***			
	1.0 Intermediate results (outputs)			
	1.1 Training Opportunities			
	Questions			
(What are the quantity, quality and nature of the outputs of the research and extension system?)	What training is available for researchers, collaborators and clients?	# trained ST in-country ST abroad LT abroad (Past 3 years)	Yes Yes Yes	Personnel system data-base
	1.2 Progression of experimentation			
	Questions			
	Is research moving from strategic, to applied to adaptive research?	Proportion of research on-station, on-farm, being demonstrated (time series)	Yes	Annual reviews extension reports
	How much research is conducted on-farm?	Res arch reports - # of trials listed		Annual reports
	How much research has moved into the field testing & demonstration stages?	# technologies moved from on-farm trials to demonstration stage/ program		Extension reports
	1.3 Surveys and constraint analysis			
	Questions			
	What studies have been initiated/completed on characteristics and constraints at agro-ecological levels, provincial levels, among cultural groups, etc. for outputs and inputs.	# projects with constraints analysis included # other studies analyzed	a lot All but varies in quality	
	How is this information to be used?	List: 1 point each - research project design - research program design - midcourse correction - impact evaluation Maximum: 4 points	 1 1 1 1	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. **Technology Generation & Transfer** (cont'd)	***1.4*** Interaction between research & extension			
	How do research & extension collaborate?	Nature, frequency of interaction Liaison officer? Y/N	Formal annual meeting Yes	
	How effective is this collaboration?	# jointly planned/implemented trials.	High	
(Swanson #10) modified	What research methodologies have been developed/refined to encourage client participation in research planning, execution, and evaluation?	List: - Baseline surveys - Program-level or center-level planning meetings? - Field days - Annual workshops	 1 1 1 1	
	What methods have been developed to monitor and evaluate technology transfer and adoption?	Committees, surveys, reports, on-farm research	Subjective Development Agency	
	1.5 Responses to government requests for policy advice	- Sessional papers - Participation in policymaking bodies - Requests for advice	None	
	2.0 Conclusive results			
	2.1 Technologies developed/released			
	Questions			
	What new varieties have been developed tested, and released to clients? (i.e., extension, farmers, private sector research)?	# varieties released	Available	NARS annual reports Extension reports
	What new technologies have been developed, tested and released to clients?	# of technologies recommended to extension	Available in Development Agency Areas	
	What recommendations have come out of commodity programs?	Proportion of programs that have released varieties or technologies		
	Has a "Menu" of technological choices been developed and offered to accommodate different systems and situations?	# of released varieties responding to low input vs. high input systems; # of techs with positive NR side effects, e.g., alley cropping, cut & carry, fodder, silage, zero-grazing	Yes	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	**2.2** Publications			
	Questions:			
	What scientific, technical and farmer-level publications have been produced?	List internal/external Level scientific technical farm level	 Few A lot Few	Annual reports Extension reports
	2.3 Inputs			
	Questions:			
Swanson #17	Are agricultural inputs (seed, fertilizers, pesticides, tools) available?	Distance from household to input supply point, # of sources of inputs - Credit given for inputs Y/N: in kind or in cash		
	Are there subsectors w/o inputs?	Y/N - high, med, low potential Y/N - areas kg/ha	Yes	
	Are there times of the year when inputs are not available, more expensive?	Y/N - timely delivery; seasonal shortages; price fluctuations for fertilizer & seed.	Yes Unclear	
	How are inputs made available to resource-poor/farmers (e.g. small packaging, etc.)	# smallest units seed or fertilizer sold/# smallholder units	No fertilizer 50 kg sack	
	2.4 Marketing infrastructure			
	Questions:			
	Are markets accessible to all producers?	- regional price variations - status of rural roads (proportion of farm housholds within 10 km of paved road	Yes Low <1%	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. **Technology Generation and Transfer** (cont'd)	***B. For the Extension System***			
	1.0 Research results/recommendations accepted and extended			
	Questions:			
Swanson #14.3	To what degree have research results been promoted by the extension service?	All recommendations Some No recommendations Why % recommendation promoted by extension	Some	T&V reports Liaison officer interviews Extension service reports
	To what extent does extension adopt researcher-recommended technologies?	All adopted Some None adopted Why	Some	
Swanson #12	How is adoption of recommendations tracked?	Tracking system exists Y/N Tracking system applied Y/N	Yes Yes	Liaison officer interviews Extension service reports
	2.0 Extension methodologies & Effectiveness			
	Questions:			
	What extension methodologies have been developed/refined to improve extension participation in research?	Ranked allocation of extension agent time in tech. generation and transfer activities	TLV-TV	T&V agent reports
Swanson #14.4 Swanson #14.5	What extension methodologies have been developed/refined to improve the extension-farmer linkage?	# of program changes based on feedback from extension	TV	T&V on station or on-farm research program descriptions/evaluations
	What publications or other media mechanisms have been produced to inform farmers of research findings?	# of households with direct contact with extension agents (male vs. female-headed) # of new messages by type Actual samples	Kits Bulletins Field days	Extension audio visual department Annual extension reports

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. **Technology Generation and Transfer** (cont'd)	C. ***Intervening Variables***			
	1.0 Markets			
	Questions:			
	1.1 Farm to market roads?	Average distance farm to market? Proportion transport cost of total cost (market prices)?	Ridiculous question	
		Farmgate vs. market price		
	1.2 Does a market information system exist for commodities?	Y/N on radio in print media	No	Observation
	1.3 Are there price constraints for commodities?			
	1.4 Are there required marketing channels that must be used?		No	
	1.5 Are there commodity marketing standards?		No	
	1.6 Are the recommended inputs available?		Yes	
	2.0 Storage and processing considerations			
	2.1 Is value added at household level for commodities examined?	Farm level profit & loss	Yes	Farm budgets by type of farm
	2.2 Proportion of post-harvest losses	Costs & returns at commodity level		
	2.3 Post production processing	Value added to commodities		

CAMEROON — MAIZE/GAROUA

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (Adoption & Beyond)	1.0 Technology Utilization			
How can the adoption of technologies produced by the NARS be measured, and results used to forecast probable impact on the national economy?	1.1 What % of farmers are using new technologies?	Adoption of technology stratified by farm size high, medium, low potential, male/female household head.		Project studies Extension service records, e.g. farm management unit. Special Studies
	1.2 Has total production increased in a commodity or region?	Production statistics; yield data; land use data by commodity & region. Production 1 area cultivated.		Central statistics office MOA statistics office Remote sensing data
	Have sales of fertilizer, seed, etc. increased? (Substitute relevant inputs/case study)	Sales records		Cooperative records Import/Export records
	Has there been a tech-related shift in crop mix?	Tech-related shift in crop mix short-term and long-term		National statistics office Remote sensing data
	2.0 Rural agro-industrial transformation			
	2.1 Has agro-industrial transformation occurred?	# of rural-based small enterprises by regions (female vs. male-owned) 10 workers or less? Increased rural savings	Maize, corn	MOA
	2.2 Has research/extension resulted in the formation or strengthening of farmer organizations?	- # organizations - # members	No organizations	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. **Intermediate Impact Indicators** (cont'd)	**3.0** Management of natural resource base			
	Questions:			
	3.1 Has NR management been an element of technology adopted?	Increased land cultivation (intensive vs. extensive) Proportion owned vs. rental land, security of access to land % top soil loss, salinization rate Sedimentation rate	No	
	4.0 Policy changes at sector level	Price policy; input policy; marketing policy	No	
IV. **Impact** How has investment in research influenced the economy of the country, in terms of incomes, productivity, production & food security (availability, access & adequacy)?	**1.0** Net farm income	1. Change in net farm income at national aggregate level in real terms. 2. Change in net farm income/ farm in real terms disaggregated by farm size male/female household heads 3. Changes in net farm income per AEPA		FAO yearbook World Bank reports Treasury reports
	2.0 Agricultural productivity			
	2.1 Has agricultural productivity increased by farm size, etc.	1. Change in value of prod/capita. 2. Change in value of production/ farm (EAPA, male/female). 3. Change in value of production/ farm by farm size. 4. Change in value of ag. production per hectare of agricultural land. 5. Change in value of ag. production by unit of ag. investment of credit for agriculture.		Central statistics offices, MOA, Treasury, Credit Bank, FAO nutrition statistics.

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. **Impact** (cont'd)	**3.0** Food Security (national level) **3.1** What is the impact of ag. research on food security at the national level?	1. Change in per capita food production and consumption. 2. Change in ag. GDP (including non-food crops). 3. Change in % self-sufficiency in basic food commodities. 4. Variability in total annual ag. production. 5. Change in per capita food imports by value. 6. Change in annual carryover stocks of basic food stuffs (buffer stocks)	Not available	

ANNEX F

MALAWI

CASE NARRATIVES AND COMPLETED INTERMEDIATE IMPACT INDICATOR MATRICES

1468-050/2ND

By 1980 the DAR had established 11 research stations, 9 experimental stations and 220 experimental sites. This research network proved to be very expensive to operate with more than 60% of the funds being spent on administrative costs, leaving very little for the research programs. This situation was reviewed by ISNAR (1982), IADS (1983) and it was decided to reorganize the DAR and reduce the research network to 4 research stations, 7 experimental stations and 14 substations. Research activities were then organized into 7 multidisciplinary research/technical Commodity teams of which the Maize Commodity Research Team is one. The Maize Commodity Research Team is led by a National Research Coordinator (NRC) who is a senior maize breeder at the Chetedzi Research Station. Current CRT staff include one senior maize breeder and commodity team leader (CTL), a senior MSc maize breeder, a MSc maize breeder, 3 maize agronomists (1 MSc and 2 BSc), 5 Field Officers (Diploma holders), and 4 Senior Field Assistants -- Table (1).

TABLE (1)

DISTRIBUTION OF DAR RESEARCH SCIENTISTS BY DISCIPLINE

Discipline	Number of Scientists	% of Total
Soil Science	5	5.4
Soil Microbiology	2	2.1
Agronomy	29	31.4
Plant Breeding	12	13.0
Entomology	9	9.8
Plant Pathology	4	4.4
Seed Science	4	4.4
Farm Machinery	4	4.4
Animal Science	6	6.5
Statistics	3	3.3
Agroforestry	3	3.3
Agricultural Economics	11	12.0
Total	92	100.0

MALAWI - MAIZE

GENERAL DESCRIPTION

Background:

White maize is the most important cereal and food crop in Malawi. It is the dietary staple of over 90% of the population, with an annual consumption of 225 - 250 kg. per capita annually. Maize is produced on roughly 1.2 million ha, primarily by small holders on approximately 70% of the cultivated area of customary lands. A small amount of maize is produced on estate lands. Hard endosperm varieties are essential given farmers' storage methods, processing techniques and dietary preferences.

Approximately 60-70% of maize is grown in intercropped systems with various crops, including groundnuts, common beans, pigeon peas, cowpeas, chickpeas, pumpkins, sweet potatoes, cassava and sorghum. Smallholders produce 90% of the country's maize, and generally use few purchased inputs. Fertilizers often are applied only as a topdress at rates considerably lower than recommended. Crop management (planting dates, weeding and plant spacing) is not optimal. The majority of maize planted (roughly 93%) is local hard endosperm (flint varieties); the remaining portion represents improved composites (2%) and hybirds (5%). National production statistics are generated from annual crop yield estimates originating from the block level of each Agricultural Development Division (ADD) and then being compiled for a national production summary in the Ministry of Agriculture (MOA). Because it is difficult to account for smallholder home consumption, it is estimated that average maize yields in Malawi are around 1 mt/ha. Yields for estate production and for well managed, high input smallholder production are higher. Experiment station yields range from 4 mt/ha for local varieties and 11 mt/ha for improved materials. This represents a gap of approximately 69% between the potential yield of currently available varieties and the national average yield.

Maize research is conducted under the auspices of the Department of Agricultural Research (DAR) under the leadership of the Chief Agricultural Research Officer (CARO). The DAR was organized around 1949. Prior to 1949 all agricultural research was the responsibility of the Department of Agriculture. The DAR was predominately staffed by expatriate staff up to 1965 when 50% of the staff were Malawian and 50% were expatriates. Out of the 18 Malawians in the DAR only 6 were graduates with a BSc degree in 1965. By 1972, there were 43 Malawians out of the 66 DAR staff, but only 11 were graduates (only one with a Ph.D. degree) out of 43 local staff. The increase in local staff at this time was due to the returning graduates from abroad that were sent overseas at Independence and to graduates from the University of Malawi, (Bunda College of Agriculture in particular, which was established in 1965). In 1986 there were 80 research scientists with degrees out of which 75 were local scientists and 5 were expatriates. The percentage of research scientists with the MSc or Ph.D. qualifications was rather low at only 26%. As of December, 1989 there were 9, 43, and 38 Malawian research scientists with the Ph.D., MSc, and BSc degrees respectively. The distribution of DAR researchers by major discipline is summarized in Table (1).

TABLE (2)

DISTRIBUTION OF MAIZE RESEARCH SCIENTISTS BY DISCIPLINE

Name	Degree	Field	Assignment
B. T. Zambezi	PhD	Plt Breeding	CRT, Chetedzi
W. G. Nhlane	MSc	Plt Breeding	Sr. Maize Brdr., Chetedzi
E. M. Sibale	MSc	Plt Breeding	Maize Breeder, Chetedzi
N. E. Nyirenda	BSc	Agronomist	Seconded to Estate Ext.
J. D. Kumwenda	PhD	Agronomist	Chetedzi
V. H. Katambe	MSc	Agronomist	Chetedzi
M. H. Gausi	Dip. Agri.	Field Officer	Chetedzi
G. Nkhono	Dip. Agri.	Field Officer	Chetedzi
P. E. Mwenda	Dip. Agri.	Field Officer	Chetedzi
E. G. Minjale	Dip. Agri.	Field Officer	Chetedzi
E. J. Chimaliro	Dip. Agri.	Field Officer	Chetedzi
A. C. Kafwafwa	Cert. Agri. Sr.	Field Asst.	Chetedzi
W. Njobvuyalema	Cert. Agri. Sr.	Field Asst.	Chetedzi
M. A. Chatupa	Cert. Agri. Sr.	Field Asst.	Chetedzi
J. D. Njunga	Cert. Agri. Sr.	Field Asst.	Chetedzi
S. W. Jalil	Cert. Agri.	Field Asst.	Chetedzi
C. T. Namagowa	Cert. Agri.	Field Asst.	Chetedzi
F. E. Kambadya	Cert. Agri.	Field Asst.	Chetedzi
M. O. Baluti	Cert. Agri.	Field Asst.	Chetedzi

Development of the maize research program has been assisted by the following projects:

USAID Malawi Agricultural Research Project, 1980-1985
USAID Malawi Agricultural Research & Extension Project, 1985-1990
World Bank National Rural Development Program (NRDP), 1978-1996.
Rockefeller Foundation, 1989-1999

Assistance included training, infrastructure development, provision of agricultural inputs, research operations assistance, technical assistance, and strengthening of extension, credit and marketing services.

Goal and Objectives:

The goal of the 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 (even eliminate) dependence on imported food and industrial crops.

The objectives of the Maize Commodity Research Group are:

- To breed for high yield, grain quality and disease resistance in both short and long-season white seeded maize varieties.

- To develop and maintain a germplasm bank with materials of diverse origin.

- To develop varieties tolerant to drought and heat for drought prone areas, e.g., Shire Valley floor and other marginal areas.

- To collaborate with foreign institutes and international research firms/organizations involved in maize, e.g., CIMMYT, SARMEIT, CIBA/GEIGY and Cargill.

- To maintain and multiply breeders' seed for large scale production.

- To determine the most suitable varieties for each area of production, e.g., high altitude and low altitude.

- To determine the best cultural methods to sustain optimum yields with economic input levels, e.g., fertilizer types, rates and times of application, use of organic manure, weed control, methods of land preparation, time of planting, plant spacing and density of new varieties, and intercropping systems for both farmer's conditions.

- To determine the status of the various maize diseases in the country and their distribution, the epidemiology of maize streak virus, the economic importance of cob rots and also to evaluate the various maize varieties in Malawi against maize streak virus and to investigate methods for Helminthosporium sp.

- To evaluate striga control methods.

In addition to research input, the maize commodity group has linkages with the adaptive research commodity group and the adaptive research commodity teams assigned to each Agricultural Development Division (ADD).

Program Evolution:

Research on the improvement of maize in Malawi has been carried out at varying degrees of emphasis over the past 75 years but maize research, as it is known today, was not initiated until 1949. In the period prior to 1950, the main thrust of agricultural research was to support export crops. The Chetedzi Research Station, formerly known as the Agricultural Research Station, was also responsible for all maize research. This included work on varietal improvement, agronomy, and plant protection. Early researchers recognized the fact that Malawians preferred "flint maize" to "dent maize" because it stored better and produced a higher proportion of white flour. In 1954 the Chetedzi station collected maize from all parts of the country to increase the scope of materials available for breeding, to classify botanically the local varieties and to gain information on the probable origin of maize which was being grown. Breeding activities at that time were geared to developing hybrids and synthetic maize varieties. Germplasm lines were introduced from South Africa, Southern Rhodesia (Zimbabwe), the U.S.A.,

and East Africa (EAAFRO) to augment local collections. No effort was made to develop a flint maize hybrid or composite at that time. All efforts were concentrated on the high yielding dent hybrids and synthetics. Prior to 1970, the varieties LH7 (Mthenga), LH11 (Bingo), SV37, SV17, SV Mionda and SV26 were released from the Chetedzi Research Station maize improvement program. In 1970 the breeding strategy was changed to breeding for composite varieties and screening of Zimbabwean and South African hybrids. This work culminated in the release of SR52, R200 and R201 in the early 1970's plus the first composite maize varieties UCA and CCA in 1974. From 1974 to 1986 the maize breeding objectives were to develop high yielding hybrids to replace SR52, whose seed was imported from Zimbabwe at a high cost. These efforts have resulted in the release of the hybrid MH12 in 1977, which replaced SR52, and the hybrids, MH15, MH16 and NSCM41 together with the composite Tuxpeno 1. The following hybrids and composites are available from the National Seed Company of Malawi as of January, 1990:

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

Though Maize research has a long history in Malawi and various variety and management technologies have been developed and recommend, the adoption of these improved technologies by small holders has been limited. The reasons for this are complex but some of the more obvious constraints (which have been identified by the DAR and ADDs) are as follows:

- Lack of improved flint (hard endosperm) genetic materials for use by the smallholders. The flint materials when processed by traditional methods produce a higher yield of acceptable maize flour for nsima (the traditional maize dish prepared by smallholder families. In addition, the flint varieties have better storing qualities and are not as susceptible to insect damage under smallholder storage conditions).

- Poor access to inputs, (e.g., credit, improved seed, fertilizer and other inputs which may be necessary for improved production).

- Pricing policy. Farm gate prices do not encourage investment by smallholders in improved inputs. As most maize is consumed by the smallholder family, they do not grow maize as a cash crop.

- Production inputs often are not available to the smallholder in a timely manner which is a constraint to good production management practices.

- Inadequate transportation to market centers in remote areas.

Despite these constraints, the small farmer has demonstrated his willingness to adopt new technologies of higher value cash crops (small holder tobacco allotments, small holder tea projects, small holder self help

rice production schemes) which will add to the family income but will not grow maize as a cash crop because it is not profitable.

Applying the Framework:

The maize research program has been well integrated into the national agriculture research program since the late 1940s when the present Department of Agricultural Research was organized. The testing of the evaluation framework developed at the early stage of this Agricultural Research Evaluation Methods and Impact Indicators project is appropriate. The Kenya Team tested the framework which was relatively successful in predicting impact of the selected research programs. The Cameroon team also found data to support the indicators and developed additional indicators which, together with those of the Kenya team, were tested in Malawi. The Malawi Team developed additional indicators which were deemed appropriate. They are: (a) tracking staff development to verify that their training was being appropriately utilized and (b) whether the national research program is well enough developed to where expatriate assistance can be assigned to operate effectively under the leadership of host country program leaders.

Level I: Institutional Base

The NARS does operate under an institutional and policy environment which provides for the appropriate institutional structures and management mechanisms which allow critical research of the maize program to be carried out. The GOM Statement of Development Policies (1987-1996) provides the umbrella under which the DAR's Agriculture Research Master Plan can be implemented.

The maize research program is only a part of a well integrated plan. However, it is the most important food crop in the country and occupies the largest land area. Thus it does require special attention in conjunction with those research areas designed to improve production in a manner compatible with conserving and improving the natural environment and at the same time addressing problems which impede improvement of small landholder families.

With the development of the Agricultural Research Master Plan, the DAR is well structured to effectively communicate its resource needs but because of the many development sector needs of the country, and constraints such as being land locked and closed-off from seaports access due to the Mozambique's civil war, the GOM has been forced to place agricultural research as a lower funding priority. However, the Ministry of Agriculture has been very effective in articulating its needs in proposals to the donor community and working with the donors in coordinating those activities to avoid duplication.

Recognizing that technology has been developed and is available for testing and adaptation, the DAR has actively pursued establishing linkages with the IARCs, developed linkages with national organizations, private sector international groups (Cargill) and other successful maize development organizations within the region. These relationships provide viable linkages for successful technology exchange, training, networking and consultation.

All evidence indicates that these linkages are valued highly and the resultant inputs are effectively being used.

The obvious gap between potential production output and what the small landholder is actually doing created the awareness within the MOA and the DAR for the need to develop a system of effective feedback which would elucidate the small farmers' actual technology needs. The donor inputs from USAID and the World Bank have been concentrating on the development and refining of these linkages as well as those with the small farmer, the extension service, and the adaptive research teams which feed into the research system. As might be expected, the first cut at establishing feedback mechanisms may not be perfect but is an excellent start.

Malawi appears to be a data-rich country. All of the ADDs collect and establish annual production data, estimates of area under cultivation, fertilizer usage, credit usage, and conservation measures implemented through the extension service each year. Each ADD funnels that information to the Ministry of Agriculture for collation and analysis at the national level. Each ADD is understaffed in the planning and evaluation area, as well as in the Ministry of Agriculture. But with computer technology and training for Malawi staff this area of data management should be on a continuous improvement curve.

Intervening variables to successful impact of research technologies create a complex environment that makes it difficult to balance and realize impact. Pricing policies for agricultural commodities, availability of agricultural inputs, marketing opportunities, and the impacts of international prices for goods and services are a few of the intervening variables that impact on the acceptance and implementation of the improved production technologies by small landholders. These are all issues with which the government is contending as it does its balancing act for developing the national economy and at the same time improving the well being of the mass of small landholders.

The institutional indicators in the matrix as applied to all of the commodity areas selected for review in our study were appropriate and not redundant. Assessment of the national situation against this mileau of information does provide excellent criteria for assessing whether or not the ingredients for successful agricultural research are in place.

Level II: Technology Generation and Transfer

According to the matrix, there are several categories of intermediate research outputs that affect the ultimate goal of research impact at the farmer level. These deal with: upgrading of professional staff and development training for non-professional staff; measuring research progression, and collecting baseline data information for target feedback interaction between the research organization and technology transfer organization levels. At the institutional level, is the research organization at work on relevant problems that present valid resource policy advice to the government in a timely manner?

The Malawi Government has been acutely aware of the shortage of trained professional agricultural scientists ever since independence. The University

of Malawi/ Bunda College, established in 1965 with the assistance of USAID, provides most of the essential physical institutional infrastructure for meeting the needs of domestic human resources. This has been the major source of BSc degree and diploma graduates for agriculture in the country since that time. Bunda graduates are recruited to fill positions throughout the country in the Department of Agriculture Research, the Department of Agriculture (agricultural services and extension) and the private sector. Graduates of the Natural Resources College, a certificate-granting institution, are mostly employed by the extension service. Starting in the 1960s the Government took advantage of donor assistance to send qualified government employees for MSc and PhD training in either the U.S. or Great Britain. Most recently, with the advent of the USAID agricultural research projects and the World Bank NRDP project, advanced technical training to the MSc and Ph.D. levels are being vigorously pursued. It has been reported that Bunda College will be opening a MSc course in agriculture in the near future. Malawi staff, who are managers, lack training in the management disciplines. The MOA is developing a long-range management training strategy to fill this gap.

There has been less advanced degree training for staff attached to the extension service both at headquarters and at the ADDs. ADD extension subject matter specialists do provide training for the RDP officers and in turn the RDP officers provide training programs for the EPA officers. These training activities usually are centered around the extension message that agents are expected to be sharing with farmers, e.g., proper cultural practices including spacing, correct varieties, weed control, intercropping and fertilizer usage.

With the implementation of the Research Master Plan, provisions are made for the Adaptive Research Commodity Team. The purpose of the ART is to test new technologies coming from the research program for appropriateness at the farmer level. The ART Commodity group works through the ADD's ART. There is evidence indicating that the existing arrangement is actually working, despite the fact that the ADD's ART work is prioritized through interaction with extension agents. Although ADD's ART is not responsible to the ART Commodity research team these linkages need to be strengthened. Both the Maize CRT and the Adaptive Research CRT are conducting adaptive and verification trials on farmer's fields. On the surface these activities are adequate and result in field testing of new varieties, fertilizer recommendations, and intercropping recommendations. These provide the extension service with materials for farm demonstrations.

The ADD's ARTs effectiveness in conducting surveys and developing baseline constraints analyses is questionable. It appears that their activities are being driven by feedback from the extension service. The role of the socio-economist on the ART should be to monitor and evaluate technology transfer and adoption. The best method appears to be the monitoring of credit packages which automatically carries current recommended practices. Cash sales of fertilizer and seed by variety may also provide some indication. But this is all indirect and does not provide any first hand farm level assessment. The role of the socio-economist, therefore, should be to help bridge this gap.

Since 1976 the DAR has released four new hybrids and two composite varieties of maize to the Malawi National Seed Company for seed multiplication and sale. That averages one new line every two years. If a flint hybrid is the largest constraint to increased production of maize, the DAR has become sensitized and is committing a large amount of its breeding resources to come up with a good flint hybrid and composites. It is estimated that a new flint hybrid will be available within four years. Currently, there is one hybrid (MH16) and one composite (CCA) which are considered to be semi-flints.

In addition to varietal releases, maize cultural practices have been developed and passed on to the DOA for dissemination to farmers. The DAR has passed on to the DOA recommendations for controlling stalk borer, intercropping spacing of maize with legumes, fertilizer use levels and the kinds of fertilizer appropriate under smallholder conditions. A menu of technological recommendations has not been developed.

Level III: Intermediate Indicators (Adoption and Beyond)

Currently, the most accurate measure of adoption and spread of the new varieties being released is through the credit package program with small holder credit clubs and through cash sales of improved seed. It is estimated that only about 10% of the small holders are using improved hybrid seed. The supposition is that when a new flint hybrid becomes available adoption will spread much faster. However, the Malawi National Seed Company seed sales indicates that new technology adoption is related to input costs and market price of grain. They have found that when market prices are favorable, sales increase dramatically. When prices are low, improved seed demand drops off dramatically. In all likelihood, other improved technologies will ride the coat tails of improved varieties. The extension service ties the sales of new seed to a package of practices. In the short run, this may be appropriate. Fertilizer sales can be tracked also. Here again, price is a significant determining factor. The annual crop surveys by the ADDs collect detailed information on crop practices, fertilizer usage, and yield data that can be disaggregated by year, gender and farm size.

Level IV: Impact

Based upon subjective estimates of area and yields of maize production by the ADDs, we cannot say that research output has made an impact on small farmholders. However, the estate farm holdings have responded to technological inputs and their average production levels exceed those of the national average. If one is to consider that in the face of declining fertility and natural resource base, then maybe there has been an impact because the national average has not dropped but remained at status quo.

Level V: Indicators

- Fertilizer usage
- Yield data
- Increased no 00% of hybrid (i.e., # farmers or acreage planted)

INTERMEDIATE IMPACT INDICATORS MATRIX

MALAWI — MAIZE

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base Does NARS have institutional structures & management mechanisms which will permit all critical functions of a research system to be effectively carried out?	***A. At national/ministerial level***		(Answers for Level I in next matrix.)	
	Manageable Interests of Parent Ministry and Institute			
	1.0 Development of national research policy as it relates to national development policy.			
	Questions:			
	Does the country have an agricultural development plan?	Y/N		
	Does the country have a research policy?	Y/N		
	Who monitors the continued concordance of research and development policies?	Name body		
	1.1 NARS priorities articulated according to research policy and resource requirements defined based on iterative planning exercises.			
	Questions:			
	What process exists for setting research priorities and allocating resources? How does this process take into account:	Level of complexity of analysis: 0 = no formal priority setting method; 1 = congruence method; 2 = weighted criteria or other formal method.		
	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 need, distribution of benefits, political considerations, etc.			
Swanson #9:1 and/or 2	The probability and cost of research success, including national use of existing personnel, infrastructure, financial resources, etc. and taking into account past research results, both positive and negative, national and international	Resource allocation to commodities; Index value % research personnel/commodity research program. (state whether planned or actual)		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.2*** Effective communication of NARS needs and acquisition of resources.			
	Questions:			
	Does NARS receive an adequate level of funding from Government?	Research budget as % of Ag. GDP.		
	Does NARS receive the types and levels of funding requests from donors?	Funding level/request		
	Does NARS effectively coordinate donor-financed research activities?	Mechanisms: - Formal, timely meetings - New project starts based on NARS priorities - New project starts outside of NARS priorities		
	Does NARS initiate the identification of donor-financed activities?	Y/N		
	1.3 Effective external (international) linkages			
	Questions:			
	Does NARS have formal linkages with IARCs, international private sector research or agri-business? With whom and what type?	List and describe: 1 point each a) technology exchange; b) training; c) networking; d) consultation Maximum: 4 points		
	1.4 Effective internal (national) linkages			
	Questions:			
	Does NARS have formal linkages with MOA/EXT, other relevant ministries, universities, development projects, local agri-business, private sector research organizations? With whom and of what type?	List and describe: 1 point each: a) Priority setting process b) NARS board membership c) Training d) Technology exchange e) Contract research (in & out) f) NARS representation on other boards Maximum: 6 points		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.5*** Monitoring of impact-level indicators by parent ministries			
	Questions:			
	Who is responsible for baseline and time series data collection on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc.?	List by function/data type.		
	What data currently exist?			
	Are data readily exchanged?	Inventory data sets Identify users for each data set.		
	1.6 Human resource management			
	Questions:			
	Does NARS have a personnel database	Y/N		
	Does a NARS manpower training plan exist?	Y/N		
Swanson #8	Is there an adequate career incentive structure to recruit & retain qualified staff?	- Operating budget/researcher - Scheme of service for researchers? Y/N - Annual attrition rate - # of vacancies - Proportion of support staff to research & technical staff		
	2.0 Intervening Variables			
	2.1 Agricultural Policies			
	Questions:			
	Does NARS have a role in input & output price policy development?	Y/N Input policy Output policy		
	Does FX policy favor ag. sector?	- Special rates for ag. export/ import licensing; Y/N - FX readily available for input imports? Y/N		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	2.2 Extension services			
	Questions:			
	What priority is given to extension?	% Ag. GDP to extension		
	Who carries out extension activities?	List		
	Extension salaries comparable to research salaries of equivalent levels?	Y/N		
George?	How effective is extension?	3 = highly effective; 2 = moderately effective; 1 = marginally effective (subjective observation)		Farmer surveys T&V report Observation Interviews

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	Is there an adequate career incentive structure to recruit and retain qualified staff?	- Operating budget/extension officer - Annual attrition rate - # of vacancies		
	B. At NARS Institute and Program levels			
	1.0 Research program planning and management			
	1.1 Development of long-term research plan			
	Questions:			
	Does institute have a long-term research plan?	Y/N		
Swanson #5, 2	Do farmer orgs. participate in plan formulation?	Y/N farmer org. index		
	Does the plan articulate priorities and resource allocations by commodities/factors?	Y/N		
	Does it include projections for manpower, infrastructure and operating funds?	Y/N		
	1.2 Development of a program structure			
	Questions:			
	Does institute have a program structure which will effectively carry out the long-term research plan?	- Existence of national programs		NARP
Swanson #7 1 and 3	Are program leaders appointed?	Y/N		
	Are programs adequately staffed?	# researcher/program # technicians/researchers (ratio) # B.S., M.S., Ph.D/program		personnel database NARP ISNAR Indicators Series

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	**1.3** Program and budget			
	Questions:			
	Does institute have a short-term program and budget?	Y/N		
	Are farmers involved in determining progams?	Farmer orgs. represented		
	Are programs based on constraints analysis?	Y/N		
	1.4 Monitoring and Evaluation (M&E)			
	Questions			
	How is research performance (efficiency) assessed?	- Active annual review process - # projects revised or cancelled		
	How is research quality assessed?	- Peer or expert review - # projects redesigned		
	Who establishes baseline data for research programs?	- Socio-economic surveys used in divising proposal? - Baseline survey		
	Who collects program-level and institute-level data for evaluation?	Individual scientists, prog. directors; M&E system		
	What are career promotion criteria?	List: Publications, advanced degrees, collaboration with extension.		
	What are criteria for pay increases?	Seniority, degree qualifications, etc.		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***Questions:***			
	How effective is the flow of information between research and its clients: policy-makers, extension services, farmers and others?	Mechanisms: Board meetings, sessional papers, annual reports, meetings with farmer org., bulletins, mass media messages.		
	1.5 External communication			
	Do institute centers and programs have formal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agri-business organizations for problem identification, program formulation and execution?	List linkages: 1 point each a. problem definition b. investigation c. analysis d. evaluation Maximum: 4 points		
	With whom and of what type?			
	1.6 Internal communication			
	What formal linkages exist within institute, e.g. between programs, disciplines?	Multidisciplinarity: 1 point each a. Problem definition b. Investigation c. Analysis d. Evaluation Maximum: 4 points		Annual reports Interviews with program leaders
	How are multidisciplinary problems approached?			
	Is NR mgt./sustainability incorporated into redesign? (indicate multidisciplinarity)	Cite examples: - Shift from chemical to biological pest control - Agroforestry research - Reduced proportion of inorganic to organic nitrogen sources		Annual reports Policy statements

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	2.0 **Financial Resource Management**			
	2.1 Acquisition of funds			
	Questions:			
	Are funds received by institute headquarters, stations and programs in a timely way and in adequate amounts?	- Date requested, date received; - Programs/projects halted for funding shortfalls (# & proportion) - # of researchers without funded projects		
	2.2 Funds disbursement			
	Questions			
	Do station and/or program heads have the delegation of authority necessary to permit a flexible yet accountable use of funds?	Y/N		
	Can funds be retained and carried over from one year to the next?	Y/N		
	2.3 Accounting			
	Questions			
	Are adequate accounting procedures and staff in place throughout the system?	FM system centralized Y/N No. of clearances required? Trained accountants at each center?		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer	***A. For the Research System***			
	1.0 Intermediate results (outputs)			
	1.1 Training Opportunities			
	Questions			
(What are the quantity, quality and nature of the outputs of the research and extension system?)	What training is available for researchers, collaborators and clients?	# trained ST in-country ST abroad LT abroad (Past 3 years)	9 PhD * 43 MSc * 38 BSc * * total degrees	Personnel system data-base
	1.2 Progression of experimentation			
	Questions			
	Is research moving from strategic, to applied to adaptive research?	Proportion of research on-station, on-farm, being demonstrated (time series)	—emphasis on-farm —adequate —(no #) extension service - Adaptive Res. Team	Annual reviews extension reports
	How much research is conducted on-farm?	Research reports - # of trials listed	# tech. transferred 1990 - 8 improved varieties available	Annual reports
	How much research has moved into the field testing & demonstration stages?	# technologies moved from on-farm trials to demonstration stage/ program		Extension reports
	1.3 Surveys and constraint analysis			
	Questions			
	What studies have been initiated/completed on characteristics and constraints at agro-ecological levels, provincial levels, among cultural groups, etc. for outputs and inputs.	# projects with constraints analysis included # other studies analyzed	—questionable effectiveness of surveys for constraint development —maize cultural practices have been developed and passed on to the DOA	
	How is this information to be used?	List: 1 point each - research project design - research program design - midcourse correction - impact evaluation Maximum: 4 points	1 1 ? 0	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. **Technology Generation & Transfer** (cont'd)	**1.4** Interaction between research & extension			
(Swanson #10) modified	How do research & extension collaborate?	Nature, frequency of interaction Liaison officer? Y/N	—Adaptive Research team - joint res. & extension —linkage needs strengthening —T&V system farmer block meetings to get feedback —M&E in each ADD	
	How effective is this collaboration?	# jointly planned/implemented trials.		
	What research methodologies have been developed/refined to encourage client participation in research planning, execution, and evaluation?	List: - Baseline surveys - Program-level or center-level planning meetings? - Field days - Annual workshops	—	
	What methods have been developed to monitor and evaluate technology transfer and adoption?	Committees, surveys, reports, on-farm research		
	1.5 Responses to government requests for policy advice	- Sessional papers - Participation in policymaking bodies - Requests for advice		
	2.0 Conclusive results			
	2.1 Technologies developed/released			
	Questions			
	What new varieties have been developed tested, and released to clients? (i.e., extension, farmers, private sector research)?	# varieties released	Since 1976 - 4 hybrids & 2 composite varieties	NARS annual reports Extension reports
	What new technologies have been developed, tested and released to clients?	# of technologies recommended to extension	—No menu of tech. recommendations —NR = yes hi input = yes National seed company: ADMARC	
	What recommendations have come out of commodity programs?	Proportion of programs that have released varieties or technologies		
	Has a "Menu" of technological choices been developed and offered to accommodate different systems and situations?	# of released varieties responding to low input vs. high input systems; # of techs with positive NR side effects, e.g., alley cropping, cut & carry, fodder, silage, zero-grazing		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	**2.2** Publications			
	Questions:			
	What scientific, technical and farmer-level publications have been produced?	List internal/external Level scientific technical farm level	Prior to 1970 - 6 hybrids & synthetic maize varieties As of 1990 - 8 hybrids & synthetic maize varieties	Annual reports Extension reports
	2.3 Inputs		—Y = in kind credit —Yes, low potential —Untimely & shortages, price fluctuation	
	Questions:			
Swanson #17	Are agricultural inputs (seed, fertilizers, pesticides, tools) available?	Distance from household to input supply point, # of sources of inputs - Credit given for inputs Y/N: in kind or in cash		
	Are there subsectors w/o inputs?	Y/N - high, med, low potential Y/N - areas kg/ha		
	Are there times of the year when inputs are not available, more expensive?	Y/N - timely delivery; seasonal shortages; price fluctuations for fertilizer & seed.		
	How are inputs made available to resource-poor/farmers (e.g. small packaging, etc.)	# smallest units seed or fertilizer sold/# smallholder units		
	2.4 Marketing infrastructure			
	Questions:			
	Are markets accessible to all producers?	- regional price variations - status of rural roads (proportion of farm housholds within 10 km of paved road)	hi promotion by extension adapted	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	***B. For the Extension System***			
	1.0 Research results/recommendations accepted and extended			
	Questions:			
Swanson #14.3	To what degree have research results been promoted by the extension service?	All recommendations Some No recommendations Why % recommendation promoted by extension	hi promotion by extension adapted to regional situation through extension reports & ART reports	T&V reports Liaison officer interviews Extension service reports
	To what extent does extension adopt researcher-recommended technologies?	All adopted Some None adopted Why		
Swanson #12	How is adoption of recommendations tracked?	Tracking system exists Y/N Tracking system applied Y/N		Liaison officer interviews Extension service reports
	2.0 Extension methodologies & Effectiveness			
	Questions:			
	What extension methodologies have been developed/refined to improve extension participation in research?	Ranked allocation of extension agent time in tech. generation and transfer activities	See Malawi beans except C.2.1 = Yes, recently C.2.3 = yes	T&V agent reports
Swanson #14.4 Swanson #14.5	What extension methodologies have been developed/refined to improve the extension-farmer linkage?	# of program changes based on feedback from extension		T&V on station or on-farm research program descriptions/evaluations
	What publications or other media mechanisms have been produced to inform farmers of research findings?	# of households with direct contact with extension agents (male vs. female-headed) # of new messages by type Actual samples		Extension audio visual department Annual extension re

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	C. *Intervening Variables*			
	1.0 Markets			
	Questions:			
	1.1 Farm to market roads?	Average distance farm to market? Proportion transport cost of total cost (market prices)?		
		Farmgate vs. market prices		
	1.2 Does a market information system exist for commodities?	Y/N on radio in print media		Observation
	1.3 Are there price constraints for commodities?		Yes	
	1.4 Are there required marketing channels that must be used?		Yes	
	1.5 Are there commodity marketing standards?			
	1.6 Are the recommended inputs available?		Sometimes	
	2.0 Storage and processing considerations		processing (milling) constraints)	
	2.1 Is value added at household level for commodities examined?	Farm level profit & loss		Farm budgets by type of farm
	2.2 Proportion of post-production losses	Costs & returns at commodity level		AGREDAT
	2.3 Post production processing	Value added to commodities		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (Adoption & Beyond)	1.0 Technology Utilization			
How can the adoption of technologies produced by the NARS be measured, and results used to forecast probable impact on the national economy?	1.1 What % of farmers are using new technologies?	Adoption of technology stratified by farm size high, medium, low potential, male/female household head.	10%	Project studies Extension service records, e.g. farm management unit. Special Studies
	1.2 Has total production increased in a commodity or region?	Production statistics; yield data; land use data by commodity & region. Production 1 area cultivated.	Production increased (sales)	Central statistics office MOA statistics office Remote sensing data
	Have sales of fertilizer, seed, etc. increased? (Substitute relevant inputs/case study)	Sales records	decreased - sales of improved hybrid seed and also fertilizer depend on market price of grain	Cooperative records Import/Export records
	Has there been a tech-related shift in crop mix?	Tech-related shift in crop mix short-term and long-term	No None except millers None	National statistics office Remote sensing data
	2.0 Rural agro-industrial transformation			
	2.1 Has agro-industrial transformation occurred?	# of rural-based small enterprises by regions (female vs. male-owned) 10 workers or less? Increased rural savings		MOA
	2.2 Has research/extension resulted in the formation or strengthening of farmer organizations?	- # organizations - # members		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (cont'd)	**3.0** Management of natural resource base			
	Questions:			
	3.1 Has NR management been an element of technology adopted?	Increased land cultivation (intensive vs. extensive) Proportion owned vs. rental land, security of access to land % top soil loss, salinization rate Sedimentation rate	Intensive, yes Prob. - customary land privatized Contour ridges being built to decrease run-off	
	4.0 Policy changes at sector level	Price policy; input policy; marketing policy		
IV. Impact How has investment in research influenced the economy of the country, in terms of incomes, productivity, production & food security (availability, access & adequacy)?	**1.0** Net farm income	1. Change in net farm income at national aggregate level in real terms. 2. Change in net farm income/ farm in real terms disaggregated by farm size male/female household heads 3. Changes in net farm income per AEPA		FAO yearbook World Bank reports Treasury reports
	2.0 Agricultural productivity			Central statistics offices, MOA, Treasury, Credit Bank, FAO nutrition statistics.
	2.1 Has agricultural productivity increased by farm size, etc.	1. Change in value of prod/capita. 2. Change in value of production/ farm (EAPA, male/female). 3. Change in value of production/ farm by farm size. 4. Change in value of ag. production per hectare of agricultural land. 5. Change in value of ag. production by unit of ag. investment of credit for agriculture.		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. **Impact** (cont'd)	**3.0** Food Security (national level)			
	3.1 What is the impact of ag. research on food security at the national level?	1. Change in per capita food production and consumption. 2. Change in ag. GDP (including non-food crops). 3. Change in % self-sufficiency in basic food commodities. 4. Variability in total annual ag. production. 5. Change in per capita food imports by value. 6. Change in annual carryover stocks of basic food stuffs (buffer stocks)		

MALAWI -- BEANS

Background

Beans (Phaseolus vulgaris L.), are the the second most important food crop produced by smallholders in Malawi. They form the basis of the the protein component of smallhoder diets, either as beans or as bean leaves prepared into relish to accompany nsima made from maize or cassava. Beans are a much more accessible source of protein for smallholders than animal protein. As noted in the socioeconomic study of beans in Northern Malawi carried out under the USAID-funded Bean-Cowpea Collaborative Research Support Program (CRSP), "...undoubtedly, the nutritional contribution of beans to the family diet is important. However, it apparently is the availability of beans, or at least bean leaves, for relish which is the most critical concern of the family. In the absence of some kind of relish, the total level of calories consumed is reduced even when the supply of maize is adequate" (Barnes-McConnell, 1989). In a country in which malnutrition is a newly-recognized and increasing problem (see USAID CDSS 1991), especially among resource-poor smallholders, the role of beans in the diet is of critical interest. Beans are also an important source of cash income when sold either on local markets or direct to ADMARC, the GOM parastatal marketing organization. Beans are also exchanged and given as gifts to relatives and neighbors, and are part of the farming system affected by and affecting communal labor and labor which is paid for in cash.

Beans are intercropped, primarily with local, composite or hybrid maize, with peas, pumpkins, bananas, cassava, rape, coffee and yams. They are grown in pure stands on mounds in marshy soils (dimba fields), or in maize fields after the maize has been harvested. They are also relay cropped. A number of families observed in the socioeconomic study of the North managed to have beans for the majority of months of the year over a study period of two years (1984-86).

A key element in the characterization of beans in Malawi is that there is a very broad range of genetic diversity among bean varieties present in the country. Also, beans have been present for about 300 years. They include both climbing and bushy varieties. Beans are produced mainly as mixtures of different types, varying in colour, shape and size, in order to maintain diversity, and/or are planted in a series of particular pairs, to maximize beneficial, and minimize deleterious characteristics. The results of CRSP-funded studies indicate that yield is not the single most important criterion as far as smallholder producers are concerned; rather, resistances to diseases and climatic fluctuations, as well as time of maturity, seem to be the most important features from the producer point of view.

Program Evolution and Priorities

The first bean research conducted in Malawi was done ad hoc by faculty members at Bunda College, beginning in 1969, especially by the then Chair of the Crop Production Department. (Of the three original bean researchers at Bunda, two have left to become staff at IARCs.) Funding for their research at that time was extremely limited, derived from small grants available from the University Research and Publications Committee, which had a maximum of MK 3,000 per year (approximately $US 1,200). By 1979, after collecting local landraces throughout Malawi, these three original researchers released six lines as varieties. These

varieties were given to the National Seed Company for multiplication and distribution. At that point, the University had no more funds for research on beans, so that the researchers were unable to carry out further experiments on yields, resistances, and key constraints.

The Seed Company did attempt to multiply these varieties, and to sell them to farmers. However, they found that this was an uneconomic proposition, since farmers saved their own seed, and only bought improved seed once every three to five years. This has continued to be a marketing and distributional problem, and the Seed Company has now decided to stop producing bean seed, since it is uneconomic, although researchers at Bunda now have developed materials for three new varieties--29 x P692; 2-10 x 8-7 and 25-2 x 8-7. According to the Agricultural Research Strategy Plan of 1983, the national bean program is located at Bunda, will be dealt with primarily in terms of intercropping and applied research on farming systems, and operated under a Contract Research Program (IADS, 1983). This plan notes that under the prior situation, the DAR made limited contributions to the bean and livestock programs at Bunda, "largely 'in kind' rather than financial". It is indicated, however, that this kind of contract research will encourage interdisciplinarity in problem-solving approaches.

Under the draft Agricultural Research Master Plan of July 1988, the Bean Commodity Team is still located at Bunda College unlike the Commodity Teams for other major crops, which are located within the Department of Agricultural Research (DAR). Its status is somewhat anomalous in that it comes under the larger team for Grain Legumes, Oilseeds and Fibres which is located at DAR (see Table 1).

Program Goal and Objectives

The program goal is to "encourage the growing of beans in pure and mixed stands for consumption and sale". Constraints identified are a) low-yielding varieties, b) disease and pests, c) poor cultural practices, and d) poor nodulation. The research objectives, therefore, are to a) develop and select adapted bean cultivars with high yields and disease resistance; b) investigate appropriate cultural practices for increased production under both irrigated and rainfed conditions and in pure and mixed stands, and c) study effects of nitrogen-fixing bacteria on bean yield.

In the priority-setting part of the masterplanning exercise, beans were included as a Priority I crop, along with rice, groundnuts, cattle, poultry, tree nuts, coffee, and tropical fruits. Funding projections for "other grain legumes", which does not indicate the proportion for beans, are only one-third of those for maize over the five-year plan period. To some extent, this is misleading, however, for two reasons. First, a considerable amount of research on maize includes, or has implications for, research on beans, due to the frequency of intercropping of the two, and due to the relationship among intercropping, soil fertility and nitrogen fixation by legumes, including beans. 2This is also true for some of the work being carried out by the agroforestry and soil fertility teams. Second, the bean program has, fortunately, received considerable financial support from the Bean-Cowpea CRSP, and some support from the CIAT regional network for Southern Africa (with A.I.D. funding). Funding is also likely to be forthcoming from the Rockefeller Foundation for 1990-92.

Funding for the College's institutional development under A.I.D.'s HRID Project will also have an impact on the bean program.

TABLE 1

BEAN COMMODITY RESEARCH TEAM STAFF 1988/89

A.B.C. Mkandawire*	Acting Coordinator and Crop Physiologist/Agronomist
J.M. Bokosi*	Plant Breeder
L.M. Kantiki	Entomologist
W.A.B. Msuku*	Plant Pathologist
S.K. Mughogho	Soil Scientist/Agronomist
R.M. Mkandawire	Rural Sogiologist
N.Z. Lupwayi	(Soil Science study leave)
H.R. Mloza-Banda*	(Agronomy study leave)
M. Mafuleka*	(Food Science study leave)

* Long-term training under Bean-Cowpea CRSP.

The team puts out a joint annual report for the CRSP and for the National Program, which reports experiments carried out and results, and projects experiments for the following year. The fact that this is done in a single report may be an indication of the near synonymousness of the CRSP and the Program, as well as of an attempt to conserve scarce funds.

The Bean-Cowpea CRSP - Malawi-Michigan State University Project

The Bean-Cowpea CRSP is "a coordinated research effort which addresses hunger and malnutrition in Africa and Latin America. The focus...is on **collaboration**, the characteristic of this research approach which distinguishes it from the more traditional agricultural research being carried out at local, national, regional and international research institutions. This approach includes financial collaboration for the research in that U.S. and Host Country (H.C.) institutions, as well as ...A.I.D., provide monetary or in-kind support necessary for the scientists to address problems of production and utilization of beans...and cowpeas" (CRSP, 1988).

As the CRSP Technical Report also indicates, a unique aspect of the CRSP is the extensive linkages whih are developed over time and which support two-way communication. "As the partners in this scientific effort exchange data on a collegial basis, the benefits of their research enrich both the U.S. and Host Countries and contribute to the development of sustainable agricultural production systems." Unlike some other CRSP projects, the Bean-Cowpea CRSP has a distinct WID component, intended to insure that research is conducted that will benefit small-scale farmers and women in developing countries by improving their nutritional status and standards of well-being. The program provides funds to support social science related concerns in individual (country) projects. It has been most significant in training and in providing a knowledge base and socio-cultural context for biological research in projects, including the one in Malawi.

Discussing the impact of the CRSP on the program, researchers interviewed indicated that it was the "salvation" of the program when it began in 1982, and that its most important single effect has been the institutionalization of the bean program in Malawi.

Under the Bean-Cowpea CRSP, unlike the general model, a collaborating country project is run by/through one U.S. university. It is also unique in that the Project Director for the project in the U.S. has been a social scientist. Other disciplines are represented in the U.S. team, as well as in the Malawi team, as is shown in Table 2 below.

TABLE 2

MALAWI - MICHIGAN STATE UNIVERSITY
GENETIC, AGRONOMIC, AND SOCIO-CULTURAL ANALYSIS
OF DIVERSITY AMONG BEAN LANDRACES IN MALAWI

Principal Investigators

M. Wayne Adams, Crop and Soil Sciences, MSU
Thomas Isleib, Crop and Soil Sciences, MSU
Wilson Msuku, Crop Production, Bunda College of Agriculture

Co-Investigators

Henry Mloza-Banda, Crop Production, Bunda College
James Bokosi, Crop Production, Bunda College
Alex Mkandawire, Crop Production, Bunda College
Anne Ferguson, Bean/Cowpea CRSP/WID, MSU
Susan Sprecher, Crop and Soil Sciences, MSU

Maintenance of genetic diversity by smallholders is a key subject for socioeconomic research under the Bean-Cowpea CRSP Malawi-Michigan State University Project. Basic research is also being carried out on a number of genetic and agronomic aspects, including allozyme distribution, agronomic influences on diversity, and genetic variation in cooking time. The socioeconomic studies, being carried out in the North, Central and Southern regions of the country, will both provide baseline data for the whole bean research program and for the CRSP, and at the same time allow an "examination of the relationship between stratification within the smallholder sector <u>and bean and other</u> crop diversity....[to] determine if amount of bean diversity present varies by stratum or type of farming household and, if so, ...to examine the implications for food security. Of special concern are the effects on diversity, and ultimately on household well-being, of the declining size of landholdings in the Central Region" (CRSP, 1988).

One of the key findings of the socioeconomic research is that women in Malawi are most responsible for the maintenance of genetic diversity in beans, and also for bean production. Therefore, research which improves access to

protein through improvements in production and increases in consumption of beans is likely to have a direct positive impact on those in the Malawian population most at risk of malnutrition--women and children. Other research, reported in the Malawi CDSS indicates that one third of smallholder households are women-headed, and that child malnutrition tends to be significantly less in women-headed households than in male-headed households (CDSS). These findings will be checked against the Food and Nutrition Surveillance project presently nearing completion and funded by A.I.D., UNICEF and Rockefeller.

The questions of multiplying and distribution of certified bean seed are also being addressed by the researchers in the Bean Program. They have prepared a proposal for Rockefeller Foundation funding that will address these issues, either through a revolving fund approach or another mechanism to ensure that farmers can multiply certified seed, which will then be distributed or marketed to other farmers. The details of this proposal are presently being developed, but it is likely to receive from $200-400,000 of funds for two years or more. This is in fact a good indicator of the applied emphasis of some of the research being carried out in Malawi, including that on beans, and the willingness of on-station and university researchers to address smallholder constraints by providing improved varieties, improved cultural practices, and addressing socioeconomic constraints, in collaboration with team social scientists and with AGREDAT, the branch of the Ministry which is in charge of economic dimensions of agricultural research and extension. It is noteworthy that, in this case, they have sought external funding for the fundamental distribution question as well as for more traditional research concerns.

Applying the Framework

Level I: Institutional Base

Unlike the maize research program, the bean program has not been well-integrated into the national agricultural research system since its inception shortly after Independence. Its placement at Bunda College has tended to make it somewhat peripheral institutionally, and perhaps in terms of its impact.[1] Since the College, part of the University of Malawi, is under the Ministry of Education rather than the Ministry of Agriculture, coherence in funding is not obvious. On the other hand, it is an early example of contracting out research by the research establishment, one of the indicators of probable successful impact in the matrix. The policy environment in which the program operates is recently much more supportive than before, since the existence of malnutrition in Malawi has been more openly recognized, and since the constraints on smallholder production and income have become a focus for national policy directions, including those of agricultural research. In terms of resource allocations compared with other Priority I crops, it would appear that without external funding from A.I.D. through the CRSP, the HRID project, the Michigan-University of Malawi Project, and the Rockefeller Foundation, the program would be significantly short of operational and training funds. The Bank, in its triennial review with the GOM of agricultural research places little emphasis on the bean program, partly because of its somewhat peripheral location at Bunda (GOM, 1989).

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[1] There are, however, secondments from Bunda to DAR, and DAR researchers, after retiring at 50, can come and join the Faculty at Bunda.

As has been indicated above, a strong point of the bean program has been the emphasis on describing smallholder farming systems and the place of beans in those systems, including attention to gender aspects of production and distribution. This program, then, scores high on analysis of constraints, and recognizing the importance of farmer priorities, including the de-emphasis on improving yields at the expense of other beneficial characteristics, the role of beans in soil fertility maintenance, and as both a relay and intercrop. The research agenda appears to be defined largely in terms of increasing resistances to pests and diseases, as well as stress from weather conditions, rather, for example, on increased yields through improved varieties that would have high input requirements beyond the reach of most shallholders.

Similarly, the program potentially scores high on external and internal linkages (with other commodity teams in DAR, with regional IARCs and networks through the CRSP and CIAT), although these have been somewhat constrained by the absence of key staff on long-term training. Collaboration with adaptive research and extension has been somewhat limited by transportation and funding constraints for trials on farmers' fields, although to some extent, this is being done, including using students doing their senior thesis work to carry out on-station and on-farm trials.

Through the CRSP, international and regional exchanges of information are made possible, and publications are encouraged. There were 11 publications generated by the CRSP from 1988, while three staff are still in training. Three dissertations are thus in progress which will in turn generate both knowledge and further publications.

Level II: Technology Generation and Transfer

As has been indicated above, research on beans is perhaps less "flashy" than research on maize or other crops where improved varieties can lead to significant increases in yield, or intensification of production, although these may be highly input-dependent. However, in terms of most of the Level II indicators, the bean program scores high--training, on-farm and on-station research with demonstrations, constraints analysis, other related studies carried out, utilization of study results. It is less clearly "good" on moving research results to the farmers, although it is relatively early in the life of the program as currently constituted to make this judgment. A key constraint--the non-economic nature of marketing improved seed--is largely outside the control of the researchers, although as has been indicated, they now intend to tackle this constraint themselves. Multidisciplinary team approaches in the bean program appear to be good, partly in line with overall Malawian research policy and structure, but also as a result of CRSP orientation. As has been mentioned, links to extension at the ADD level probably need greater attention, as does collaboration with other commodity teams in planning field trials and experiments (particularly with maize and agroforestry and soil fertility).

Level III: Intermediate Impact Indicators--Adoption and Beyond

As a key element in the diet of almost all Malawians, beans are a very appropriate area for research emphasis. Further, if distributional problems can be addressed by the public sector where they have not been salient for the private sector, it is likely that adoption rates for improved varieties and

cultural practices generated by research will be high. This would seem especially likely because of the inherent farmer-oriented nature of the research that is being carried out. Beans are both a source of food and a source of cash income, primarily for women, who will hire labor to cultivate beans, and will use the cash generated by sales of beans to hire labor for other crops. They might, in some instances, use cash from bean sales to purchase inputs for other crops, such as maize.

The contextual variables for Level III, which we have characterized as rural transformation--marketing, infrastructure such as roads, small and medium enterprises, are outside the domain of agricultural research, but it is worth noting that these are areas of emphasis now for GOM policy, and especially for the USAID/Malawi program. Thus, the environment into which findings and recommendations from bean research will fit is likely to be a more conducive one than that which obtained in the past. Since there is no clearly organized smallholder constituency, except through the Party structure -- this is a particularly positive situation, and differs a lot from the former total emphasis on large estates and cash crops for export. Thus, the bean program itself may be a good indicator of policy shifts, and an element in further policy reforms or adaptations that may be necessary to enhance the potential of program results.

Level IV: Impact

The Food and Nutrition Surveillance Project as well as new nutrition surveillance programs being designed by the MOA--also with A.I.D. assistance through Cornell University--will provide additional data on household-level food consumption and nutritional and health status of women and children. Analysis of the former is about to begin later this year. Meanwhile, the socioeconomic studies of the three major regions of the country being carried out under the CRSP provide a wealth of micro-level data on health status, labor inputs, crop production, cooking, as well as socio-cultural factors relating to and affected by, the production and consumption of beans. The bean program relates directly, ultimately, to the adequacy component of food security, as well as to increased production and productivity, both of beans themselves, as well as of other crops intercropped with beans, and on overall maintenance of soil fertility. Therefore, its impact can be measured on a number of dimensions, using data sources and methods which are largely already in place, and a number of which are funded by A.I.D.

INTERMEDIATE IMPACT INDICATORS MATRIX

MALAWI — BEANS

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base Does NARS have institutional structures & management mechanisms which will permit all critical functions of a research system to be effectively carried out?	***A. At national/ministerial level*** **Manageable Interests of Parent Ministry and Institute** ***1.0*** Development of national research policy as it relates to national development policy. ***Questions:***			
	Does the country have an agricultural development plan?	Y/N	Yes	Statement of Development Policies 1987-96
	Does the country have a research policy?	Y/N	Yes	
	Who monitors the continued concordance of research and development policies?	Name body Office of President ___ Ag. Res. Council		Ag. Research Master Plan
	1.1 NARS priorities articulated according to research policy and resource requirements defined based on iterative planning exercises. ***Questions:***			
	What process exists for setting research priorities and allocating resources? How does this process take into account:	Level of complexity of analysis: 0 = no formal priority setting method; 1 = congruence method; 2 = weighted criteria or other formal method.	(1) contribution to national food self-sufficiency export value, cash crop potential, import substitution; (2) lack of shelf technologies, differences in farmer vs. research yields, producer demand for improved tech. & funds allocated to various commodities in the past. Perception that there is no food security problem; cash crop/exports emphases.	Ag. Res. Master Plan (2) see p. 49 & p. 51
	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 need, distribution of benefits, political considerations, etc.			
Swanson #9:1 and/or 2	The probability and cost of research success, including national use of existing personnel, infrastructure, financial resources, etc. and taking into account past research results, both positive and negative, national and international.	Resource allocation to commodities; Index value % research personnel/commodity research program. (state whether planned or actual)		see p. 53 & p. 53 planned - see Swanson p. 20 Staff/commodity group, see p. 102 masterplan.

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***1.2*** Effective communication of NARS needs and acquisition of resources.			CDSS 1991
	Questions:			
	Does NARS receive an adequate level of funding from Government?	Research budget as % of Ag. GDP.	1989 - 349 4 mk Ag = 44 mk budget 1988 - 657.86 mk total budget DAR 4.37 - 52% AGOA	Masterplan p. 81
	Does NARS receive the types and levels of funding requests from donors?	Funding level/request		
	Does NARS effectively coordinate donor-financed research activities?	Mechanisms: - Formal, timely meetings - New project starts based on NARS priorities - New project starts outside of NARS priorities	Suggested donor cond w. modification on chain appear to coincide with masterplan. Have turned down FAO/UNDP actual #/type of projects in development budget.	
	Does NARS initiate the identification of donor-financed activities?	Y/N	Doesn't seem to yet - although yes on SADCC Steering Committee	
	1.3 Effective external (international) linkages			
	Questions:			
	Does NARS have formal linkages with IARCs, international private sector research or agri-business? With whom and what type?	List and describe: 1 point each a) technology exchange; b) training; c) networking; d) consultation Maximum: 4 points	IITA, CIAT, ICRISAT, CIMMYT, ISSIPI? ICRAF, ISNAR a) yes b) yes c) yes d) yes = 4	
	1.4 Effective internal (national) linkages			
	Questions:			
	Does NARS have formal linkages with MOA/EXT, other relevant ministries, universities, development projects, local agri-business, private sector research organizations? With whom and of what type?	List and describe: 1 point each: a) Priority setting process b) NARS board membership c) Training d) Technology exchange e) Contract research (in & out) f) NARS representation on other boards Maximum: 6 points	1 1 1 1 1 1 ?	Masterplan project reports interviews

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.5*** Monitoring of impact-level indicators by parent ministries			
	Questions:			
	Who is responsible for baseline and time series data collection on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc.?	List by function/data type.	ADDS - res., adaptive research & extension, AGREDAT planning & evaluation units.	
	What data currently exist?			
	Are data readily exchanged?	Inventory data sets Identify users for each data set.	See annexes -	ASA data, land h____ credit, yield, ha, prod, food balance, land husbandry, demonstration, womens progs., inputs, salts
	1.6 Human resource management			
	Questions:			
	Does NARS have a personnel database	Y/N	yes - training unit	DAR, DOA, Office Pres. & Cabinet Treasury, ADMARC, AGREDAT donors
	Does a NARS manpower training plan exist?	Y/N	yes - training unit	
Swanson #8	Is there an adequate career incentive structure to recruit & retain qualified staff?	- Operating budget/researcher - Scheme of service for researchers? Y/N - Annual attrition rate - # of vacancies - Proportion of support staff to research & technical staff	Have developed new scheme of service for enhanced career ladder. High vacancy level at bottom ranks & above due to high # on training. Probably not enough support staff for research unless count adaptive rsearch teams	
	2.0 Intervening Variables			
	2.1 Agricultural Policies			
	Questions:			
	Does NARS have a role in input & output price policy development?	Y/N Input policy Output policy	 don't know don't know	
	Does FX policy favor ag. sector?	- Special rates for ag. export/ import licensing; Y/N - FX readily available for input imports? Y/N	strict controls? no; IMF, subsidy issue MADIA, CDSS	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	**2.2** Extension services ***Questions:***			
	What priority is given to extension? Who carries out extension activities?	% Ag. GDP to extension List	? high priority adaptive research teams land husbandry womens' programs Extension Aids Branch	
George?	Extension salaries comparable to research salaries of equivalent levels?	Y/N	Yes: upward mobility faster in extension	
	How effective is extension?	3 = highly effective; 2 = moderately effective; 1 = marginally effective (subjective observation)	2	Farmer surveys T&V report Observation Interviews Adaptive res. evaluations at ADD level
	Is there an adequate career incentive structure to recruit and retain qualified staff?	- Operating budget/extension officer - Annual attrition rate - # of vacancies		? See Bank project documents - appraisal ? 122 vacancies FA level

MALAWI — BEANS

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***B. At NARS Institute and Program levels***			
	1.0 Research program planning and management			
	1.1 Development of long-term research plan			
	Questions:			
	Does institute have a long-term research plan.	Y/N	Yes	Master plan 1983 Master plan 1988
	Do farmer orgs. participate in plan formulation?	Y/N farmer org. index	None? except estate growers - Farmers Welfare	Tobacco Growers?
Swanson #5, 2	Does the plan articulate priorities and resource allocations by commodities/factors?	Y/N	Yes	
	Does it include projections for manpower, infrastructure and operating funds?	Y/N	Yes	
	1.2 Development of a program structure			
	Questions:			
	Does institute have a program structure which will effectively carry out the long-term research plan?	- Existence of national programs	Yes	NARP
	Are program leaders appointed?	Y/N	Yes	
Swanson #7 1 and 3	Are programs adequately staffed?	# researcher/program # technicians/researchers (ratio) # B.S., M.S., Ph.D/program	Getting there with 132 long-term trainees 1984 to date for research & extension	personnel database NARP ISNAR Indicators Series

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***1.3*** Program and budget			
	Questions:			
	Does institute have a short-term program and budget?	Y/N	Yes	
	Are farmers involved in determining progams?	Farmer orgs. represented	Through pilot communication project & block meetings	Adaptive research team surveys & feedbacks ag. survey
	Are programs based on constraints analysis?	Y/N	Yes - weighted systems	
	1.4 Monitoring and Evaluation (M&E)			
	Questions			
	How is research performance (efficiency) assessed?	- Active annual review process - # projects revised or cancelled	Yes Don't know yet	
	How is research quality assessed?	- Peer or expert review - # projects redesigned	Yes Don't know yet	
	Who establishes baseline data for research programs?	- Socio-economic surveys used in divising proposal? - Baseline survey	AGREDAT, adaptive res; social research, ASA	individual commodity group surveys, e.g. agroforestry
	Who collects program-level and institute-level data for evaluation?	Individual scientists, prog. directors; M&E system	No M&E system prog., AGREDAT, extension	
	What are career promotion criteria?	List: Publications, advanced degrees, collaboration with extension.	pub, advanced degrees collab. with Extension at ADD level?	
	What are criteria for pay increases?	Seniority, degree qualifications, etc.	Both	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***Questions:***			
	How effective is the flow of information between research and its clients: policy-makers, extension services, farmers and others?	Mechanisms: Board meetings, sessional papers, annual reports, meetings with farmer org., bulletins, mass media messages		Annual reports behind 1984 bulletins, pamphlets seminars, monthly meetings at ADDs Extension Aids Branch - videos, etc.
	1.5 External communication	List linkages: 1 point each		
	Do institute centers and programs have formal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agri-business organizations for problem identification, program formulation and execution?	a. problem definition b. investigation c. analysis d. evaluation Maximum: 4 points	1 1 1 ? 3+	Interviews, seminar & commodity group reports, adaptive research reports, etc.
	With whom and of what type?		University, private sector (seed)	
	1.6 Internal communication			
	What formal linkages exist within institute, e.g. between programs, disciplines?	Multidisciplinarity: 1 point each a. Problem definition b. Investigation c. Analysis d. Evaluation Maximum: 4 points	1 1 1 1 = 4	Annual reports Interviews with program leaders
	How are multidisciplinary problems approached?			Annual reports Policy statements
	Is NR mgt./sustainability incorporated into redesign? (indicate multidisciplinarity)	Cite examples: - Shift from chemical to biological pest control - Agroforestry research - Reduced proportion of inorganic to organic nitrogen sources		Interviews MARE eval., MARE tech. reports, DAR reports, publications Agroforestry team Very good score here.

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	**2.0 Financial Resource Management**			
	2.1 Acquisition of funds			
	Questions:			
	Are funds received by institute headquarters, stations and programs in a timely way and in adequate amounts?	- Date requested, date received; - Programs/projects halted for funding shortfalls (# & proportion) - # of researchers without funded projects	No; 99 projects, some no funding, vacancies from training overseas; insufficient operating funds, esp. transport	Interviews directors, researchers, ADDs
	2.2 Funds disbursement			
	Questions			
	Do station and/or program heads have the delegation of authority necessary to permit a flexible yet accountable use of funds?	Y/N	Don't know - have some flexibility	
	Can funds be retained and carried over from one year to the next?	Y/N	Don't know - yes if from Rockefeller	Interview station heads
	2.3 Accounting			
	Questions			
	Are adequate accounting procedures and staff in place throughout the system?	FM system centralized Y/N No. of clearances required? Trained accountants at each center?	Seems to be ok. Yes, in staffing pattern	MKamanger paper on stations; interviews

MALAWI — BEANS

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer	***A. For the Research System***			
	1.0 Intermediate results (outputs)			
	1.1 Training Opportunities			
	Questions			
(What are the quantity, quality and nature of the outputs of the research and extension system?)	What training is available for researchers, collaborators and clients?	# trained ST in-country ST abroad LT abroad (Past 3 years)	? ? 5 MS/PhD	Personnel system data-base CRSP reports
	1.2 Progression of experimentation			
	Questions			
	Is research moving from strategic, to applied to adaptive research?	Proportion of research on-station, on-farm, being demonstrated (time series)	mainly on-station	Annual reviews extension reports
	How much research is conducted on-farm?	Research reports - # of trials listed	Adequate but duplicative	Annual reports CRSP reports
	How much research has moved into the field testing & demonstration stages?	# technologies moved from on-farm trials to demonstration stage/ program	3 new varieties	Extension reports
	1.3 Surveys and constraint analysis			
	Questions			
	What studies have been initiated/completed on characteristics and constraints at agro-ecological levels, provincial levels, among cultural groups, etc. for outputs and inputs.	# projects with constraints analysis included # other studies analyzed	Socioeconomic study of North being replicated in Center & South	
	How is this information to be used?	List: 1 point each - research project design - research program design - midcourse correction - impact evaluation Maximum: 4 points	1 ? 1 1 = 3	

MALAWI — BEANS

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. **Technology Generation & Transfer** (cont'd)	***1.4*** Interaction between research & extension			
(Swanson #10) modified	How do research & extension collaborate?	Nature, frequency of interaction Liaison officer? Y/N	Yes - intercropping with maize	Adaptive research team reports at ADD Extension reports/res. reports
	How effective is this collaboration?	# jointly planned/implemented trials.		
	What research methodologies have been developed/refined to encourage client participation in research planning, execution, and evaluation?	List: - Baseline surveys - Program-level or center-level planning meetings? - Field days - Annual workshops	Yes Yes	
	What methods have been developed to monitor and evaluate technology transfer and adoption?	Committees, surveys, reports, on-farm research		On-farm adaptive research?
	1.5 Responses to government requests for policy advice	- Sessional papers - Participation in policymaking bodies - Requests for advice	N/A except part on other commodity groups review committees	
	2.0 Conclusive results			
	2.1 Technologies developed/released			
	Questions			
	What new varieties have been developed tested, and released to clients? (i.e., extension, farmers, private sector research)?	# varieties released	6 + 3 to seed company	NARS annual reports Extension reports
	What new technologies have been developed, tested and released to clients?	# of technologies recommended to extension	several - intercropping with maize	
	What recommendations have come out of commodity programs?	Proportion of programs that have released varieties or technologies		
	Has a "Menu" of technological choices been developed and offered to accommodate different systems and situations?	# of released varieties responding to low input vs. high input systems; # of techs with positive NR side effects, e.g., alley cropping, cut & carry, fodder, silage, zero-grazing	All responsive to smallholder constraints most	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	**2.2** Publications			
	Questions:			
	What scientific, technical and farmer-level publications have been produced?	List internal/external Level scientific technical farm level	CRSP reports annual res. reports Yes Yes No	Annual reports Extension reports
	2.3 Inputs			
	Questions:			
Swanson #17	Are agricultural inputs (seed, fertilizers, pesticides, tools) available?	Distance from household to input supply point, # of sources of inputs - Credit given for inputs Y/N: in kind or in cash	In-kind credit at ADD/RDP/EPA level cash sales ADMARE sales points in kind	
	Are there subsectors w/o inputs?	Y/N - high, med, low potential Y/N - areas kg/ha	Untimely distribution; insufficient amounts fert. & seed for both state & smallholder sectors	See ADD & National Statistics
	Are there times of the year when inputs are not available, more expensive?	Y/N - timely delivery; seasonal shortages; price fluctuations for fertilizer & seed.	Yes - fluatuates due to policy changes - structural adjustment	
	How are inputs made available to resource-poor/farmers (e.g. small packaging, etc.)	# smallest units seed or fertilizer sold/# smallholder units	Small bags - also bought by estate farmers	
	2.4 Marketing infrastructure			
	Questions:			
	Are markets accessible to all producers?	- regional price variations - status of rural roads (proportion of farm housholds within 10 km of paved road	pannational producer ____ prices from ADMARK = marketing inefficiencies. Differential prices for tobacco large vs. small holders	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	***B. For the Extension System***			
	1.0 Research results/recommendations accepted and extended			
	Questions:			
Swanson #14.3	To what degree have research results been promoted by the extension service?	All recommendations Some No recommendations Why % recommendation promoted by extension	Yes No seed available ? 20%?	T&V reports Liaison officer interviews Extension service reports
	To what extent does extension adopt researcher-recommended technologies?	All adopted Some None adopted Why	Adaptive res. teams test in different regional environments then adopt if appropriate	Adaptive res. team reports
Swanson #12	How is adoption of recommendations tracked?	Tracking system exists Y/N Tracking system applied Y/N		Liaison officer interviews Extension service reports
	2.0 Extension methodologies & Effectiveness			
	Questions:			
	What extension methodologies have been developed/refined to improve extension participation in research?	Ranked allocation of extension agent time in tech. generation and transfer activities	Yes but too many other responsibilities	T&V agent reports
Swanson #14.4 Swanson #14.5	What extension methodologies have been developed/refined to improve the extension-farmer linkage?	# of program changes based on feedback from extension	"infusion" pilot communication project, videos, block meetings	T&V on station or on-farm research program descriptions/evaluations
	What publications or other media mechanisms have been produced to inform farmers of research findings?	# of households with direct contact with extension agents (male vs. female-headed) # of new messages by type Actual samples	Yes — 1/10? contact farmers farm mag., bulletins	Extension audio visual department Annual extension reports

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	C. Intervening Variables			
	1.0 Markets			
	Questions:			
	1.1 Farm to market roads?	Average distance farm to market? Proportion transport cost of total cost (market prices)?		State marketing board
		Farmgate vs. market prices		
	1.2 Does a market information system exist for commodities?	Y/N on radio in print media	Yes	Observation
	1.3 Are there price constraints for commodities?		?	
	1.4 Are there required marketing channels that must be used?		Yes	
	1.5 Are there commodity marketing standards?		No	
	1.6 Are the recommended inputs available?		Not always	
	2.0 Storage and processing considerations		Are important - no processing off-farm	
	2.1 Is value added at household level for commodities examined?	Farm level profit & loss	Not really	Farm budgets by type of farm
	2.2 Proportion of post-production losses	Costs & returns at commodity level	Don't know	CRSP studies
	2.3 Post production processing	Value added to commodities	No	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (Adoption & Beyond)	**1.0** Technology Utilization			
How can the adoption of technologies produced by the NARS be measured, and results used to forecast probable impact on the national economy?	**1.1** What % of farmers are using new technologies?	Adoption of technology stratified by farm size high, medium, low potential, male/female household head.	Don't know yet	Project studies Extension service records, e.g. farm management unit. Special Studies
	1.2 Has total production increased in a commodity or region?	Production statistics; yield data; land use data by commodity & region. Production area cultivated.	Maybe north – check data	Central statistics office MOA statistics office Remote sensing data
	Have sales of fertilizer, seed, etc. increased? (Substitute relevant inputs/case study)	Sales records	Seed not sold	Cooperative records Import/Export records
	Has there been a tech-related shift in crop mix?	Tech-related shift in crop mix short-term and long-term	No	National statistics office Remote sensing data
	2.0 Rural agro-industrial transformation			
	2.1 Has agro-industrial transformation occurred?	# of rural-based small enterprises by regions (female vs. male-owned) 10 workers or less? Increased rural savings	Little; farm work for others	MOA
	2.2 Has research/extension resulted in the formation or strengthening of farmer organizations?	- # organizations - # members	no	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (cont'd)	**3.0** Management of natural resource base			
	Questions:			
	3.1 Has NR management been an element of technology adopted?	Increased land cultivation (intensive vs. extensive) Proportion owned vs. rental land, security of access to land % top soil loss, salinization rate Sedimentation rate	Yes - intensive Problem Contour ridges being built to decrease run-off	
	4.0 Policy changes at sector level	Price policy; input policy; marketing policy		FAO yearbook World Bank reports Treasury reports
IV. Impact How has investment in research influenced the economy of the country, in terms of incomes, productivity, production & food security (availability, access & adequacy)?	**1.0** Net farm income	1. Change in net farm income at national aggregate level in real terms. 2. Change in net farm income/ farm in real terms disaggregated by farm size male/female household heads 3. Changes in net farm income per AEPA		
	2.0 Agricultural productivity			Central statistics offices, MOA, Treasury, Credit Bank, FAO nutrition statistics.
	2.1 Has agricultural productivity increased by farm size, etc.	1. Change in value of prod/capita. 2. Change in value of production/ farm (EAPA, male/female). 3. Change in value of production/ farm by farm size. 4. Change in value of ag. production per hectare of agricultural land. 5. Change in value of ag. production by unit of ag. investment of credit for agriculture.		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. **Impact** (cont'd)	**3.0** Food Security (national level)			
	3.1 What is the impact of ag. research on food security at the national level?	1. Change in per capita food production and consumption. 2. Change in ag. GDP (including non-food crops). 3. Change in % self-sufficiency in basic food commodities. 4. Variability in total annual ag. production. 5. Change in per capita food imports by value. 6. Change in annual carryover stocks of basic food stuffs (buffer stocks)		

MALAWI - NATURAL RESOURCES MANAGEMENT

OUTLINE

I. The Conceptual Framework

II. The Process Leading to Impact

III. Factors Endogenous to the Research/Extension System

A. The Development of National Research Programs

1. National/Research Policies
2. Effective External Linkages
3. Effective Internal Linkages
4. Adequate Information/Library Resources
5. Research Planning, Organization, Management, Budgeting

B. The Transfer of Technologies to Extension and Commerce

1. Commodity/Adaptive Research Linkages
2. Research/Extension Linkages
3. Research/Commercial Interests Linkages

C. The Transfer of Technology to Farmers

1. Private Promotion of New Technologies
2. Public Extension Planning, Organization, Management, Budgeting

IV. Factors Exogenous to the Research/Extension System

A. National Policies

1. Macroeconomic
2. Agricultural Sector - Input and Output Marketing

B. Marketing Infrastructure - Crop Storage and Transport
C. Access to Land and Labor
D. Cooperatives - Indigenous Local Organizations
E. Financial Institutions - Access to Credit

V. Impact Indicators

A. Technology Utilization
B. Productive Capacity
C. Household/Farm Production
D. Industry/Trade Spinoffs
E. National Production

VI. Conclusions

I. The Conceptual Framework

Agricultural research projects designed by AID generally have dual objectives: to generate technology and to build indigenous research capacity. Often the field-level impact (increased production, productivity, and incomes), is described in the goal statement of a logical framework matrix, whereas the building of the research institution is identified as the purpose. Implied in this type of project description is the notion that building an institution will achieve the goal of increasing production, productivity, and incomes. Unfortunately this leap of logic contains a good number of important assumptions that more often than not result in limited or no impact from agricultural research, simply because the improved technology does not reach or is not appropriate to farmers' production or marketing constraints.

The methodology of the research indicators exercise leads one to identify the constraints to farmer adoption of new technology at all steps in the process from the conceptualization of research themes to final impact on the economy. The process of development and transfer of natural resources management technologies using indicators from the Malawian case study is herein presented in two categories: factors that are (1) endogenous and (2) exogenous to the research/extension system. Those factors that are endogenous to the research/extension system include the development of national research programs, the transfer of technologies from research to public extension services or private commercial interests, and the transfer to and adoption of new technology by farmers. Factors which are exogenous to the system include macroeconomic and agricultural sector policies, input and output marketing, marketing infrastructure, cooperatives or indigenous local organizations, and credit.

On the front end of the research/impact continuum, research projects have come into being after a significant amount of more basic and applied research has been performed, mostly regionally or internationally, and some internally. The extent to which basic or applied research is needed, as opposed to adaptive research, dictates in part the length of time required to achieve impact. An examination of the Malawi case shows the importance of bringing to bear the international body of knowledge on priority research problems. With a minimum of well-trained researchers and technical assistance the Malawian Department of Agricultural Research (DAR) has demonstrated the capacity to effectively borrow research findings, methodologies, or germplasm, from the region or internationally, and adapt technologies to suit local conditions. In doing this Malawian research programs have moved technology from research to extension within a relatively short period of 8-10 years. As a further result of past and on-going investments in training scientists the time-frame for adapting research results to Malawian conditions is now potentially even shorter.

In the middle of the continuum, the transfer of technology to

farmers must combine socially and economically viable extension messages with a cost-effective extension methodology. Malawian experience shows that it is possible to have a well-thought out extension approach but have relatively little impact on the vast majority of smallholder farmers. The reasons for this are several: new technologies which are dependent on expensive inputs have been biased toward relatively wealthier farmers; extension themes have little new technology to offer to resource-poor farmers; even where new technogy exists there are insufficient operating funds to effectively mobilize the technicians to reach farmers; and inputs and credit arrive late or are insufficient.

Finally, an examination of the Malawian experience demonstrates that at the back end of the research/impact continuum, factors exogenous to the research/extension system are crucial to the technology transfer process and final impact. On the economic side, macroeconomic and agricultural sector policies, efficient input and output markets, marketing infrastructure, and access to credit will provide an incentive structure for farmers to invest in improved technologies; whereas on the farmer household side, indigenous local organizations, access to land and labor resources, and cultural preferences will all have an effect on farmers ultimate decisions to take risks and adopt new methods.

The findings of the Malawian research indicators study have interesting implications for AID programming in Malawi and other countries. First of all, the institutional base of DAR permits the Mission to target discrete assistance to key commodity research programs and, with a minimum of consultative short-term technical assistance, expect to achieve impact within a relatively short time-frame. Furthermore, the exercise has focused on a number of sector policies that could be targeted for change through non-project assistance: policy changes which are needed in order to realize a return on research investments. The linkage between policy and research interventions can be further strengthened by allocating NPA counterpart funds to research operating expenses on targeted priority problems.

In the remainder of this report an attempt is made to identify the key indicators of progress and impact of agricultural research on improving natural resources management (NRMS). Based on the probable impact improved technologies have had on farmer productivity, and past and present AID interest and involvement in these research areas, this study has identified the most promising areas of NRMS research as being (1) soil and water conservation (contour bunds), and (2) agroforestry (alley-cropping and tree spacing), as they pertain to improving cropping systems and increasing soil fertility on a sustainable basis.

II. The Process Leading to Impact

The analysis provided herein follows the methodology developed by the Research Indicators Team that visited Kenya for

those questions and indicators that are or were the most important in achieving an impact from NRMS research. Liberties were taken in the order of presentation in order to identify the indicators corresponding to the steps new technologies follow from research problem identification to final impact. More specifically, the questions were re-ordered to follow the process that takes place from level 1: the conduct of a research and technology transfer program, through level 2: variables that condition farmer's response to a new technology, to level 3: the impact of an improved technology on production and the economy. In the process several new questions and indicators have been identified, and slight modifications of existing questions to fit NRMS research were made.

Level 1: The following schema identifies the important steps, beginning with the identification of a priority problem, which are internal or endogenous to the research and extension system.

```
Problem---->Research---->Research---->Technology
Identified  Conducted    Adapted       Delivered
```

Level 2: A number of other factors are important in that they determine the responses of farmers to an improved technology that is presented to them. They are essentially socioeconomic -- input and output prices, availability, timing, land and labor resources, and cultural preferences -- and are presented below. These are labelled intervening variables in the methodology.

```
Prices      Farmer       Land
Capital---->Adoption<----Labor
Credit      Decisions    Culture
```

Level 3: Finally, there are a number of impact indicators at several different levels of analysis concerned with intermediate, household, and national level impact, which will occur in the following order.

```
Productive---->Productivity---->Industry---->National
Capacity       and Incomes      and Commerce Production
```

III. Factors Endogenous to the Research/Extension System

Under this heading we will examine indicators of research progress and impact as they relate to research and extension activities. In Malawi, as in most African countries, the public sector has dominated research on food crops and farm management areas that are intended to assist the smallholder farmer. While growers of some commercialized commodities have organized their own research programs that may in fact benefit a segment of smallholder farmers, most smallholders depend on the Department of Agricultural Research (DAR) of the Ministry of Agriculture for the development of improved technologies. This is especially true for NRMS research.

A. Level 1: The Development of National Research Programs

1. National/Research Policies

Questions:	Indicators:
Does the country have an agricultural development plan that reflects the importance of NRMS research?	Yes

Although the response to this question is affirmative, the Statement of Development Policies, 1987-96, outlining support for (1) food self-sufficiency, (2) import substitution, (3) export enhancement, and (4) cash crop promotion, is somewhat vague in providing quidance to DAR in setting research priorities. According to the Malawi National Agricultural Research Project (NARP) Triennial Review, the national priorities allow for the justification of any research project, and they are not fully integrated with other government policies, including commodity prices and input subsidies. On the other hand, the Statement calls for an examination of the critical area of natural resource management in farming operations, upon which increasing agricultural production depends.

Does the country have a research policy reflecting the importance of NRMS research?	Yes/No

An Agricultural Research Master Plan has gone through several drafts, the latest of which was January, 1989. This document provides significantly more guidance on research priorities than in the past. With respect to NRMS research, specific areas including soils, agroforestry, and intercropping are identified; and soils and agroforestry have been given commodity research status in the DAR. In addition, adaptive research has been given commodity research status and with the feedback of farmers and extension agents has incorporated NRMS research into their research agenda.

2. Effective External Linkages

Does NARS have effective formal and informal linkages with IARCs, other international research institutes, other NARS in the region, and access to technical assistance for NRMS research?	Yes/No

Between 1980 and 1986 the DAR conducted research on the soil conservation practice of constructing contour bunds on slopes of 7-8 degrees for four water catchments under different management regimes. The research demonstrated the utility of those structures in controlling soil erosion and nutrient loss. In

it's conception the research drew upon previous research in the U.S. in particular, and expanded knowledge of the importance of contour bunds on watershed management in the tropics. With their own resources the Land Husbandry Division is attempting to carry the research one step further to demonstrate the effects of contour bunds on production and productivity. By building on international experience, the DAR has validated and given impetus to the promotion of "marker ridges", which are pegged for farmers by extension agents and constructed during the dry season.

The establishment of agroforestry research linkages with IARCs and other NARS in the region is off to a shaky start. While Malawi is undoubtedly benefiting from the international body of knowledge on agroforestry research and effective technical assistance provided by the Rockefellor Foundation, relations with the International Center for Research on Agroforestry (ICRAF) have been strained because of the perception that the regional SADCC program, as it was defined by ICRAF, does not meet the needs of Malawi. The problem appears to be one of communication and collaboration with NARS in defining priority areas for research, and needs to be worked through to avoid duplication of research while meeting the needs of all countries in the region.

3. Effective Internal Linkages

Does NARS have effective formal and informal linkages with other public and private research institutes in the country?	Yes

At least three Malawian institutions are involved in NRMS research: the DAR of the Ministry of Agriculture (MOA); the Ministry of Forestry and Natural Resources; and Bunda College. For the most part the division of responsibilities between the Ministries has been well-delineated; the DAR takes responsibility for agroforestry as it pertains to agricultural production. The DAR also has responsibilty for soil and water conservation research. On the other hand Bunda College, which is in the Ministry of Higher Education, does not appear as well integrated into the soils and agroforestry commodity research groups of the DAR as they could be. They are proposing projects that duplicate work in agroforestry; but are also conducting soil classification and fertility surveys which complement the work of the DAR. Within the MOA the Land Husbandry Division and the DAR have collaborated well in conducting soil conservation research.

4. Adequate Information/Library Resources

Do research proposals and write-ups contain extensive reviews of the literature from scientific journals and up-to-date information in their fields of research?	Yes/No

Scientists at the main research station at Chitedze have a library facility constructed under the NARP, that appears to be well-supplied and well-managed. Other research stations throughout the country are less well-endowed, but do have librairies with reference materials. However, it is likely that the cost of maintaining these facilities -- while extremely important -- is beyond the means of the DAR. Therefore without donor support the DAR would find it difficult to maintain up-to-date editions of research journals and other reference materials.

A review of research papers and plans shows that DAR scientists, with the possible exception of adaptive researchers located in the extension service, have access to current research in the fields of soil conservation and agroforestry. With assistance from the Office of Development Assistance (ODA) of Great Britain, the Land Husbandry Department of the MOA conducted a thorough literature review of soil conservation research in the United States and elsewhere prior to embarking on the project. As a result the research added to existing knowledge and contributed to an understanding of the effects of soil erosion, especially in the tropics. Similarly, the agroforestry research action plan contains a broad review of research on low-input agricultural systems; and the program has benefited from earlier research in Malawi since 1972 on the introduction and establishment of Leucaena spp., although much of the research done at that time was on livestock and poultry feeding rations.

5. Research Planning, Organization, Management, Budgeting

Are NARS priorities articulated according to research policy and resource needs defined by iterative planning exercises?	Level of complexity: 1 Index value %

Decisions as to resource allocation among development and research options are made by the MOA, and translated into research programs by the DAR. In organizing the research program, the DAR has created seven commodity groups: cereals, grain legumes, horticulture, livestock, soils and agroforestry, plant protection, and adaptive research. In the case of natural resource management research it is significant that soils and agroforestry have been given commodity group status: a position that is generally reserved for specific crops and livestock. This is a reflection of the priority given by government to natural resource base issues, and the need to find sustainable solutions to the problem of declining soil fertility. Because of it's commodity group status, the soils and agroforestry research teams are adequately funded, with donor assistance.

B. The Transfer of Technologies to Extension and Commerce

1. Commodity/On-Farm Research Linkages

How strong are the linkages between the commodity research teams and on-farm researchers? High Score

The DAR has adopted a unique -- and quite effective -- organizational arrangement for adaptive research. As mentioned above adaptive research has been given commodity group status. Adaptive researchers participate as equals on the research teams of other commodity groups; but their main "raison d'etre" is to research solutions to the more intractable problems faced by farmers and serve as a conduit of information back to the stationed-based researchers in the other commodity groups. At the same time, the other commodity groups perform their own on-farm research because the adaptive researchers could not possibly do it all. One important difference is that the other commodity research teams are comprised of agricultural scientists only, whereas the adaptive teams include a team of one socioeconomist and one agronomist based at each of the eight divisions of the extension service throughout the country.

In spite of the fact that the adaptive research commodity group is only about three years old, one interesting outcome of adaptive research is that they have demonstrated to researchers and extension agents alike that farmer practices make sense. For example, many farmers have long inter- or relay-cropped a variety of food crops in the same field. Adaptive research has verified that not only is the total yield higher than in monoculture arrangements, but the soil is protected for longer periods from erosion. These successes have helped to overcome the research station bias felt by some of the adaptive researchers -- that they were less scientific or professional. In order to retain good researchers in the adaptive research commodity group the incentive structure will have to promote them at rates equal to other commodity group scientists.

2. Research/Extension Linkages

How strong are the linkages between the commodity and adaptive research teams and the extension service? High Score

The positioning of the adaptive research teams in the regional offices of the extension agency places them in an excellent position to interact regularly with extension agents. In fact, the groups interact frequently in both informal and formal reviews of the research program. In responding to extension demands, adaptive researchers are now fine-tuning inter- and relay-cropping recommendations. Several adaptive research teams have chosen, with extension service input, to begin trials on agroforestry as well. Hopefully, and quite likely, they will improve on the recommendations of extension agents who with good intentions have tried to promote agroforestry using recommendations from outside that subsequent

research in Malawi has shown to be unsuited to local conditions.

3. Research/Commercial Interests Linkages

How strong are the linkages between the research service and input and output commercial interests? Low Score

The normal market response mechanisms to new technologies and feedback to research and development do not operate well in the context of highly controlled input and output markets. As was seen in the maize example, consumers have little or no choice in the improved varieties available for purchase. There is naturally even less market response for soil conservation and agroforestry research for soil improvement, because they do not offer a marketable product. However, to illustrate the point there seem to have been good linkages between research and the livestock and poultry feeding industry in the mid-1970's. It was at this time that Leucaena spp. was first introduced and tested in Malawi; and research was conducted on the optimal mixes of Leucaena leaf and other feeds in livestock and poultry rations. Leucaena leaf producers in the Shire Valley found a market for the leaf at the National Grain and Milling Company in Blantyre, who used it in poultry rations because of its effect on coloring egg yokes. Unfortunately, the Milling Company might have found an alternative feed supplement because they stopped accepting the leaf. Leucaena also has been and still is grown by dairy farmers as a feed supplement during the dry season.

C. The Transfer of Technology to Farmers

1. Private Promotion of New Technologies

Does the private sector promote the use of new NRMS technologies? Low Score

In part because the trade of smallholder production is largely limited to the parastatal marketing institution ADMARC, a private sector-based system of marketing inputs has not developed. As a result the system is not particularly responsive to farmer's requirements. Recently Cargill Corp. has invested in the National Seed Company of Malawi and holds a majority interest in it's shares. Even so the low purchasing power of smallholders and their dispersion throughout the country may prevent the development of private sector input marketing. In any case it is almost certain that NRMS research and development will not produce anything that is attractive to the private sector, unless there develops a market for tree seedlings: a role now performed by the Ministry of Forests and Natural Resources.

2. Public Extension Planning, Organization, Management, Budgeting

Does the extension service effectively Medium Score

promote the use of new NRMS technologies?

Relative to many African countries the extension service in Malawi operates well. Under their decentralized structure the eight Agricultural Development Divisions (ADDs) have significant responsibilities to tailor the extension program to the needs of their farmers; while at the same time they have direct access to the Principal Secretary of the MOA. Perhaps structurally they have too many levels of supervision and training; and consequently inadequate contact between the Subject Matter Specialists at the ADD or Rural Development Project (RDP) levels and the Field Assistants (FAs): the lowest level agents. These FAs also have significant credit and marketing responsibilities on behalf of the Smallholder Agricultural Credit Administration of the MOA and ADMARC, which take up a fair amount of their time and conflict with their role as advisor to the farmer.

The two primary constraints to the effectiveness of the extension service are the number of appropriate extension messages they have for smallholder farmers and the operating expenses available to deliver them to farmers. On the first constraint they are making excellent progress through the adaptive research program at developing appropriate technologies for low-input cropping systems, especially in tree spacing, alley-cropping, and inter- and relay-cropping. The latter have already been translated into extension messages and are being delivered to farmers. Furthermore, the soil and water conservation techniques of putting in contour bunds on sloping lands (now called marker ridges to avoid the stigma of colonial times) that have been validated by research are being "pegged" by Land Husbandry Officers of the ADDs and RDPs when operating expenses are available. Reportedly, farmer demand outstrips the ability to provide the service in spite of the farmer labor requirement involved (the work is largely performed during the dry season).

IV. Level 2: Factors Exogenous to the Research/Extension System

A. National Policies

1. Macroeconomic

Do macroeconomic policies affect the adoption of new NRMS technologies? Probably Not

It appears that macroeconomic reforms and structural adjustment have impacted negatively on smallholder farmers in that the reduction of social services and higher prices paid for goods affects those most who can least afford them. The linkage between macroeconomic reforms and the adoption of NRMS technologies is less apparent, but nonetheless there. As prices for agricultural inputs are raised, more and more smallholder farmers, due to their limited landholding size, are forced to

depend on low-input cropping systems to maintain production levels. For the majority of smallholders, increasing productivity is crucial to meeting increased food demand from the rapidly expanding population. Off-farm employment opportunities are not likely to absorb and employ a significant part of the labor force. Currently, the technology has not been completely developed and as a result productivity is declining.

2. Agricultural Sector - Input and Output Marketing

Are there ag. sector marketing policies which are counterproductive to the adoption of new NRMS technologies?	Probably Not

Reforms intended to liberalize pricing and marketing of food crops do not yet appear to have significantly stimulated private sector marketing of the major commodities; while the parastatal continues to assume this role. As already stated, research on NRMS does not generally lend itself to marketing opportunities. To the contrary, market incentives for agricultural production have the potential of causing harm to the environment if further extensification onto more marginal lands without proper conservation measures were to occur. The relative abundance of land on estates permits them to practice a more productive fallow system, but at the same time they are slower to adopt conservation measures and establish woodlots in spite of government requirements. On the smallholder side, farmers are increasingly adopting conservation measures to increase productivity because they are forced to intensify production on ever scarcer land.

B. Marketing Infrastructure

Are there adequate crop storage and transport facilities to support the adoption of NRMS technologies?	Not Relevant/ Good

While these factors may be important to the adoption of other improved technologies, especially maize for its storage and processing characteristics, they are not as important to the adoption of NRMS technologies, with the possible exception of farmer access to extension services. Malawi has a good system of major and secondary roads, therefore, extension agents are able to move around when the have transport. However, even the price of a bicycle is beyond the means of agents and their ability to repay a loan.

C. Access to Land and Labor

Do land tenure arrangements or access to land and/or labor constrain the adoption of NRMS technologies?	No

For the smallholder farmer access to land is the major constraint to increasing aggregate agricultural production. Ironically, it is the lack of available land that favors the adoption of NRMS technologies among smallholders. As farmers are forced to increase productivity per unit of land, they must turn to NRMS technologies which are by nature intended to do just that. With respect to labor, soil conservation structures are put in place when labor is less constrained; and the agroforestry commodity and adaptive research groups are currently examining the issue as it relates to tree establishment and management practices. The recommendations that go to extension will have to take into account these factors.

There is general agreement that while land is scarce, the Malawian lease and customary land tenure arrangements per se give both estate and smallholder farmers the security they require to make long-term improvements on the land. In spite of this, estate owners do not make those improvements because they do not have the economic incentives to invest in them. But as mentioned before they practice a more sustainable fallow system. And the largest estates growing perennial tree or bush crops represent a much more sustainable use of the land than smallholder production of annual food crops. Unfortunately, estate crops do not feed people or provide enough jobs to gainfully employ the large number of farmers on economically unviable smallholdings, at least under currently available farm practices. Soil conservation and agroforestry will improve the food and nutrition situation considerably, but not entirely.

D. Cooperatives - Indigenous Local Organizations

Do coops or local organizations exist to facilitate the adoption of new NRMS technologies?	Yes

Research has demonstrated that a package of improved new technologies including contour ridges and land use planning (crop rotations and inter- and relay-cropping, tree spacing, and alley-cropping) -- on a catchment basis --is most effective in increasing the sustainable productive capacity of the land. In order to realize the full benefits of proper land use planning for watersheds, community participation and consensus is required. While parts of this technological package have only recently been fully developed for extension and the productivity effects are only beginning to be realized, the research results promise hope in turning around the trends in declining soil fertility. Because the technology is most effective when applied to whole watersheds, local indigenous authorities and groups will be required to implement this package. For example, in Blantyre ADD some villages have formed conservation committees to supervise the construction and placement of contour ridges and the planting of bananas or other non-root crop perennials on the ridges. In most areas of Malawi, local organizations can be used to mobilize community action to put into practice NRMS

technologies.

E. Financial Institutions - Access to Credit

Do financial and credit institutions exist to provide credit for new NRMS technologies?	No

Obviously, because of the long-term nature of NRMS interventions credit will not likely be available to smallholder farmers so that they can invest in new NRMS technologies. Nevertheless, modest amounts of medium-term credit to the larger smallholders or smaller tobacco estates might facitate the adoption of improved NRMS practices, particularly the construction of conservation structures and the establishment of woodlots, on those lands. In theory, because smallholder credit is given on the basis of a group guarantee, a farmer could take credit for tree seedlings. But in actuality credit is currently given on an in-kind basis for commodities only available in ADMARC stores.

V. Level 3: Intermediate/Final Impact Indicators

A. Technology Utilization

What % of farmers are using new NRMS technologies?	Medium

The two agroforestry technologies that have promise are tree spacing of Acacia Albida, and alleycropping with various tree species. The benefits of Acacia Albida are already known to farmers, who protect them in their fields. The first attempts to actually raise the trees and space them in fields has begun, and the benefits in terms of increased production have been studied. A relatively small number of farmers will have succeeded in establishing the trees in their fields in the next two years, but the benefits will be realized in an even longer time-frame. By 1992 we might expect that the extension themes have been developed and adopted by 1,000 farmers in areas where the technology has potential. Research on alleycropping is well along the way to providing recommendations for extension within the next 2-3 years.

What is the % of land put under improved NRMS technologies?	Medium

Data on ADD programs to lay out "marker ridges" for farmers are often reported in kms., and occasionally in hectares, rather than in the number of adopting farmers. Assuming that the average distance between ridges is 5 meters, roughly 2 kms. of ridges would be constructed in 1 hectare. The team was not able to obtain data from each of the eight ADDs, however, three of them reported on the average a total of 1,000 kms. of contour bunds constructed per year, or 500 hectares. The primary constraint to

doing more is the lack of operating funds -- not farmer demand.

B. Productive Capacity

Has the adoption of NRMS technologies increased the productive capacity of the natural resource base?	Yes

Research has demonstrated that the practice of laying out contour bunds and employing improved cultural practices of planting in furrows along the contour and of crop rotation, inter- and relay-cropping, greatly reduces soil erosion. Expressed in terms of soil loss in one experiment, the catchment basin where no conservation structures were constructed and no improved cultural practices were employed lost on the average 10.8 tons of soil per ha. per year, whereas the catchment basin with conservation structures but no improved cultural practices had soil losses of 2.6 tons per ha. per year. The soil loss in the catchment basin under conservation structures and improved cultural practices lost only 0.1 tons per ha. per year. According to the research report, soil losses over 10 tons exceed the capacity of soils in the tropics to regenerate topsoil in a year, and the figure is considerably less for soils that are continuously cropped.

There are, however, a few questions to be raised in extrapolating those research results and in estimating the benefits of contour bunds to other areas. First of all, rates of erosion may vary on different soil types, depending on the percentage of clay, silt, and sand. Secondly, the research was conducted on slopes of 7-8 degrees. While these slopes may be average (they are at least less than the 12 degree limit recommended for agricultural use), the relationship between slope and erodibility is likely linear if not geometrical, i.e., the steeper the slope the greater the erosion. And it is worth noting that according to several Land Husbandry Officers interviewed, fields with slopes as gentle as 2-3 degrees could be highly eroded. Given the foregoing caveats, the savings in top soil from the construction of 1,000 kms. of contour bunds would equal 2,000 tons per year.

Apart from fertilizer the most promising technology to add plant nutrients is agroforestry, keeping in mind that it mainly adds N by fixing atmospheric nitrogen. N is by far the most limiting plant nutrient, so one can expect a significant response. A measure of soil fertility, and more precisely the status of N, might be used to monitor the on-going status of the resource base for agricultural production in a representative sample of Malawian soils. Measures of N will indicate whether the longer-term fertility of the soil is being enhanced by adding plant nutrients rather than merely being mined on an unsustainable basis. Plant tissue analysis should be performed to help interpret and verify soil test findings.

C. Household/Farm Production

Has agricultural productivity increased from the adoption of NRMS technologies, according to farm size?	Probably

The research on the effects of constructing contour bunds demonstrated that the bunds prevent soil erosion and nutrient loss; but it did not show the effects on crop productivity. It would be useful to follow up with the Blantyre ADD on obtaining yield data from the research sites, while being very careful to sample plots with similar cropping and fertilizer histories.

The impact of tree spacing of Acacia Albida on farmer production and productivity will be felt after a five year period when the trees have been established, and will have to estimated from on-going research results, especially on-farm trials under farmer management. On the other hand preliminary results demonstrate that the returns to alleycropping with Leucaena can be realized immediately after establishment of the tree crop. Maize yields on research plots increased from 1.6 to 2.2 tons per hectare with no fertilizer application; from 3.0 to 3.7 tons per hectare with 50 kgs. of N; and from 3.1 to 4.2 tons per hectare with 100 kgs. of N. In the future agroforestry's contribution to increasing maize production can be calculated by knowing the number of farmers who have adopted the technology multiplied by the theoretical yield from research on farmer's fields. The ADDs could easily track these adoption rates and report them back to the Mission on a yearly basis.

In Malawi it is important to disaggregate household production data by farm size because of the large disparaties that exist in access to land. A large number of farmers have little or no land on which to expand production, and there are reported tendencies to move production onto steeper hillsides and more marginal lands. Therefore, a measure of productivity will permit the Mission to monitor the extent to which intensification or extensification is occuring. This is especially important for the smallholder sector, but it is also important to monitor production and productivity trends in the estate sector. Current data is disaggregated by smallholder farm size, but I believe does not include data on small estates.

D. Industry/Trade Spinoffs

Has rural agro-industrial transformation occurred as a result of the adoption of NRMS technologies?	No

or,

Have the number of marketing firms for a commodity increased as a result of the adoption of NRMS technologies?	No

Some of the by-products of agroforestry have the potential of providing the raw materials for small industries, such as the use of Leucaena leaf in feed rations for poultry or dairy cattle, or the use of trees from woodlots for charcoal production. While the use of Leucaena leaf in poultry rations for a time flourished, the market proved not to be sustainable. And the number of livestock farmers feeding Leucaena as a feed supplement has remained low, probably less than 5%. Lastly, up to now most charcoal production has relied on wood from the Viphya plantation or natural woodlands. Unfortunately, the potential for spinoffs and value added production from NRMS-generated products is low at present. At best NRMS technologies should lead to more sustainable levels of production of marketable food and cash crops.

E. National Production

What has been the contribution of improved NRMS technologies to production of a commodity nationally or regionally?	Low

It may well be impossible to separate the contribution of NRMS-research generated impact from that of other commodity research or the effects of market prices and policy changes. Even the fairly widespread adoption of NRMS technologies would not have an immediate impact on productivity and production, by it's nature. Therefore, it may be most profitable to ask what the situation may have been or would be over the long-run if NRMS techologies were not adopted, working backwards from on-farm research results, to the number of farmers adopting a technology, to the theoretical increases in production and productivity which would occur over a fairly long period of time, e.g., 10 years. From such data one might estimate the replacement value of the production increases in terms of the cost to import food or the savings in foreign exchange.

VI. Conclusions

There are at least two major lessons which can be learned from the indicators exercise in Malawi: (1) that we are now in a better position to concentrate on research impact because of past investments in institution building; and (2) agricultural research, if properly targeted, can play a significant role in alleviating production constraints provided farmers have access to land resources, market incentives and appropriate policy environments.

At their present stage of development, the Malawi national agricultural research program is at the point where they can effectively borrow and adapt the technologies that the country requires to increase agricultural production. The investments that were required to bring the program to this point were substantial; and the gains made are very fragile. Like many

African countries, Malawi is unable to support the recurrent costs of the program, and will depend upon donor support to keep the system going and scientists motivated. Futhermore, they will for many years to come have to rely on the international research community for the basic and some applied research from which they can adapt technologies suitable for Malawi.

In the future A.I.D. may have to further focus the research effort to building research producing capacities in only a few countries. Given our declining resources, and those of most host countries, perhaps it is possible for A.I.D. to direct our interventions to build upon the institutional development which has already taken place in many countries like Malawi, and concentrate on the expected returns (impact) of specific, well-defined research outputs. The research program in Malawi is in fact moving in this direction: national priorities have been set; resources have been focused and re-allocated; and the national program has defined specific research targets in maize breeding and agroforestry that have relatively short time-frames.

Another reason for targeting our research investments on specific outputs will be to enhance farmer's comparative advantages and help them to capitalize on opportunities for income generation as well as food security. The Malawi case is a good example of a country that is doing many things right from the perspective of the traditional roles of the public sector (research and extension); and yet the rural economy is stagnating because of statist sectoral policies which inhibit the development of a market economy. Those policies, coupled with a skewed distribution of land disfavoring the large majority of smallholders, have created disincentives to producing marketable crops and forced farmers to eke out a subsistence living by seeking wage labor on estates, where they can. Clearly, these policies require addressing before many farmers find it in their interest to take risks in adopting new technologies.

In such an environment low input NRMS interventions may be the best solutions for increasing the productivity of resource-poor farmers. For both soil and water management and agroforestry technologies, the incremental gains in production can make a difference in food crop availability to the groups most at-risk of being malnourished. Without the development of these technologies elsewhere and their adaptation to Malawi, resource-poor farmers would have little hope in increasing food production -- and even less hope for doing it on a sustainable basis.

INTERMEDIATE IMPACT INDICATORS MATRIX

MALAWI — NATURAL RESOURCES MANAGEMENT

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base	***A. At national/ministerial level***			
Does NARS have institutional structures & management mechanisms which will permit all critical functions of a research system to be effectively carried out?	**Manageable Interests of Parent Ministry and Institute**			
	1.0 Development of national research policy as it relates to national development policy.			
	Questions:			
	Does the country have an agricultural development plan?	Y/N	Yes - Statement of Dev. Pol. 1987-96	
	Does the country have a research policy?	Y/N	Yes - Ag. Res. Master Plan	
	Who monitors the continued concordance of research and development policies?	Name body		
	1.1 NARS priorities articulated according to research policy and resource requirements defined based on iterative planning exercises.			
	Questions:			
	What process exists for setting research priorities and allocating resources? How does this process take into account:	Level of complexity of analysis: 0 = no formal priority setting method; 1 = congruence method; 2 = weighted criteria or other formal method.	0 - any research project justified	
	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 need, distribution of benefits, political considerations, etc.			
Swanson #9:1 and/or 2	The probability and cost of research success, including national use of existing personnel, infrastructure, financial resources, etc. and taking into account past research results, both positive and negative, national and international	Resource allocation to commodities; Index value % research personnel/commodity research program. (state whether planned or actual)		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	**1.2** Effective communication of NARS needs and acquisition of resources.			
	Questions:			
	Does NARS receive an adequate level of funding from Government?	Research budget as % of Ag. GDP.		
	Does NARS receive the types and levels of funding requests from donors?	Funding level/request		
	Does NARS effectively coordinate donor-financed research activities?	Mechanisms: - Formal, timely meetings - New project starts based on NARS priorities - New project starts outside of NARS priorities		
	Does NARS initiate the identification of donor-financed activities?	Y/N		
	1.3 Effective external (international) linkages			
	Questions:			
	Does NARS have formal linkages with IARCs, international private sector research or agri-business? With whom and what type?	List and describe: 1 point each a) technology exchange; b) training; c) networking; d) consultation Maximum: 4 points	Good cooperation w/US research on contour ridges Shaky linkages on agroforestry research. Strained relations w/ICRAF	
	1.4 Effective internal (national) linkages			
	Questions:			
	Does NARS have formal linkages with MOA/EXT, other relevant ministries, universities, development projects, local agri-business, private sector research organizations? With whom and of what type?	List and describe: 1 point each: a) Priority setting process b) NARS board membership c) Training d) Technology exchange e) Contract research (in & out) f) NARS representation on other boards Maximum: 6 points		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***1.5*** Monitoring of impact-level indicators by parent ministries			
	Questions:			
	Who is responsible for baseline and time series data collection on production, changes in crop patterns and input use, natural resource management variables, farm incomes, etc.?	List by function/data type.		
	What data currently exist?	Inventory data sets		
	Are data readily exchanged?	Identify users for each data set.		
	1.6 Human resource management			
	Questions:			
	Does NARS have a personnel database	Y/N		
	Does a NARS manpower training plan exist?	Y/N		
Swanson #8	Is there an adequate career incentive structure to recruit & retain qualified staff?	- Operating budget/researcher - Scheme of service for researchers? Y/N - Annual attrition rate - # of vacancies - Proportion of support staff to research & technical staff		
	2.0 Intervening Variables			
	2.1 Agricultural Policies			
	Questions:			
	Does NARS have a role in input & output price policy development?	Y/N Input policy Output policy		
	Does FX policy favor ag. sector?	- Special rates for ag. export/ import licensing; Y/N - FX readily available for input imports? Y/N		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	2.2 Extension services			
	Questions:			
	What priority is given to extension? Who carries out extension activities?	% Ag. GDP to extension List		
	Extension salaries comparable to research salaries of equivalent levels?	Y/N		
	How effective is extension?	3 = highly effective; 2 = moderately effective; 1 = marginally effective (subjective observation)		Farmer surveys T&V report Observation Interviews
George?				

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	Is there an adequate career incentive structure to recruit and retain qualified staff?	- Operating budget/extension officer - Annual attrition rate - # of vacancies		
	B. At NARS Institute and Program levels			
	1.0 Research program planning and management			
	1.1 Development of long-term research plan			
	Questions:			
	Does institute have a long-term research plan?	Y/N		
Swanson #5, 2	Do farmer orgs. participate in plan formulation?	Y/N farmer org. index		
	Does the plan articulate priorities and resource allocations by commodities/factors?	Y/N		
	Does it include projections for manpower, infrastructure and operating funds?	Y/N		
	1.2 Development of a program structure			
	Questions:			
	Does institute have a program structure which will effectively carry out the long-term research plan?	- Existence of national programs		NARP
Swanson #7 1 and 3	Are program leaders appointed?	Y/N		
	Are programs adequately staffed?	# researcher/program # technicians/researchers (ratio) # B.S., M.S., Ph.D/program		personnel database NARP ISNAR Indicators Series

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	***1.3*** Program and budget			
	Questions:			
	Does institute have a short-term program and budget?	Y/N		
	Are farmers involved in determining progams?	Farmer orgs. represented		
	Are programs based on constraints analysis?	Y/N		
	1.4 Monitoring and Evaluation (M&E)			
	Questions			
	How is research performance (efficiency) assessed?	- Active annual review process - # projects revised or cancelled		
	How is research quality assessed?	- Peer or expert review - # projects redesigned		
	Who establishes baseline data for research programs?	- Socio-economic surveys used in divising proposal? - Baseline survey		
	Who collects program-level and institute-level data for evaluation?	Individual scientists, prog. directors; M&E system		
	What are career promotion criteria?	List: Publications, advanced degrees, collaboration with extension.		
	What are criteria for pay increases?	Seniority, degree qualifications, etc.		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. Institutional Base (cont'd)	***Questions:***			
	How effective is the flow of information between research and its clients: policy-makers, extension services, farmers and others?	Mechanisms: Board meetings, sessional papers, annual reports, meetings with farmer org., bulletins, mass media messages.		
	1.5 External communication			
	Do institute centers and programs have formal linkages with clients, including extension services, provincial-level policy makers, universities, farmers, private sector research and agri-business organizations for problem identification, program formulation and execution?	List linkages: 1 point each a. problem definition b. investigation c. analysis d. evaluation Maximum: 4 points		
	With whom and of what type?			
	1.6 Internal communication			
	What formal linkages exist within institute, e.g. between programs, disciplines?	Multidisciplinarity: 1 point each a. Problem definition b. Investigation c. Analysis d. Evaluation Maximum: 4 points		Annual reports Interviews with program leaders
	How are multidisciplinary problems approached?			Annual reports Policy statements
	Is NR mgt./sustainability incorporated into redesign? (indicate multidisciplinarity)	Cite examples: - Shift from chemical to biological pest control - Agroforestry research - Reduced proportion of inorganic to organic nitrogen sources		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
I. **Institutional Base** (cont'd)	**2.0 Financial Resource Management**			
	2.1 Acquisition of funds			
	Questions:			
	Are funds received by institute headquarters, stations and programs in a timely way and in adequate amounts?	- Date requested, date received; - Programs/projects halted for funding shortfalls (# & proportion) - # of researchers without funded projects		
	2.2 Funds disbursement			
	Questions			
	Do station and/or program heads have the delegation of authority necessary to permit a flexible yet accountable use of funds?	Y/N		
	Can funds be retained and carried over from one year to the next?	Y/N		
	2.3 Accounting			
	Questions			
	Are adequate accounting procedures and staff in place throughout the system?	FM system centralized Y/N No. of clearances required? Trained accountants at each center?		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer	***A. For the Research System***			
	1.0 Intermediate results (outputs)			
	1.1 Training Opportunities			
	Questions			
(What are the quantity, quality and nature of the outputs of the research and extension system?)	What training is available for researchers, collaborators and clients?	# trained ST in-country ST abroad LT abroad (Past 3 years)		Personnel system data-base
	1.2 Progression of experimentation			
	Questions			
	Is research moving from strategic, to applied to adaptive research?	Proportion of research on-station, on-farm, being demonstrated (time series)	Increased adaptive and on-farm research in past 3 years - some duplication	Annual reviews extension reports
	How much research is conducted on-farm?	Research reports - # of trials listed		Annual reports
	How much research has moved into the field testing & demonstration stages?	# technologies moved from on-farm trials to demonstration stage/ program		Extension reports
	1.3 Surveys and constraint analysis			
	Questions			
	What studies have been initiated/completed on characteristics and constraints at agro-ecological levels, provincial levels, among cultural groups, etc. for outputs and inputs.	# projects with constraints analysis included # other studies analyzed	No mention of constraints	
	How is this information to be used?	List: 1 point each - research project design - research program design - midcourse correction - impact evaluation Maximum: 4 points		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation & Transfer (cont'd)	***1.4*** Interaction between research & extension			
(Swanson #10) modified	How do research & extension collaborate?	Nature, frequency of interaction Liaison officer? Y/N	—excellent and frequent interaction - attention to extension agent input	
	How effective is this collaboration?	# jointly planned/implemented trials.	—effectiveness promising —on-farm research impt.	
	What research methodologies have been developed/refined to encourage client participation in research planning, execution, and evaluation?	List: - Baseline surveys - Program-level or center-level planning meetings? - Field days - Annual workshops		
	What methods have been developed to monitor and evaluate technology transfer and adoption?	Committees, surveys, reports, on-farm research		
	1.5 Responses to government requests for policy advice	- Sessional papers - Participation in policymaking bodies - Requests for advice		
	2.0 Conclusive results			
	2.1 Technologies developed/released			
	Questions			
	What new varieties have been developed tested, and released to clients? (i.e., extension, farmers, private sector research)?	# varieties released	little or no consumer choice in improved varieties available	NARS annual reports Extension reports
	What new technologies have been developed, tested and released to clients?	# of technologies recommended to extension	Good linkage between foeds & livestock & poultry industry	
	What recommendations have come out of commodity programs?	Proportion of programs that have released varieties or technologies	Several techs recc. to extension - tree spacing, alleycropping	
	Has a "Menu" of technological choices been developed and offered to accommodate different systems and situations?	# of released varieties responding to low input vs. high input systems; # of techs with positive NR side effects, e.g., alley cropping, cut & carry, fodder, silage, zero-grazing	Yes - NR - esp. smallholder farmer	

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	**2.2** Publications			
	Questions:			
	What scientific, technical and farmer-level publications have been produced?	List internal/external Level scientific technical farm level		Annual reports Extension reports
	2.3 Inputs			
	Questions:			
Swanson #17	Are agricultural inputs (seed, fertilizers, pesticides, tools) available?	Distance from household to input supply point, # of sources of inputs - Credit given for inputs Y/N: in kind or in cash		
	Are there subsectors w/o inputs?	Y/N - high, med, low potential Y/N - areas kg/ha		
	Are there times of the year when inputs are not available, more expensive?	Y/N - timely delivery; seasonal shortages; price fluctuations for fertilizer & seed.		
	How are inputs made available to resource-poor/farmers (e.g. small packaging, etc.)	# smallest units seed or fertilizer sold/# smallholder units		
	2.4 Marketing infrastructure			
	Questions:			
	Are markets accessible to all producers?	- regional price variations - status of rural roads (proportion of farm housholds within 10 km of paved road		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	***B. For the Extension System***			
	1.0 Research results/recommendations accepted and extended			
	Questions:			
Swanson #14.3	To what degree have research results been promoted by the extension service?	All recommendations Some No recommendations Why % recommendation promoted by extension	(?) some dev. approp. tech for low-input cropping systems & soil & water conservation	T&V reports Liaison officer interviews Extension service reports
	To what extent does extension adopt researcher-recommended technologies?	All adopted Some None adopted Why		
Swanson #12	How is adoption of recommendations tracked?	Tracking system exists Y/N Tracking system applied Y/N		Liaison officer interviews Extension service reports
	2.0 Extension methodologies & Effectiveness			
	Questions:			
	What extension methodologies have been developed/refined to improve extension participation in research?	Ranked allocation of extension agent time in tech. generation and transfer activities	ADDs have direct access to Principal Sec. of the MOA	T&V agent reports
Swanson #14.4 Swanson #14.5	What extension methodologies have been developed/refined to improve the extension-farmer linkage?	# of program changes based on feedback from extension	Eight ADDs tailor extension program to needs of farmers	T&V on station or on-farm research program descriptions/evaluations
	What publications or other media mechanisms have been produced to inform farmers of research findings?	# of households with direct contact with extension agents (male vs. female-headed) # of new messages by type Actual samples	Conflict of interest - FAs credit & marketing responses for Smallholder Ag. Credit Admin.	Extension audio visual department Annual extension reports

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
II. Technology Generation and Transfer (cont'd)	C. Intervening Variables			
	1.0 Markets			
	Questions:			
	1.1 Farm to market roads?	Average distance farm to market? Proportion transport cost of total cost (market prices)?	Good major & 2 day roads	
		Farmgate vs. market prices		
	1.2 Does a market information system exist for commodities?	Y/N on radio in print media		Observation
	1.3 Are there price constraints for commodities?			
	1.4 Are there required marketing channels that must be used?			
	1.5 Are there commodity marketing standards?			
	1.6 Are the recommended inputs available?			
	2.0 Storage and processing considerations			
	2.1 Is value added at household level for commodities examined?	Farm level profit & loss		Farm budgets by type of farm
	2.2 Proportion of post-production losses	Costs & returns at commodity level		
	2.3 Post production processing	Value added to commodities		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (Adoption & Beyond)	**1.0** Technology Utilization			
How can the adoption of technologies produced by the NARS be measured, and results used to forecast probable impact on the national economy?	**1.1** What % of farmers are using new technologies?	Adoption of technology stratified by farm size high, medium, low potential, male/female household head.	Medium %	Project studies Extension service records, e.g. farm management unit. Special Studies
	1.2 Has total production increased in a commodity or region?	Production statistics; yield data; land use data by commodity & region. Production 1 area cultivated.	Soil erosion decreased effect on productivity not clear yet	Central statistics office MOA statistics office Remote sensing data
	Have sales of fertilizer, seed, etc. increased? (Substitute relevant inputs/case study)	Sales records		Cooperative records Import/Export records
	Has there been a tech-related shift in crop mix?	Tech-related shift in crop mix short-term and long-term		National statistics office Remote sensing data
	2.0 Rural agro-industrial transformation			
	2.1 Has agro-industrial transformation occurred?	# of rural-based small enterprises by regions (female vs. male-owned) 10 workers or less? Increased rural savings	No	MCA
	2.2 Has research/extension resulted in the formation or strengthening of farmer organizations?	- # organizations - # members		

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
III. Intermediate Impact Indicators (cont'd)	**3.0** Management of natural resource base ***Questions:***			
	3.1 Has NR management been an element of technology adopted?	Increased land cultivation (intensive vs. extensive) Proportion owned vs. rental land, security of access to land % top soil loss, salinization rate Sedimentation rate	Yes - intensive land cult trees spacing & alley cropping contour ridges built for conservation	
	4.0 Policy changes at sector level	Price policy; input policy; marketing policy		
IV. Impact How has investment in research influenced the economy of the country, in terms of incomes, productivity, production & food security (availability, access & adequacy)?	**1.0** Net farm income	1. Change in net farm income at national aggregate level in real terms. 2. Change in net farm income/ farm in real terms disaggregated by farm size male/female household heads 3. Changes in net farm income per AEPA		FAO yearbook World Bank reports Treasury reports
	2.0 Agricultural productivity			
	2.1 Has agricultural productivity increased by farm size, etc.	1. Change in value of prod/capita. 2. Change in value of production/ farm (EAPA, male/female). 3. Change in value of production/ farm by farm size. 4. Change in value of ag. production per hectare of agricultural land. 5. Change in value of ag. production by unit of ag. investment of credit for agriculture.		Central statistics offices, MOA, Treasury, Credit Bank, FAO nutrition statistics.

ISSUES	QUESTIONS	INDICATORS	ANSWERS	SOURCES
IV. Impact (cont'd)	3.0 Food Security (national level)			
	3.1 What is the impact of ag. research on food security at the national level?	1. Change in per capita food production and consumption. 2. Change in ag. GDP (including non-food crops). 3. Change in % self-sufficiency in basic food commodities. 4. Variability in total annual ag. production. 5. Change in per capita food imports by value. 6. Change in annual carryover stocks of basic food stuffs (buffer stocks)		