Report

Improving Monitoring, Evaluation, Adaptive Research and Impact Assessment for Conservation Farming in Zambia

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Report

Improving Monitoring, Evaluation, Adaptive Research and Impact Assessment for Conservation Farming in Zambia

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Preface

Several people in Zambia and elsewhere contributed their time and ideas to this effort. Ted Hunting, Dr. Obed Lungu and Mukelabai Ndiyoi made direct written contributions to the report covering the cost benefit analysis, soils investigations and adaptive research respectively, although none were formally engaged as consultants. Ted carefully reviewed the first draft of the report and assisted with many tasks during his two and half weeks in Zambia. The ECAZ team leader, Albert Chipeleme, contributed generously of his time to help me understand the team's approach, problems and accomplishments as well as identifying several factual inaccuracies in the early drafts of the report. His frankness and openness to suggestions have contributed considerably to our respective tasks and hopefully the eventual success of the ECAZ team's efforts. Other members of the ECAZ team made themselves available for detailed discussions on their roles.

At USAID/Lusaka, several individuals ably facilitated this consultancy mission, notably Morse Nanchengwa of the Agricultural Development Office, who provided direction and friendly suggestions throughout. The sad passing of his mother during the mission made it necessary for Cris Muyunda, to step in temporarily. My thanks to David Soroko, Cynthia Bryant, Lumbe Mumba, Kreole Mwamba, Moffat Selemani and several USAID drivers for their assistance in a variety of capacities.

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Thanks to Sinikka DeHanas, Program Manager at the Winrock International offices in Virginia for her friendly efficiency in making the administrative arrangements for this mission as painless as one might imagine.

Several individuals in government, donor agencies, private commercial firms, NGOs and farmer groups who are interested and/or involved in conservation farming listened patiently to my questions and collectively were responsible for most of what is included in this report. I wish to thank especially, Peter Aagaard and Dutch Gibson of CFU, Layton Mwale, Director of Field Services in MAFF, Dr. Stephen Muliokela, Director of GART, Dr. Bhola Nath Verma of ZAMSEED, Dr. Henrietta Kalinda-Chilumbu of SCC, Par Oscarsson of LMCF/SCAFE, Anthie Dickie of GTZ/Luso Consult, Mike Mailloux and Jessica Farmer, both of CLUSA. I take full responsibility for all errors and omissions. The views expressed do not necessarily reflect those of USAID or Winrock International.

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Acronyms

ASIP	Agricultural Sector Investment Programme
C/B	Cost/Benefit
CF	Conservation Farming
CFU	Conservation Farming Unit
CLUSA	Cooperative League of the USA
CMS	Credit Management Services
DAPP	Development Assistance People to People
ECAZ	Environmental Conservation Association of Zambia
FASAZ	Farming Systems Association of Zambia
FINNIDA	Finnish International Development Agency
GART	Golden Valley Agricultural Research Trust
GRZ	Government of the Republic of Zambia
ICRAF	International Centre for Research on Agro Forestry
ILCA	International Livestock Centre for Africa
INESOR	Institute of Economic and Social Research
LLFSP	Luapula Livelihood & Food Security Programme
LM&CF	Land Management & Conservation Farming Programme of MAFF
MAFF	Ministry of Agriculture, Food and Fisheries
MSU	Michigan State University
NGO	Non Governmental Organization
NORAD	Norwegian Agency for International Development
NSHDP	National Small Holders Development Programme
P	Phosphate
PAM	Programme Against Malnutrition
ODI	Overseas Development Institute
SCAFE	Soil Conservation and Agro Forestry Extension
SCC	Swedish Cooperative Centre
SCRB	Soil and Crops Research Branch of MAFF
Sida	Swedish International Development Agency
SOW	Scope of Work
UNZA	University of Zambia
USAID	United States Agency for International Development
WVI	World Vision International
ZAMSEED	Zambia Seed Company
ZNFU	Zambia National Farmers Union

Executive Summary

Conservation Farming, a term which encompasses a range of practices aimed at improving productivity through packages of soil and moisture management methods, is rapidly becoming the major thrust of the agricultural development strategies of several public, non governmental and private agencies in Zambia. Currently, the effort is being spearheaded in two provinces by the Conservation Farming Unit which provides technical and logistical support to a number of NGOs and private commercial firms who are promoting conservation farming methods through extension, input supply, marketing assistance and credit to farmer groups. Recently, the Government of Zambia launched a national program designed to promote conservation farming countrywide.

The Environmental Conservation Association of Zambia was contracted by USAID in mid 1998 to perform a range of monitoring, evaluation, adaptive research and impact assessment services related to conservation farming for an initial period of one year. The association assembled a team of experienced researchers, mainly from the University of Zambia to carry out the work. The team's responsibilities involve a variety of roles and relationships vis-à-vis stakeholders which cannot be easily accommodated by a single team or agency. The differing requirements of these tasks contributed to tensions between the team and participating agencies, particularly during in the early stages of team's work, and have limited its utility to date. The team could have done more to improved its relations with stakeholders, but personal and organizational relationships are a two way street. Many stakeholders 'tuned out' after the first quarterly meeting and made little effort to offer constructive suggestions. There was no attempt to harmonize the team's data collection and analysis with those of implementing agencies, most of whom have on going monitoring activities. The conservation farming monitoring and evaluation efforts remain fragmented and less effective than they might be as a consequence. The team understandably looked upon USAID as its principle client and did not devote as much attention to the concerns of other stakeholders as a consequence.

The team has completed its first year of work and is currently finalizing its annual report. The team's work can contribute to a better understanding of several aspects of the conservation farming promotional efforts, including the reasons for adoption and non adoption, the impacts on soil fertility and yields and the effectiveness of different extension approaches. Areas of weakness include the cost/benefit analysis and more generally the socio-economic and gender dimensions of conservation farming. The team members are aware of these and other problem areas and are undertaking to address at least some of them in the final version of their annual report. The team has collected and analyzed a considerable amount of information relating to promotion and impacts of conservation farming. Most of this information is not in a form which is readily accessible to stakeholders. It is in the interests of all concerned that the final versions of the team's reports be strong and useful products.

The socio-economic data reviewed is of a rather basic nature and it will be difficult to assess more than the most easily visible impacts (e.g. adoption and yield changes). Given the complex nature of small holder production systems, the current approach is likely to miss significant portions of the impacts. It is not reasonable to expect definitive results in the area of impact assessment, given the fact that team's work began after the initiation of the promotional programs and these activities are still continuing. Current adoption rates are likely to be strongly influenced by group pressures and credit requirements.

There are several problems with the current set of cost/benefit calculations assembled by the team which should be corrected as part of the production of the final report. Beyond improving the specific calculations, there is serious question about the utility of this form of analysis in understanding farmer acceptance of conservation farming and its potential impacts.

The effectiveness of the adaptive research supporting conservation farming promotional efforts is likely to be critical to its acceptance by significant numbers of farmers. There is considerable variation in the farming systems and soil conditions throughout Zambia. One set of practices is highly unlikely to fit all conditions. The Conservation Farming Unit initiated adaptive research in response to problems being brought to their attention from the field and has contracted with the Golden Valley Agricultural Research Trust to conduct adaptive trials on its behalf. A comprehensive plan for adaptive research support for conservation farming is needed and the monitoring team's reports contain a number of suggestions which might be incorporated into such a plan. The terms of reference for the upcoming NORAD/Sida evaluation of their support to the Conservation Farming Unit does not reference adaptive research, but consideration should be given to its inclusion in that review. The adaptive research should take account of livestock and agroforestry dimensions. Livestock are extremely important components of most Zambian farming systems, but aside from sources of draft power, they have not been given much consideration in conservation farming promotional efforts.

The research plan and particularly the criteria used for designing trials and analyzing results should give attention to the considerations which farmers themselves use in their decisions about whether or not to adopt specific technologies and methods. Experiences in Zambia and elsewhere raise serious questions about the validity of using standard cost benefit analysis and particularly yield per unit of land as the most important indicators of performance, especially for areas and farming systems where land is relatively plentiful. Assessment criteria are complex and an understanding of what small holders feel is important seems to be an essential first step. The monitoring team's studies offer some clues in this regard, but further probing and qualitative analysis would be useful. It is strongly recommended that priority be given to farmer testing and adaptation of technologies to local conditions.

There are several possibilities for meeting the adaptive research needs of conservation farming, virtually all of which envisage engaging adaptive research capacities in several agencies, in both the public and private sectors. Given the nature of the tasks and the distribution of capacity, it will be necessary to enlist staff from several organizations.

Commercial firms are playing increasingly prominent roles in the promotion of conservation farming, reflecting a growing appreciation, particularly among cotton agencies, that the health of the entire farming system has important consequences for cash crop production. Outgrower programs that require the use of conservation farming methods as a condition for credits can accelerate its adoption. However, the outgrower approach is only effective where there is a strong cash crop component which is not currently the case in several parts of the country. It remains to be seen whether the intensive supervision commercial firms provide as part of the promotion of specific cash crops will carry over to the range of conservation farming practices and whether the adoption rates will hold up as supervised credit is withdrawn. Currently cash crops are a strong

driving forces in the promotion of conservation farming.

The comparative strengths of NGOs and Agribusiness firms suggest that the two organizational groupings can strongly compliment one another in efforts to assist small farmers. NGOs can focus on group formation and strengthening while agribusiness firms (as well as the Conservation Farming Unit and the Ministry of Agriculture, Food and Fisheries) can provide extension and supervised credit for a range of commodities. NGOs can help farmer groups make connections with those service providers which best match their needs and priorities.

Recommendation 1: Priority attention should be given to the finalization of one or more of monitoring team's final reports. Two stand-alone documents might be most effective. The first should be a short (20-page) report covering the major findings and making recommendations to stakeholders on ways forward. The main report would cover the team's statement of work, but organized to provide support for the major points in the short volume. The team should consult with a small group of interested stakeholder representatives on the structure and content of the short report in particular.

Recommendation 2: A decision on whether and how to continue the impact monitoring should await the finalization of the monitoring team's report and responses from the stakeholders on the recommendations in that report. The program of future work should be developed in consultation with stakeholders. Specific attention should be given to the issues of greatest concern to different groups of stakeholders and to the consultative arrangements and reporting formats which can be most useful to them.

Recommendation 3: The emphasis placed on impact assessment should be reconsidered, given the importance of other concerns, notably adaptive research, and the possibility of combining and synchronizing data collection and analysis efforts for conservation farming. Michigan State University might be asked to propose arrangements for assessing socio-economic impacts as part of its contract.

Recommendation 4: Stakeholders should reconsider using yields (returns to land) as the principle criteria for assessing the performance of conservation farming technologies since land is not generally a limiting factor in Zambia. Cost/benefit analysis also has significant limitations. Gross Margin Analysis is the most straightforward cost/benefit method for Zambian small holder conditions. An effort should be made to better understand how farmers in different areas and situations assess technologies and translate these considerations into an additional set of criteria for assessing performance. Possible candidates include returns to labor (particularly during the peak labor period); and extent to which a technology increases or decreases flexibility in the allocation of resources.

Recommendation 5: More effort should be made to identify and monitor farmers adopting conservation farming methods who have not been assisted through supervised credit programs. Farmers abandoning these methods should be routinely interviewed to determine the specific reasons. This information should be used to guide adaptive research in support of conservation farming.

Recommendation 6: Monitoring of conservation farming impacts on soil quality should continue, preferably as a component of the adaptive research program. Adaptive research should explore alternatives to practices such as potholing for us in areas with sandy soils and hard plowpans.

Recommendation 7: Adaptations of conservation farming technologies to better suit local conditions should be an on-going effort. Adaptive research support should be considerably strengthened through the recruitment of a research coordinator and the engagement of other research and promotional staff, including farmers, to undertake adaptive trials in all areas where conservation farming is being promoted. Use should be made of existing farming systems teams and adaptive research capacities in various organizations. Most adaptive research should be carried out on farm to allow farmers in different locations to assess technologies and assist in developing alternative methods where needed.

Recommendation 8: The participation of agribusiness concerns should continue to be sought in the promotion of conservation farming, in areas where a strong cash crop potential exists. The Ministry of Agriculture, Food and Fisheries should consider targeting those areas and groups where this is not the case. NGO involvement in group formation and strengthening should be encouraged as a prerequisite to conservation farming and cash crop promotional efforts using supervised credit.

1. Introduction

1.1 Background

This report covers a consultancy mission for USAID Zambia aimed at improving impact-monitoring systems for Conservation Farming (CF) in June-August, 1999. CF, a term which encompasses a range of practices aimed at improving productivity through packages of soil and moisture management methods[1], is rapidly becoming the major thrust of the agricultural development strategies of several public, non governmental and private agencies in Zambia. The approach has a long history in Zambia, dating back to the 1930s (Malesu and Luputa, 1999). The Ministry of Agriculture, Food and Fisheries (MAFF) of the Government of the Republic of Zambia (GRZ) have operated a Land Management and Conservation Farming (LM&CF) Programme for a number of years with support from Sida[2]. The most recent effort is spearheaded by the Conservation Farming Unit (CFU) that commenced operations in 1996 with support from NORAD, FINNIDA and Sida. Currently, CFU also receives support from LONRHO cotton and the World Bank supported Agricultural Sector Investment Project (ASIP) through MAFF. CFU provides technical and logistical support to a number of Non Governmental Organizations (NGOs) and private commercial firms who are promoting CF methods through extension, input supply, marketing assistance and credit (in most instances) to farmer groups[3]. The groups were mostly formed by participating agencies for a variety purposes prior their exposure to CF promotional efforts. CFU and these agencies are proposing to expand their activities in response to encouraging information on farmer adoption of CF practices. Recently, the Honorable Minister of Agriculture, Food and Fisheries launched the National Small Holder Development Program (NSHDP), designed to promote CF countrywide among 400,000 farm families[4].

In 1998, USAID approached CFU and other participants with an offer to support CF impact monitoring activities. There was general agreement that selected monitoring activities would compliment what participating agencies were doing for themselves in areas such as cost effectiveness and impact assessment which are of particular interest to donors. CFU and participating agencies generally lacked the necessary capacities and/or resources to carry out such work. The Environmental Conservation Association of Zambia (ECAZ) was contracted in mid 1998 to perform a range of monitoring, adaptive research and impact assessment services for an initial period of one year. ECAZ is affiliated with the Zambian National Farmers Union (ZNFU) and CFU is a technical unit of ZNFU, but both operate autonomously from each other and from ZNFU. ECAZ's Scope of Work encompasses elements of adaptive research, operational monitoring of field activities, evaluation and impact assessment (see Annex I). ECAZ assembled a team of experienced researchers, mainly from the University of Zambia (UNZA) to carry out the work. ECAZ has completed its first year of work and formally presented its findings at a workshop of CF stakeholders on July 9th, 1999. The presentations and discussions during and following the

[1] There are several references which describe the range of CF methods, notably CFU, 1997 and Elwell, 1995.
[2] LM&CF was previously known as Soil Conservation and Agro Forestry Extension (SCAFE), regional program supported by Sida and is still commonly referred to by this name.
[3] The participating agencies at the present time include the Cooperative League of the USA (CLUSA), LONRHO Cotton and Development Assistance People to People (DAPP).
[4] The NSHDP features assistance in farmer group formation, training, extension, credit, input supply and output marketing (MAFF, 1999).

meeting offered suggestions on the future of CF impact monitoring activities.

1.2 Purpose

The overall purpose of this consultancy is to improve CF impact monitoring. USAID/Zambia does not support CFU directly, but is providing funds to the Cooperative League of the USA (CLUSA) which is cooperating with CFU in the promotion of CF. USAID, together with other CF stakeholders, wish to better understand the performance and potential of CF to contribute to the growth of Zambian rural incomes through sustainable improvements in agricultural productivity and production[5]. The impact monitoring work being undertaken by ECAZ under the terms of a contract with USAID is seen as hopefully providing stakeholders with the information and analysis needed to objectively assess the overall approach, progress to date and future directions.

The specific tasks of the mission, as detailed in the Statement of Work (SOW) for the mission, include i) assessing ECAZ monitoring personnel, methods and results; ii) commenting on the effects which CF is having on agribusiness-small farmer business relations; and iii) assessing CF adaptive research needs and capacities (see Annex II).

1.3 Approach

During the course of the consultancy mission, the consultant reviewed several documents and held discussions with most of the principal CF stakeholders (see references and Annex III, Persons and Organizations Contacted). Field trips were made to locations in Central and Southern Provinces where CF field activities are present (see Annex IV, Itinerary). Considerable time was spent with members of the ECAZ team as well as in reviewing and commenting on successive drafts of their Final Report. The consultant's responsibility to assess ECAZ's efforts was tempered somewhat by his feeling that the interests of all would be best served by suggesting ways in which ECAZ's final report could be improved. ECAZ has been very responsive and it is understood that several comments are being taken into account in the finalization of ECAZ's report.

The consultant interacted frequently with USAID staff, notably Morse Nanchengwa of the Agricultural Development Office, who provided guidance on a range of matters relating to the mission. In accordance with the SOW for the mission, an implementation plan was drafted and revised during the 2nd and 3rd weeks of the mission. The final version of the implementation plan included preliminary observations relating to each of the 13 items in the SOW. Discussions on the implementation plan and preliminary observations with USAID served to sharpen the focus of the mission for the remaining weeks. A draft report was submitted to USAID for review during the 5th week and revisions made on the basis of comments prior to the consultant's departure from Zambia on August 10th. The report was finalized in September.

Several issues arose during the course of the consultancy that were not specifically related to the SOW. Topics included i) assessments of aspects of CF promotional efforts; and ii) prospects from

[5] USAID also provides support to World Vision International (WVI) which is promoting CF and previously was associated with CFU, but is not a formal participant at the present time.

transgenic cotton in Zambia. In some cases, the consultant prepared separate notes on these issues at the request of USAID and/or individual CF stakeholders.

1.4 Structure of the Report

The report is structured to encompass all 13 items in the SOW, but with some regrouping and reordering to improve readability. The two sections which follow (2 and 3) review the ECAZ team, methods and findings in key areas, notably i) baseline data collection and analysis; ii) costs and benefits; iii) adoption rates and socio-economic impacts; and iv) impacts on soil conditions. Sections 4 and 5 examine adaptive research support for CF and the effects of CF on agribusiness-small farmer relations respectively. The final section presents the major findings and recommendations. Annexes include the scopes of work for ECAZ (I) and the current mission (II), organizations and persons contacted (III) and the itinerary (IV). Annex V incorporates sections of a paper by the consultant on maize research impacts in Africa, which relate to CF impact assessments and adaptive research in particular. Annex VI is devoted to responses to the specific questions on soils in the SOW.

2. The ECAZ Team and Its Task

2.1 The Statement of Work

The objective of the ECAZ impact monitoring effort is "to determine the environmental, economic and social impact of Conservation Farming, including:

(a) the advantages and disadvantages of conservation farming for Zambian smallholder farmers; and,
(b) whether conservation farming can lead to increased rural incomes in an environmentally sustainable way (with particular emphasis in the lower rainfall agro-ecological regions I and II.)" (From ECAZ Statement of Work, Annex I)

ECAZ's Statement of Work includes an impressive range of tasks encompassing several functions, notably operational monitoring, evaluation and impact assessment relating to conservation farming. In addition, ECAZ is called upon to i) develop a CF baseline database "that describes rural family social, economic and farm characteristics"; ii) develop a results and impact report format to provide information to stakeholders on adoption rates, costs and benefits of CF methods; iii) train enumerators and field support staff in CF collaborating agencies; iv) establish an analytical basis which yield relevant findings on a timely basis; and iv) explore opportunities to disseminate lessons learned through public and private media.

The current mission is not intended as a comprehensive assessment of the work of ECAZ, although the consultant is asked to review features of the impact monitoring efforts and to comment generally on their activities to date. The SOW for the mission focuses on specific aspects, including adoption rates, costs, benefits, and the baseline database. The SOW also encompasses other issues, notably agribusiness-small holder relationships and adaptive research support which are not explicitly part of the ECAZ's responsibilities[6].

2.2 Definitions of Functions

In attempting to understand the implications of ECAZ's broad statement of work, it is useful to distinguish among the following functions which for purposes of this report might be grouped under the general heading of "impact monitoring", the term used by USAID and ECAZ to describe the work of the ECAZ team.

1. **Operational Monitoring** involves checking on the range of tasks to be carried out, including group formation, numbers of participants in credit programs, disbursement of inputs, extent to which key operations (land preparation, planting and weeding) are being carried out in accordance with the extension/credit protocols; etc. Most CF agencies carry out their own operational monitoring internally[7]. However, in some instances the involvement of an external

[6] However, some of the team's activities are closely related to adaptive research, notably aspects of the socio-economic work and CF impacts on soils.
[7] Some of the monitoring systems are community based, involving the participation of farm families, as is the case with CLUSA (Lyons, 1998)

agency is desirable to improve its efficiency. The utility of operational monitoring usually depends on a very tight turn around and feedback of information to those who can take the necessary corrective actions. The primary users of operational monitoring are the field staff and HQs of participating agencies.

ECAZ's collection of data on adoption of CF practices, including checks on the extent to which specific operations have been carried out by farmers in accordance with CF protocols is information which could have been used to reinforce the operational monitoring efforts of the implementing agencies. For a variety of reasons, including ECAZ's reporting timing and formats, this was not done which is unfortunate, because of all the functions undertaken by ECAZ, this work could have been most immediately useful to the implementing agencies.

2. **Evaluation** involves periodic objective assessments of performance in relation to project objectives. Evaluations are usually carried out by external (to the project) agencies to better ensure objectivity and avoid conflicts of interest. Evaluations often include consideration of the organizational, technical and methodological dimensions of a project. The primary users of evaluations are donors and decision-makers as well as the staff of participating agencies.

   An example of an evaluation is the upcoming NORAD/Sida review of their support to CFU/CF scheduled for October 1999. Evaluations often involve a quite different set of relationships with stakeholders than those implied by other functions, notably operational monitoring and adaptive research. Operational monitoring in particular involves relations which are basically friendly and supportive, or at least should be, while evaluation teams are required to critically assess performance in relation to objectives. Evaluations can be critical (or even fatal) to the programs of implementing agencies that are dependent on continuing donor and/or government support.

   ECAZ included the term "evaluation" in its reports although curiously the term is not used in its SOW. The First Quarterly report of the ECAZ team gave prominence to the evaluative role and set a somewhat adversarial tone to their work from the onset vis-a-vis the implementing agencies (ECAZ, 1998a). The first report was quite critical of several aspects of the CF promotional efforts. The second and subsequent reports were much more positive and balanced, but the differences served to raise further questions about the reliability of the information ECAZ was generating (ECAZ 1998b, 1999, 1999a-e).

3. **Adaptive Research** often encompasses a cycle of activities, including i) collection and analysis of existing situations (baseline database); ii) assessment of constraints and areas of opportunity; iii) identification and testing of improvement measures (methods and technologies), both on-farm and on-station; iv) transfer of information on improvement measures to extension/farmers; and v) obtaining feedback from farmers on the suitability of the recommendations. Ideally, all these activities take account of socio-economic and environmental considerations as well as technical factors. Adaptive research serves to guide the design and subsequent refinement of promotional programs such as CF. Accordingly, the primary users of adaptive research are the staff of participating agencies. Adaptive research might be carried out by one or more agencies, but close teamwork and linkages are essential to its success.

Currently, CF trials are carried out by the Golden Valley Agricultural Research Trust (GART) under contract to CFU (on station research) and by the staff of cooperating agencies (on-farm research). Examples include the work supported by Lonrho cotton on tillage and herbicides (Arulussa, 1997; Lonrho Cotton, 1999).

ECAZ's analysis of CF adoption rates, costs and benefits could have been used to inform adaptive research efforts, but this connection does not appear to have been made. Some of the ECAZ data collection has drawn upon the results of the adaptive trials demonstrations carried out on station and on farm by CFU and its partner organizations. Neither ECAZ nor the stakeholders appear to have regarded ECAZ's work in these areas as being of relevance to the immediate concerns of the implementing agencies[8]. Rather, the effort was intended to inform stakeholders, notably donors, of the extent to which actual performance compared to expectations and was contributing to program objectives (e.g. increasing rural incomes).

4. **Impact Assessment** involves the collection and analysis of technical and socio-economic data relating to the changes or impacts that take place as the result of the adoption of technologies and methods, such as CF, by farmers. Impact assessment is often only meaningful if carried out over a number years commencing with the onset of a program. Because of the time required for impacts to work their ways through the farming systems of individual farmers (all of whom are different from one another) and the difficulties involved in attributing impacts to specific causes in many instances, impact assessment is often a costly and time consuming exercise requiring a range of socio-economic and technical skills. This is particularly true if both socio-economic and environmental impacts are being assessed, as is the case with the work of ECAZ. Impact assessment may draw upon research results, but is often of limited utility as a guiding mechanism for a program while it is being implemented. Studies of impacts address accountability by enabling stakeholders, notably donors and implementing agencies to make ex-post assessments of the extent to which the program has contributed to policy objectives, such as the enhancement of rural incomes. Such assessments can assist these agencies in modifying their general strategies. Unfortunately, past experiences are often given little or no consideration in the refinement of strategies and policies which tend to be driven by other imperatives[9]. The stakeholders who may have been involved in the design and initial implementation of a project or program are often no longer in the same positions by the time the results of serious impact studies become available. Because of the costs and research skills required for impact assessments, it is often not undertaken by implementing agencies, unless they are explicitly required to do so by funding agencies. Assessments of socio-economic and environmental (soils) impacts of CF are part of the responsibilities of ECAZ.

5. **Monitoring and assessing extension methodologies** involves a mixture of operational monitoring, evaluation, adaptive research and impact assessment. It is included here as a separate topic to underscore the fact that i) a variety of extension approaches are being used by CF participating agencies; ii) extension methods are important (critical) to the success of the

[8] Beyond the obvious need to be concerned about continuity of support from donor agencies.

[9] As an example, in the late 1980s and early 1990s, USAID's Africa Bureau provided considerable support to Michigan State University (MSU) and others to assess the impacts of the Agency's support for Agricultural Research in Africa south of the Sahara since the independence period (Gilbert, et al, 1994). Although the results of these studies were overwhelmingly positive, the findings had little impact on the continuing decline of USAID support for agricultural research in the region.

program; and iii) assessment of extension methodologies does not fall neatly in any of the preceding categories. An assessment of extension approaches forms part of ECAZ's SOW (item 18 under recommendations). The effectiveness of extension approaches is also part of the draft terms of reference for the upcoming NORAD/Sida evaluation. However, the time available for this evaluation is limited and it is anticipated that they will have to rely heavily on readily accessible information[10]. Monitoring and assessing extension methodologies could be carried out by implementing agencies, possibly with inputs from adaptive research and individuals with extension expertise. The main clients of these efforts are the implementing agencies.

ECAZ's responsibilities include a combination of monitoring, evaluation, adaptive research and impact assessment. These functions involve a variety of roles and relationships vis-à-vis stakeholders which cannot be easily accommodated by a single team or agency. The differing requirements of operational monitoring and evaluation, for example, may have contributed to tensions between ECAZ and participating agencies, particularly during in the early stages of ECAZ's work.

2.3 Leadership, Team Selection, Composition and Continuity

The ECAZ team began to come together in the course of the submission of a proposal to USAID in mid 1998. Key players at the onset were Lovemore Simwanda, Chairman of ECAZ, and Albert Chipeleme, Head of Soil Science Department and Lecturer/Specialist in Tillage/Land Resource Management at the University of Zambia (UNZA). Chipeleme became team leader and held that position through most of the effort except for three weeks in May/June. The team leader assembled a core team including Simwanda (conservationist/extension specialist), T.T. Kambikambi (Monitoring Agronomist/Data Analyst) and C.K. Chileya (Socio-economist). Additional consultants were engaged to cover specific areas of the Statement of Work, notably O. I. Lungu (Soil Fertility/Land Management Expert), W. Mulonga (Land and Water Management Expert), P. Chibbamulilio (Evaluation and Monitoring/Financial Expert), and M.N. Isimwaa (Resource Economist).

Five of the team members, including two members of the core team were drawn from three UNZA departments, notably Soils, Agronomy and Agricultural Economics. The remaining three team members were independent consultants at the time of the inception of the study, although one (Chileya) currently is on the staff of the local FAO office and another (Simwanda) is Executive Chairman of ECAZ. Team members were chosen on the basis of their areas of expertise in relation to the requirements of their SOW. An effort was made to cover all the critical areas in their SOW in the selection of the original team and the formal qualifications of the team members seem broadly consistent with the requirements of the contract. However, there was no core team member or member of the initial team with specific expertise in economics which is curious given the prominence of C/B analysis in the SOW[11]. Two economists (Chibbamulilio and Isimwaa) were

[10] A recently completed study supported by the World Bank reviews extension approaches in Zambia and suggests improvements (Ashworth, 1999 & 1999a).

[11] Chileya was engaged as the socio-economics member of the core team, although his background is primarily in sociology. His role in the work of the team was mainly focused on the initial period and declined when he took a position with FAO in late '98.

subsequently engaged during the second and fourth quarters to work on costs and benefits respectively.

There have been problems in the continuity of staff for the team. The two economists were engaged only during the 2nd and 4th quarters and experienced problems with the data collection and analysis as is discussed in more detail below (section 3.3). The soils work was adversely affected by the untimely death of Dr. Mulonga in early '99. Initially, Drs. Mulonga and Lungu had divided up the soils work between the Central and Southern Provinces. Dr. Lungu agreed to take over all the soils work in both provinces with the passing of Dr. Mulonga. There was a lack of continuity and leadership in socio-economics in particular. Given the importance of the C/B work, adoption rates and the baseline data, it would have been preferable to have a senior agricultural economist in the core team who had experience in these areas.

Initially, the team operated out of the ECAZ's offices in accordance with the original proposal and plan. This arrangement proved to be unsatisfactory as ECAZ was unable to provide the required logistical support. Team operations were shifted to UNZA where several of the team members maintain offices. The team made use of UNZA offices, transport, computers and secretarial support for much of the time.

2.4 Interactions with CF Stakeholders

A number of the stakeholders, including representatives of ECAZ, ZNFU, CFU, GART, NORAD, CLUSA, SCC (Swedish Cooperative Centre), SCAFE (Soil Conservation and Agro Forestry Extension), Sida, WVI, PAM (Programme Against Malnutrition), CARE, FINNIDA, MAFF and the World Bank, were interviewed during the course of the mission (see Annex III, Persons and Organizations Contacted). The ECAZ stakeholders workshop on July 9th provided an opportunity to hear the views of several additional parties. The opinions on the work ECAZ has done to date range from mildly positive to negative. There is appreciation for the complexity of the tasks which ECAZ has sought to undertake. A common view is that ECAZ monitoring has not told them anything they did not already know[12]. Their approach, including the reporting format and timing does not appear to be fulfilling the needs of any of the stakeholders. Although some monitoring activities can and should be undertaken by participants themselves, notably operational monitoring, there are roles which could be usefully performed by one or more external agencies on behalf of agencies supporting and promoting CF.

Part of ECAZ's problem lies in the diverse needs and expectations of the stakeholders. ECAZ's SOW covers a number of somewhat distinct functions, ranging from reinforcing operational monitoring to adaptive research, evaluation and impact assessment. Operational monitoring and adaptive research functions can be immediately useful to implementing agencies, but the choice of topics and particularly the reporting timing and formats were apparently not selected with these needs in mind. Implementing agencies have been cooperating with ECAZ in data collection which takes up the time of their field staff, but they do not as yet (at least prior to the final report) feel

[12] In the view of the consultant, this is not a fair assessment and is based on quick reading of the reports in most instances. Examples of ECAZ's findings which at least some stakeholders found interesting and useful are included in several sections of this report.

they have received useful information and analysis from ECAZ in return. The cost and benefit information should be useful in guiding decisions about the promotional messages used by the implementing agencies, but was not linked to the adaptive research trials being carried out by GART, Lonrho Cotton and CFU.

Arguably, ECAZ's SOW primarily reflects donor concerns with impacts and overall program performance in relation to policy objectives or thrust areas (e.g. conserving the environment and enhancing rural incomes). However, USAID specially consulted with the implementing agencies on the SOW for the impact monitoring and sought their participation in their participation in the quarterly meetings to review ECAZ's findings and progress.

The tone of ECAZ's first quarterly report (ECAZ, 1998a) issued in October, 1998 and the stakeholder response to that report illustrates the problems which ECAZ has faced in attempting to play a variety of roles which involve quite different relationships with clients. In criticizing aspects of the CF package and promotional efforts, the report took an evaluative or judgmental stance vis-a-vis the implementing agencies in the presence of representatives of the donor agencies. The negative response of the implementing agencies was predictable, but caught the ECAZ team very much by surprise by their own admission. In contrast, efforts to reinforce operational monitoring by bringing problems to the attention of the staff of the implementing agencies as they occur implies a much more friendly, interactive and supportive set of relationships. The C/B work might have been carried out as an integral part of the adaptive research work in collaboration with GART, CFU and implementing agencies and involved close working relationships with these organizations.

Impact assessment, on the other hand, is longer term and somewhat removed from immediate program implementation and operational monitoring concerns. Impact assessments are necessarily more evaluative in character, but often very much after the fact such that the implications for near-term program implementation may be limited. Caution is required in using the preliminary findings from impact assessments of on-going projects to guide implementation strategies for those projects. Implementing agencies might accept the desirability of impact assessments in theory, but privately regard them as a 'loose canon', which can raise doubts among decision makers in government and donor agencies and cause serious, if unintended, damage at critical junctures. In retrospect, it seems unrealistic to have expected a single agency to be able to successfully balance these multiple roles and relationships with the stakeholders.

Little effort appears to have been made to explore the possibilities for harmonizing the ECAZ data collection and analysis with those of implementing agencies, notably SCAFE and the Agricultural Sector Investment Programme (ASIP) which have ongoing monitoring and impact assessment efforts covering CF approaches undertaken by MAFF (SCAFE, n.d. & 1999, Malesu & Luputa, 1999). The ECAZ team did make use of data provided by participating agencies including CFU, CLUSA, DAPP and GART, but did not try to understand the analysis and reporting formats of these agencies which might have made ECAZ's results more useful and accessible to these agencies. Clearly, important opportunities have been missed to develop a common monitoring, adaptive research and impact assessment approach covering the range of CF approaches and participating agencies, as partially called for in ECAZ's SOW (item 2 under Related Contractor Requirements). The efforts to date remain seriously fragmented and less effective than they might be as a

consequence. ECAZ understandably looked upon USAID as its principle client and perhaps did not devote as much attention to the needs and concerns of other stakeholders as a consequence. Such attention could have dramatically improved ECAZ's relations with stakeholders.

In retrospect, the ECAZ might also have usefully added process monitoring to its agenda in order to better understand and interact with stakeholders, individually and collectively. Process monitoring focuses on interactions between and within organizations and village level groups[13]. There are overlaps with operational monitoring, but process monitoring is more concerned with processes or how things are happening rather than whether or not specific activities have been carried out in accordance with plans. Process monitoring can be thought of as a form of communication among participants designed to alert those concerned to the existence of problems in the area of organizational relationships which could affect the success of the program. Process monitoring is best carried out by an agency with good communication skills which is perceived by all parties as being neutral and fair. This need not be a separate agency. The process monitoring role might fall upon one or more individuals from participating agencies with the requisite skills, if the character of the program suggests that process monitoring might be useful. Process monitoring is most frequently carried out informally on an ad hoc basis, and is often not even recognized as a dimension of monitoring.

Although ECAZ certainly could have done things which would have improved its relations with stakeholders, personal and organizational relationships are a two way street. Many stakeholders 'tuned out' after the first quarterly meeting and made little effort to offer constructive suggestions which might have improved the utility of ECAZ's efforts[14].

[13] For a discussion of process monitoring methods and experiences see Mosse et al, 1998.

[14] The ECAZ team did meet with CFU representatives following the first Quarterly meeting in September, 1998 to explore closer collaboration, but the discussions were not particularly productive.

3. ECAZ Team Methods and Activities

3.1 Baseline Database and Socio-economic Characterizations

The initial baseline database is presented in the Vol II of ECAZ's Second Quarterly Report (ECAZ, 1998b) and refinements are made in the Fourth Quarterly Report (ECAZ, 1999c) as well as in the draft final report (ECAZ, 1999d). Suggestions have been made to the team on the manner in which this information might be used in the final. The socio-economic data reviewed is of a rather basic nature and it will be difficult to assess more than the most easily visible impacts (e.g. adoption and yield changes). Given the complex nature of small holder production systems, the current approach is likely to miss significant portions of the impacts. Changes in resource allocations by farm families (notably land and labor), is not easily extracted from the information presented. Much of the data presented in the Quarterly reports is aggregated for the two provinces and little effort was made to distinguish results by geographic area and farming system type. Information exists on the farming systems of these areas, but these sources are not referenced and it is assumed they were not consulted in developing the baseline information[15]. Most significantly, efforts to consult with stakeholders on their information requirements were not successful. As noted above, no effort was made to coordinate the baseline database effort with the activities of others, notably SCAFE and ASIP.

There is clearly scope for improvement in the socio-economic characterizations in ECAZ's data. The study of improved fallows in Eastern Region (Peterson, 1999) provides an illustration of the utility of a socio-economic information that is more disaggregated than that of ECAZ, particularly in addressing gender-related issues. Furthermore, SCC has developed a monitoring framework which might serve as a model for other monitoring activities (SCC, 1999)[16].

As noted by the ECAZ team in the draft final report, the utility of the baseline information for impact assessment purposes has been compromised somewhat by the fact that the data collection took place two cropping seasons after the initiation of CF promotional activities (ECAZ, 1999d).

3.2 Cost Benefit Data Collection and Analysis

ECAZ made considerable efforts to survey, quantify, and compare the costs and benefits using conservation farming (CF) practices and conventional (non-CF) practices. However, small farmers' costs, benefits and profitability proved difficult to measure consistently over large numbers of farmers and a wide variety of farming conditions and crops[17]. The monitoring covered only the latest cropping season, during which ECAZ surveyed both CF and non-CF practices. The results are a bit curious in that they suggest considerable increases in labor inputs for CF on the three major crops (maize, cotton and sunflower) compared to conventional practices for hoe farmers. This contradicts the findings in two earlier studies focusing on cotton and food crop

[15] The ECAZ team has indicated that data will be disaggregated in the final report.

[16] NGOs have recently set up an Agro-NGO consultative forum which among things will be exchanging ideas of monitoring. SCC and the SCAFE monitoring unit are spearheading this effort.

[17] The C/B information is currently contained in sections 2.3.4 and 2.3.5 and Annex pp. 46-52 of the Fourth Quarterly Report (ECAZ 1999c); and sections 4.2.1-4.2.5 of the draft Final Report (ECAZ 1999d).

production in Southern Province (Keyser & Mwanza, 1996; Arulussa, 1997). Furthermore, as shown in Table I, findings for the three sources used by ECAZ are not themselves consistent and differ widely from the two earlier studies. Discrepancies can in part be traced in part to the fact that some of the data relate to different areas and years. In addition, it is clear that labor requirements during the first year of adoption of CF are heavier than in subsequent years[18].

Manual labor comprises the major variable in assessing small farm profitability. One of the most apparent CF benefits for small farmers was thought to be the need for less manual labor because it could reduce the time required for land preparation, enable more timely planting, and bring additional land under cultivation. Confirming this, it has been noted that in the Southern Province, where the majority of farmers recently lost practically all their cattle (including draft oxen) to corridor disease, large numbers of farmers are reported to have adopted CF practices in whole or in part because they required less labor.

Survey results suggest farm labor use varies widely, possibly because large amounts were provided by family members rather than hired labor, and the responses were based entirely on the farmers' recall. Responses obtained on farm outputs may be more reliable because the interviews were conducted near harvest time. However, variations resulted because some farmers harvested parts of their fields early for consumption purposes. Also, many subsistence farmers may have been reluctant to reveal accurate output figures for fear of possibly consequent obligations within their communities. Crop yields also varied widely from place to place depending on soil conditions, differences in application rates for chemical inputs, and seed qualities. As a consequence of these factors, one cannot place a great deal of confidence in the data.

ECAZ efforts to assess small farm profitability under CF and conventional practices are complicated by the need to value farm labor appropriately to reflect the real costs faced by the farmers. The major portion of small farm labor requirements is provided by family members with no cash outlay. Furthermore, hired labor is rarely paid on a per day basis but rather in proportion to the total area of land worked (accomplished in some places at about 5 hours per day and in others at more or less than that) regardless of the number of days it has taken.

[18] This is due in large part to the labor requirements of the "holy method" and additional weeding. Annual weeds should become progressively less of a problem, but control of perennial species could become more demanding. In cooperation with Lonrho Cotton, CFU is carrying out herbicide trials and training programs in an effort to address the problem of additional weeding requirements during the initial years (Lonrho Cotton, 1999).

Table 1: COMPARISON OF FARM LABOR ESTIMATES

	COTTON (man-days/ha)		MAIZE (man-days/ha)	
	Conventional Tillage	Conservation Tillage	Conventional Tillage	Conservation Tillage
KEYSER/MWANZA (1996)				
			(With Fertilizer)	
Land Prep. & Planting	38	25	53	40
Weeding	40	60	47	53
Spray/Fertilizer	12	12	10	10
Harvest & Pack	50	50	40	40
Misc.	3	3	5	5
TOTAL	**143**	**150**	**155**	**148**
			(Without Fert.)	
			53	40
			47	53
			-	-
			30	30
			5	5
			135	**128**
LONRHO COTTON (1997)				
(HOE)				
Establish	78	15		
Weeding	62	62		
Other	65	63		
TOTAL	205	140		
ECAZ - SURVEY				
Land Prep.	30	64	20	63
Planting	12	32	11	28
Thinning	18	35	6	10
Weeding	52	97	38	54
Harvesting	43	94	26	28
TOTAL	**155**	**322**	**104**	**183**
ECAZ-GART				
Land Prep.	6	40	6	40
Planting	11	6	12	6
Thinning	3	3	3	2
Weeding	46	39	27	33
Harvesting	45	41	9	8
TOTAL	**111**	**129**	**57**	**89**
ECAZ-CLUSA				
Land Prep.	9	30	9	30
Planting	3	6	3	6
Thinning	3	3	-	3
Weeding	24	32	16	32
Harvesting	4	4	4	2
TOTAL	**43**	**75**	**32**	**73**

There are clearly ways in which the C/B analysis can be improved. It has been suggested to the ECAZ team that they estimate the opportunity cost of farm labor taking into account non-farming, income-earning activities such as retail trading and beer brewing available to some family members. Further, ECAZ could estimate a farmer's daily cost of subsistence taking into account the value of commodities frequently traded in exchange for a short period of farm labor. Based on these estimates, ECAZ could estimate a daily rate per man-day in the crop budgets for different operations at different times of the year. To reflect the real costs and benefits currently faced by small farmers, it is recommended that average harvest time prices used in the comparative crop budgets be derived from the prevailing domestic market prices.

In view of the number and complexity of variables and the difficulty in improving accuracy of the information, attempts to further monitor the costs, benefits and farm profitability over substantial (possibly increasing) areas, would not be cost effective. More effective would be to focus assessments on incremental costs and benefits in connection with adaptive research in a few selected farms.

Most farmers practicing CF in one way or another also have separate fields where they are practicing conventional tillage. Monitoring the different practices on a given farm or set of farms would provide a more indicative comparison which could subsequently be shared over a wide area. Application of sensitivity analysis to the crop budgets obtained under these circumstances would enable the findings to be used in formulating adjustments to farm practices in other areas.

The key question to be addressed is the desirability and practicality of linking cost and return data collection to the technical adaptive research being carried out by GART and CFU. The consultant strongly supports such a linkage. C/B calculations, including assessments of risks and labor requirements should form part of the development and testing of technologies both on station and especially on-farm. If these calculations are not favorable, the technologies and methods involved may not be ready for promotion[19]. It is not cost effective to discover this after packages have been widely extended to farmers.

The more fundamental issue is the extent to which C/B analysis correctly reflects the way in which farmers assess technologies. Past research and experience suggests that the assessment criteria which farmers use may be quite different from those commonly employed by researchers, as discussed by Gilbert (1995):

> *"Most resource-poor farm families throughout Africa are primarily interested in saving resources, particularly labor during the peak labor period, rather than in returns to land.…… Many farmers assess a technology in terms of the extent to which they might be able to shift resources (land and labor) currently devoted to maize production into some other activity, hopefully while still at least maintaining current levels of maize production. That activity might not be related to agriculture at all or even to generating income from other sources. Sending children to school is perhaps the most common example.*

[19] However, if farmer tests and evaluations of these technologies suggest they are attractive to farmers, they might be promoted as is, a low or negative C/B ratio not withstanding. Obviously, someone (other than the farmers) has missed something.

A second consideration that is very important to farmers is flexibility. Does an innovation increase or decrease flexibility in terms of the timing of specific operations, notably planting and weeding?…. An illustration of….. saving resources and increasing flexibility is the growth in the popularity of early maturing maize as a substitute snack food during the early harvest period in West Africa. Labor that women in particular expend in preparing food is reduced at a time when they are particularly busy with farming activities. Green maize can also be sold to generate cash at a time when it tends to be in short supply for many rural families……innovations for maize [may] allow a farmer to shift some good quality land out of maize and into a higher value crop, possibly by moving the maize to a less productive field.…… Resource productivity increases, the farmer is happy, yet by standard measures of impact, nothing happened." [20]

In summary, there is considerable scope for improving the C/B work carried out by the ECAZ and it is understood that at least some of the concerns will be addressed in the final report. However, there are serious limitations to the inferences that can be drawn even from a reasonably accurate (for a given year and location) C/B analysis. More attention might be given to the reasons why farmers adopt (or reject) technologies and how these criteria can be better integrated into adaptive research activities.

3.3 Adoption Rates

ECAZ has collected information on adoption rates which suggests that significant numbers of farmers who were exposed to CF promotional activities have adopted the practices[21]. Adoption rates for the first few years of a program such as CF should be treated with caution. Current adoption rates and associated resource reallocations by farm families may be temporary, and strongly influenced by group pressures, credit and input inducements (as well as by weather and policies). Slow rates of adoption in the early phases of a program may not correctly indicate eventual farmer acceptance of a package of practices, particularly in the case of technologies such as CF where there is an initial increase in costs and the benefits are realized over several years.

The consultant has reviewed ECAZ's findings on adoption rates and compared these with those of other studies and the opinions of informed observers. Farmers are asked why they adopted or rejected CF methods, but the analysis of these responses is limited and with some notable exceptions, the results are rather predictable[22]. There is little effort to place the results in the contexts of the farming systems of specific areas. With a few exceptions the data tables represent aggregations of data from different areas and implementing agencies. Subsequent reports may include breakdowns and additional analysis. The depth of analysis and its potential utility stands in contrast to some other work, notably that on improved fallows in Eastern Province (Peterson,

[20] Further discussion on this issue is included in Annex V.

[21] The Fourth Quarterly Report (ECAZ, 1999c) indicates adoption rates of 57% for 1998/99 and 31% as the overall rate for the past three seasons.

[22] One exception is the information presented in Section Two of the Fourth Quarterly Report which describes modifications in CF practices made by one farmer in Southern Province (ECAZ, 1999c).

1999), assessments of minimum tillage among cotton producers in Central Province (Arulussa, 1997, Keyser and Mwanza, 1996) and the monitoring recently initiated by SCC (SCC, 1999).

Emphasis should be placed on monitoring the extent to which adopters seriously modify or abandon critical CF practices and why[23]. ECAZ results do not appear to fully reflect these changes at present. Abandonment and practice modification are actions which can be best addressed as part of the adaptive research efforts, utilizing feedback from implementing agencies on the extent of the changes and possible reasons. Direct contact between research staff and farmers making such changes would be useful to understand the rationales. A continuing flow of feedback from the field can assist research staff in the design and testing of modifications in CF practices. This is already happening, but involvement of the ECAZ team appears to be minimal.

There are various ways in which farmers who are not receiving credit can be monitored. A broad, self monitoring system using contact farmers and group leaders is already partially in place among some of the implementing agencies, notably CLUSA (Lyons, 1998). The roles and responsibilities of contact farmers and village level para workers could be expanded to include the monitoring of adopters among their neighbors. Most of the unsupported adopters are likely to come from the same village or neighboring villages. A sample might be drawn from these adopters which could be monitored on a regular basis. Unsupported adopters should be a special focus of adaptive research efforts, possibly by inviting some of them to participate in on farm tests and provision of feedback to research. Such 'external' monitoring can reinforce the self-monitoring by field staff, contact farmers and para workers by encouraging prompt and accurate reporting. As an additional 'check' on adoption, implementing agencies might sponsor drawings in which all farmers using CF would be asked to give their names. All the names would be placed in a bowl and the names drawn would receive a small prize (and a visit to their CF plots by field staff to certify that they were using CF). The names submitted to the drawing could be checked against the lists prepared by the field staff and contact farmers and new names checked out. Some of version of this approach might be carried out by ECAZ or another external monitoring agency in the future.

[23] ECAZ has captured some of these as illustrated by the description of farmer modifications of CF practices included in Section 2 of Fourth Quarterly Report (ECAZ, 1999c). A farmer in Southern Province (P. Mayumda) made changes in plant population, and enlarged the planting basins, resulting in significantly higher yields of 8-9 mt/H.

3.4 Assessing Impacts

A significant portion of ECAZ's efforts is related to assessing impacts from the promotion and adoption of CF. ECAZ has focused primarily on C/B comparisons per hectare between CF and traditional and conventional tillage systems for impact monitoring. While it is possible to make such comparisons within the timeframe of one year, the results will be strongly influenced by exogenous variables, notable weather. Both 97/98 and 98/99 cropping seasons enjoyed adequate rainfall with no periods of drought of significance in Southern and Central Provinces. For these years, one of the key features of CF, namely reducing the effects of mid and late season droughts, could not be tested. In fact, some crops such as guar beans, which have a low tolerance for wet soil conditions, performed less well than they probably would have done using conventional tillage.

More significantly, C/B comparisons for specific crops do not capture the full range of impacts associated with technological change, notably the resource reallocations and avoidance of negatives (e.g. effects of drought and pests). Such changes are much more difficult to measure and no effort was made by the ECAZ team to assess these less visible impacts, which can often be quite significant[24].

While it is not difficult to point to examples of more comprehensive and rigorous impact monitoring approaches, one must consider the objectives, resources and timeframe of the ECAZ effort. The objectives were varied, but leaned toward serving the needs of donors for accountability. Assessing the impacts of an on-going project in a short time-frame is a questionable undertaking from the onset. There were expectations from some stakeholders that ECAZ would provide results at least quarterly which would be both accurate and useful. That may be a reasonable expectation for aspects of operational monitoring and adaptive research, but not for assessing impacts. Current adoption rates will be strongly influenced by implementing agency requirements for input credits. Farmer responses to ECAZ's questions (which were administered by the staff of implementing agencies in most instances) can be influenced by many factors and the survey protocols did not allow for the collection of qualitative information which might have assisted with the analysis and interpretations. It is understood that the final report will make an effort to draw upon the considerable body of knowledge on Zambian farming systems which exists and which could aid in the establishment of a meaningful set of baseline information.

As for impact assessment, it would be useful for decision makers in government and donor agencies in particular to indicate the timing, coverage and format of the information required, given the fact that it is not practical to present a high quality, comprehensive impact assessment on an on-going project in one year or less. GRZ and donors need to have an accounting on the effectiveness of grants and expenditures in relation to their respective program objectives and need (or least should seek) guidance from the lessons that can be provided by past and on-going activities in making decisions about future support. This suggests an intermediate set of products or reports which could draw upon adaptive research results, including C/B based on feedback from farmer tests of technologies and promotional activities, rather than a separate data collection and analysis exercise. Impact assessments may still be desirable, but are necessarily longer term (e.g.

[24] For a discussion of the range of obscured and invisible impacts, see Gilbert et al, 1994 and Gilbert, 1995. An extract from the latter reference is included as Annex V to this report.

extending beyond the time frame of the project) and generally more demanding in terms of research skills and resources. USAID's contract with the Department of Agricultural Economics at Michigan State University (MSU) to provide a range of training and advisory services could encompass at least the socio-economic dimensions of impact assessment of CF (MSU, 1999). MSU has considerable experience in this field of investigation in Africa.

3.5 Monitoring Changes in Soil Conditions

The consultants solicited comments from knowledgeable individuals, notably members of the ECAZ team and researchers among the stakeholders, on the two items in the consultants' SOW relating specifically to soils. Reviews of the soils work were generally positive, in marked contrast to the somewhat neutral to negative opinions on most other dimensions of ECAZ's monitoring efforts. Despite admitted flaws in the methods, notably the failure to take measurements in the same fields during the second and fourth quarters, the soils investigations have yielded some interesting results and made useful suggestions for the future. Clearly, monitoring of changes in soil conditions is not an area in which definitive results should be expected in the relatively short timeframe of one year. However, the studies have produced some useful findings (see box).

At the request of the consultant, Dr. Lungu of the Soil Science Department at UNZA, prepared responses to the specific questions in the SOW which are included as Annex VI. The consultant has reviewed these comments and is in agreement with them.

FINDINGS FROM CF MONITORING OF SOILS

- CF basins/potholes are effective in concentrating and preserving soil nutrients, notably phosphates (P). The basins may also improve organic content, but several years of measurement would be required to fully assess this impact.
- Basins should allow farmers to reduce or eliminate P from fertilizer applications for one or two crops on fields which have been using CF for at least two years. CFU should consider modifying fertilizer recommendations accordingly.
- Local adjustments in CF recommendations are needed to reflect variations in soil conditions. Basins are not a suitable technique for sandy soils. Farmers are understandably reluctant to prepare basins in soils where there is a hard plowpan. In these conditions if might be better to use a ripper and deep rooted plants such as cotton to loosen the soil as a first step.

The soils work is the only component of the ECAZ's activities that specifically addresses environmental impacts. Future monitoring and impact assessment efforts should broaden the scope of the environmental concerns to include changes in insect and weed regimes as well as water quality and quantity related to the introduction of CF.

4. Adaptive Research Support for Conservation Farming

4.1 Needs and Current Arrangements

The effectiveness of the adaptive research supporting CF promotional efforts is likely to be critical to its acceptance by significant numbers of farmers. CFU initiated work in Zambia largely without the benefit of in-country adaptive research. CFU promoted technologies were developed in northern Zimbabwe under similar, but not identical conditions to those found in Zambia (Elwell, 1995)[25]. The importance of learning through adaptive research in advance of launching promotional efforts is gaining wider acceptance. There is considerable variation in the farming systems and soil conditions throughout Zambia, as ECAZ's monitoring of soil conditions and adoption rates in just two provinces illustrates. Adaptations of CF technologies to better suit local conditions should be an on-going effort.

CFU initiated adaptive research in response to problems being brought to their attention from the field and has contracted with GART to conduct adaptive trials on its behalf. Examples of on-going trials are given in the box.

GART/CFU ADAPTIVE RESEARCH TRIALS, 1997/99

1. **Replicated Conservation Tillage Trial:** Six year trial to determine the additive effect of yield and gross margin of minimum tillage, conservation tillage and residue tillage compared with full tillage.
2. **Cotton Cowpea Intercropping Trial:** Three year trial to compare cowpea/cotton inter and intra crop configurations with monocrops.
3. **Herbicide Trial using Glyphosate as a Post weed Pre crop treatment:** Two year trial to test efficacy of glyphosate applied with Ulva+ as a post emergent treatment compared with hand weeding using non replicated field scale plots.
4. **Amaranthus Variety Screening Trial:** Three year trial to determine grain yields of 10 elite varieties developed at the University of Nebraska.
5. **Guar Yield Observation Plot:** Three year seed multiplication effort to observe guar performance in a medium rainfall area.

Support for CFU's adaptive research program has come from Lonrho Cotton and from ASIP via grants from MAFF. The level and scope of adaptive research efforts to date appear modest relative to the needs. Despite the grants, funds remain a limiting factor. In addition, leadership and staff to plan and execute a coordinated set of activities are in short supply. CFU is playing the leading role in designing the adaptive research program on the basis of feedback from the field and its own ideas. However, the leadership have indicated that they have difficulty finding the time to think through a coherent CF research program.

[25] However, SCAFE and SCRB of MAFF had considerable research and promotional experience with selected aspects of CF. See for example Parker &Vernon 1978 &1984.

There are several possible research themes which emerged from discussions with CF stakeholders in the course of the mission (see box). It may not practical to pursue all these themes simultaneously, particularly where significant research time is called for. However, many trials can be carried out on-farm at the initiative of farmers with advisory assistance from research or extension staff.

SUGGESTIONS FOR CF ADAPTIVE RESEARCH THEMES

- Organic alternatives to current CF recommendations
- Crop livestock interactions with CF – tradeoffs in the use of crop residues; communal grazing areas
- Trials on a broader range of crops and varieties.
- Tradeoffs in time of planting. If one cannot for what ever reason plant on time or if the early planting fails, what crops and varieties should be used?
- Agro-forestry/improved fallows and CF
- Changes in pest/disease/weed regimes with the introduction of CF
- Burning and CF. Why do people in different areas burn? How can burning be reduced?
- Plant populations and CF. Some farmers wish to tighten up spacing and increase plant populations. Others wish to intercrop.

A comprehensive plan for adaptive research support for CF is a desirable first step and the ECAZ reports contain a number of suggestions which might be incorporated into such a plan. The terms of reference for the upcoming NORAD/Sida evaluation of their support to CFU does not reference adaptive research, but consideration should be given to its inclusion in that review. ASIP is another possible source of support both for the preparation and implementation of an adaptive research plan for CF.

Research need not be limited to refinements of technologies and husbandry practices for crops. Livestock are extremely important components of most Zambian farming systems, but aside from sources of draft power, they have not been given much consideration in the development and promotion of CF. The trade offs farmers face in deciding whether to allow animals to graze crop residues or not (as is recommended by CF) need to be considered. Agro forestry is a component of the work of WVI and SCAFE which has considerable experience in this area[26]. It is recognized that the inclusion of livestock and agro forestry complicates the agenda considerably and it may be desirable to focus primarily on crops for adaptive research efforts in their initial stages[27].

[26] The study by Peterson (1999) of women's attitudes toward improved fallows suggests considerable potential for this dimension.
[27] There are numerous sources of information on methods for incorporating livestock and agro forestry into cropping system research. See publications of the International Centre for Research on Agro Forestry (ICRAF) and the International Livestock Centre for Africa (ILCA).

The research plan and particularly the criteria used for designing trials and analyzing results should give attention to the considerations which farmers themselves use in their decisions about whether or not to adopt specific technologies and methods. Too often it is assumed that farmers think like researchers (or at least that they should!) and that their primary interest is in maximizing profits and yields. Such an orientation is implicit in ECAZ's C/B analysis and in much of the adaptive research which CFU is presently supporting. Experiences in Zambia and elsewhere raise serious questions about the validity of using yield per unit of land as the most important indicator of performance, especially for areas and farming systems where land is relatively plentiful. Assessment criteria are complex, but an understanding of what small holders feel is important seems to be an essential first step. The ECAZ studies offer some clues in this regard, but further probing and qualitative analysis would be useful. Annex V of this report includes a discussion of how farmers assess technologies, portions of which may be applicable to the Zambian context.

It is strongly recommended that priority be given to farmer testing and adaptation of technologies to local conditions. The main purpose of the on-farm work is make match methods and technologies with farmer needs and constraints. Thus, farmer involvement is critically important. It is recognized that a combination of on station and on farm trials and investigations is desirable in addressing the requirements of CF, but much of the on-station work has already been done. The main reason for carrying out research on station is to be able to closely manage trials so as to hopefully obtain answers to the specific technical questions that the research is addressing. On farm trials tend to produce inconclusive answers because of the prevalence of non-experimental variables[28].

Adaptive research or farming systems research as it is sometimes referred to has a rather mixed history in Zambia. In the 1980s, donor support facilitated the establishment of Adaptive Research and Planning Teams in most provinces. The fact that the teams were better funded than the commodity and discipline based sections of SCRB contributed to considerable tension within the research service as well as between the teams and the extension services in some instances (Kean & Singhogo, 1985), . There appears to be general agreement among concerned parties and stakeholders that more adaptive research is needed for CF, but the organizational history needs to be taken into account in the process.

There are several services which adaptive research teams might perform on behalf of agencies promoting CF (see box).

[28] There is a considerable body of literature which addresses the question poised in the SOW for the consultancy mission on what research should be carried out on farm and on station. See for example Gilbert, Norman and Winch, 1980.

ADAPTIVE RESEARCH SERVICES FOR CF

- Assessments of constraints and areas of opportunity for different farming systems.
- Planning and implementation of on-station and farmer participatory research activities.
- Accessing information on CF technologies and methods from a wide variety of sources within Zambia and externally.
- Provision of information on improved CF techniques which have been adapted to local conditions through being tested by farmers.
- Training of farmers, para workers and field staff in adaptive research methods and in the use of specific techniques.
- Timely provision of feedback and monitoring information of use to stakeholders.

CF is currently being promoted using a variety of extension methods, ranging from conventional out grower schemes with supervised credit to participatory approaches in which para extension workers or contact farmers and farmer groups figure prominently. Research could usefully assess the performance of these different methods and facilitate a sharing of experiences among implementing agencies[29]. Particular attention be given to the importance of strong, functioning farmer groups in the use of both supervised credit and contact farmers or para extension workers[30].

4.2 Capacities

GART has indicated a strong interest in expanding its role in CF adaptive research, although its current capacity is quite limited. Although the trust has no plans to significantly expand its permanent staff, it can engage researchers and others on contract, as required. GART's infrastructure is more than adequate to meet CF's needs for on-station research. A significant role in CF adaptive research would shift GART's focus rather significantly toward small holder systems, but such a shift is consistent with organization's mandate which requires it to devote a portion of its efforts to addressing the needs of small holders. GART would have to rely primarily on funding from donors and/or government for this effort.

[29] ECAZ's statement of work calls for an analysis of CF extension methods (point 18), but the treatment of this issue is somewhat scattered among several reports. It is understood that the final report will include a more coherent treatment of this important topic. The SCC sponsored workshop on farmer participation (Swedish Cooperative Council, 1999a) and a recent review of extension approaches in Zambia by Ashworth (1999 & 1999a) provide useful points of departure for a comparison of CF promotional efforts. It would particularly interesting to compare the approaches being used by CFU and partners with those of SCAFE.

[30] There are many references containing examples of participatory extension (e.g. Scarborough, 1996). One project which combines farmer participation with organisational collaboration in the promotion of CF type technologies in Mashvingo province in southern Zimbabwe is of particular relevance (see Hagmann, 1998 and Hagmann et al, 1998).

The Soils and Crops Research Branch (SCRB) of MAFF and specifically the Farming Systems Unit have not been involved in CF adaptive research to date, although some reports suggest that at least some of components of CF technologies have been tested on station and on farm by SCRB in the past. The research services have faced difficulties in recent years and they are not currently operating at the performance levels they achieved a decade or more ago when donor support for public agricultural research was relatively abundant. At one time Zambia had one of the most impressive and diverse set of adaptive research programs in Africa (Kean and Singhogo, 1985). A body of knowledge was produced during this time, at least some of which should be instructive for CF promotional efforts throughout the country. The launching of NSHDP makes it imperative to resuscitate the adaptive research capacity of the SCRB and/or to make alternative arrangements that will perform this vital function.

GART's role vis-à-vis SCRB is also at issue. Some observers feel that SCRB is not capable of playing much of a role. ASIP was accompanied by a restructuring exercise which extended over several years and left programs somewhat in limbo (INESOR, 1998). Many of the most capable staff left for other positions. New recruitment has been stalled. Releases of funds were inadequate to support ongoing programs in many instances. This situation may be changing for the better. It is understood that there is support for strengthening the national agricultural research system (NARS) in ASIP. However, NARS strengthening is a medium to long term process which may have little effect on current capacity to serve CF.

An important source of relevant expertise is the Farming Systems Association of Zambia (FASAZ), a professional association, whose membership includes several current and former staff members of SCRB. Members hold positions in a variety of organizations and can be found throughout the provinces. FASAZ was officially registered as an NGO in 1995 and the association has undertaken several studies on different rural development issues. FASAZ members are in the process of developing an easily accessible database on farming systems and rural development in Zambia (FASAZ, 1999).

Various departments of UNZA collectively have considerable capacity, which could assist in meeting CF's adaptive research needs. The Departments of Crop Science (Agronomy) and Soil Science are well staffed and reasonably equipped to provide backup to adaptive research in the development of methodologies and data analysis. The Institute of Social and Economic Research (INESOR) of UNZA has competence to address socio-economic dimensions. INESOR staff has considerable research experience related to agriculture and rural development. INESOR played a leading role in the 1998 review of ASIP for GRZ and the World Bank (INESOR, 1998).

4.3 Options

There are several possibilities for meeting the adaptive research needs of CF, virtually all of which envisage engaging adaptive research capacities in several agencies, in both the public and private sectors. There are at least three organisational homes for the adaptive research, including GART, SCRB/MAFF and UNZA. It is suggested that the choice be guided by the institutional affiliation of a CF adaptive research coordinator. However, given the nature of the tasks and the distribution of capacity, it will be necessary to enlist staff from several organizations. There are

different and complimentary comparative advantages among the agencies currently interested or involved in technology development and dissemination for CF as illustrated by Table 2.

Table 2 TECHNOLOGY DEVELOPMENT AND DISSEMINATION FOR CF

(# of ♦'s is an indication of capacity of individual organizations to perform specific functions)

Complementary Task	SCRB	UNZA	INESOR	FASAZ	SCAFE	GART	CFU & OTHERS
On-Station Research	♦♦♦♦♦	♦♦♦		♦		♦♦♦♦	
On-farm Research	♦♦	♦♦	♦♦♦	♦♦♦♦♦	♦	♦♦	♦
Technology Dissemination		♦♦		♦♦♦	♦♦♦		♦♦♦
Monitoring/Implementation/Impact		♦♦♦	♦♦♦♦		♦♦♦		♦♦
Feed Back/Farmer Assessment of Technology				♦♦♦♦♦	♦♦♦		♦♦♦
Backstopping	♦♦♦♦♦					♦	♦♦♦
Training							♦♦♦

It is not necessary or even feasible to have entirely separate CF adaptive research teams. Most researchers contracted or otherwise engaged to perform research tasks need not make full time commitments. As much as possible, use should be made of on-going adaptive research activities in the field, such as the farming systems teams currently operating in Luapula and Southern Province with support from FINNIDA and the World Bank respectively (LLSP, 1999). Existing teams might be approached by the CF research coordinator to address specific CF issues.

There is growing interest in CF throughout the southern African Region and Zambia can benefit from sharing experiences and research responsibilities with national and regional organizations in neighboring countries. A workshop was held in Harare last year, which included presentations, and participation from several CF related programs within the region and outside (Benites, et al, 1998). An effort is underway to establish a regional research network to address CF needs (see GART, 1997). Much of the on-station work could be organized on a regional basis.

Zambia has considerable experience with the methods and organisational aspects of adaptive research (see Kean and Singhogo, 1985). These experiences can be drawn upon to select approaches best suited to the needs of CF and the conditions in different parts of the country. Implementing agencies responsible for extending CF can also be involved in adaptive research through such mechanisms as the farmer field schools. Adaptive research is a natural adjunct of responsibilities of contact farmers and other para extension workers. There is also a potential link between adaptive research and promotion on the one hand and marketing of inputs on the other which may prove attractive to private commercial firms and local farmer-entrepreneurs.

5. CF and Agribusiness-Small Farmer Relations

5.1 Agribusiness Interest and Involvement in CF

The most obvious and direct effects of CF on agribusiness-small holder relations stem from the fact that agribusiness firms have been involved from the onset, notably Lonrho cotton. The leadership of the CFU (Peter Aagaard) also plays a leading role in the Agribusiness Forum. Commercial firms have been engaged with small holders, often through out-growers schemes involving group formation, extension, training, supervised credit, input supply and marketing. All of these methods now form part of the approaches used by some CF implementing agencies, in varying degrees. The Deputy Permanent Secretary of MAFF characterized the recently launched NSHDP as a "national out-growers scheme". Thus, the agribusiness approach is very much in evidence.

Agribusiness firms have rather mixed views of CF which seem to relate to the extent to which there is convergence between CF methods and those recommended for out grower schemes for specific commodities. There appears to be a strong convergence in the case of cotton and certain oil seeds. However, crops such as paprika and tobacco have very demanding crop husbandry requirements which would require serious modification to be considered as CF. Yet these and other cash crops are very important driving forces in the promotion of CF, by virtue of the fact that use of CF is a requirement for receiving credit and loans are much more likely to be repaid if there is a cash crop. CF can benefit the production of cash crops such as paprika, indirectly, by enhancing the productivity of the crop production systems of farmers generally. If farmers are able to produce more maize on less land with less labour/draft power, they will have more resources to devote to cash crop production. Thus, CF could be seen as a means of facilitating improvements in the quality and quantity of cash crop production through advances in the productivity of food crops. However, experiences in Zambia and several other countries in the region, suggest that small farmer responses to CF and the resulting impacts are likely to more varied and complex[31].

5.2 Agribusiness Extension Approaches, CF and NGOs

Group approaches in the form of out grower programs have long featured in the activities of agribusiness firms. For the most part these have been rather top-down arrangements, which are specifically focused on getting inputs and extension methods to groups of farmers and collection of output for the specific commodity or commodities, which individual agribusinesses are handling. Often, little attention is given to group formation, leadership and strengthening beyond the specific requirements of the extension and marketing efforts. In this regard, the agribusiness extension approach differs rather markedly from that of some NGOs, notably CLUSA, which give considerably more attention to group formation and development than do most commercial agribusiness concerns.

One criticism of NGOs is that they are not particularly strong in technical areas, which is where agribusiness concerns generally have a comparative advantage, at least for the commodities in

[31] A discussion of how farmers assess technologies and how agricultural development efforts might better address farmer criteria is included in Annex VI.

which they have an interest. Commercial firms may be less concerned with other dimensions of small holder farming systems and have less to offer farmers for improving the production of other commodities, particularly those intended primarily for home consumption.

The preceding assessment of the comparative strengths of NGOs and Agribusiness firms suggests that the two organizational groupings can strongly compliment one another in efforts to assist small farmers. NGOs can focus on group formation and strengthening while agribusiness firms (as well as CFU and MAFF) can provide extension and supervised credit for a range of commodities. NGOs can help farmer groups make connections with those service providers, which best match, their needs and priorities. These connections are already being made, notably by CLUSA and CFU, which have been instrumental in development relations between agribusiness firms and farmer groups[32](Wentling, 1999). The potential of such arrangements are illustrated by the experiences of CLUSA sponsored depots and rural business groups in the Chibombo area of Central Province. Cheetah Paprika, a Dutch based concern, has entered into contract grower agreements with a number of rural business groups in the area, which are producing paprika for export. The results to date have been generally satisfactory for all concerned. Farmers have produced paprika of reasonably good quality and have realized extremely good returns as a result. Cheetah Paprika provides training to the Lead Contact Farmers who in turn give instructions to Contact Farmers and thence to group members producing paprika. Production loans covering both paprika and food crops are arranged by CLUSA and administered through the Credit Management Services (CMS). Paprika requires special production methods, which are quite intensive and could not be considered as CF. However, CLUSA requires groups to follow CF methods for other commodities, notably maize. Lead contact farmers and contact farmers provide extension advice to participating farmers on CF with assistance from CFU. Loan repayments are made from the receipts from the sale of paprika to Cheetah, with payments going directly from Cheetah to CMS. Thus, even though paprika production is quite different from CF, it is the paprika sales that "drive" the whole system[33].

Lonrho Cotton has had less success in developing working relations with NGOs although it has made approaches to NGOs in recent months. NGOs have expressed some interest in strengthening the existing Lonrho groups, but there has been no follow up to date. Improvements in cotton prices and/or a lowering of production costs could bring new life to these exploratory efforts by Lonrho. Smallholder cotton yields are rather low and there is considerably scope for lowering costs through changes in agronomic practices. CF promotional efforts are assisting in this regard.
The experience of CLUSA, CFU and Cheetah Paprika in Chibombo District illustrate the importance of organizational linkages in the promotion of CF. The ECAZ studies give rather limited attention to this critical dimension. Extension methods and organizational relationships are both areas deserving additional attention in efforts to better understand the performance of CF promotional efforts to date. Extension methods should be considered as topic for adaptive research, as suggested in the previous section (4). Process monitoring includes a range of methods

[32] A recent workshop on Farmer Mobilisation Strategies includes reviews of the group development activities of several NGOs involved in agricultural development in Zambia (Swedish Cooperative Centre, 1999a).
[33] There are quite possibly ways in which paprika production methods could be modified to make them more CF "friendly". The current methods could be characterized as conventional intensive cash crop production, involving nurseries, transplanting, removal of all debrie and heavy use of inorganic fertilizers and agricultural chemicals. There are alternative organic production methods and organic products generally command a higher price. The possibility of a CF organic option might be explored with Chetah Paprika, CF adaptive research providers and a selection of contact farmers.

for collecting, analyzing and disseminating information very quickly in the general area of organizational relationships (Mosse et al, 1998).

5.3 Evolution of Agribusiness-Small Farmer Relations

The Agribusiness Forum submitted a proposal to MAFF offering assistance to NSHDP. Forum members, including Amaka Holdings, ZAHVAC, LONRHO cotton and Clarke Cotton, by utilizing their existing network of 12,300 groups, represent approximately 100,000 farmers to promote CF (Agribusiness Forum, 1999). These companies are focusing their efforts on cash crops at the present time and presumably will continue to do so in the future. However, the proposal can be regarded as recognition by these companies of the value of CF and the potential benefits from assisting their farmer groups with other crops (e.g. maize and 'subsistence' crops). Greater efficiency and productivity in the production of subsistence crops could release resources for cash crop production. This represents an important change in the orientation of agribusiness firms and has implications for the relationships between these businesses and farmers. The expanded focus will place new demands on some participating firms in terms of additional services, such as adaptive research, input supply, extension, training, credit, processing, storage and marketing. Whether it is practical for all these firms to maintain the same standards of service for a broader range of crops and practices remains to be seen. There will be more scope for providing complimentary services (e.g. seed supply), which could open opportunities for these firms to recover a portion of their costs. Initially, these firms are looking to GRZ and donors to support the costs of their efforts since cost recovery for promotional efforts for subsistence crops is usually problematic[34].

The question of how ECAZ monitoring illustrates the impact of conservation farming on the risks of crop failure is a more general issue, which does not relate solely to agribusiness-small holder relationships. The extent to which CF practices contribute to achieving higher and more stable yields is an obvious attraction. One year of monitoring data will not reveal this. Several years of trials, both on-station and on-farm, which include a range of weather conditions, are required to address this question, which is properly part of the adaptive research agenda.

[34] .The USAID-supported ZATAC project involves the creation of an agribusiness investment centre which will assist commercial firms interested in working with small holders. The project will get underway during the latter part of 1999 and could be a source of assistance in this area.

5.4 Agribusiness-Government Relations

Private sector participation in the provision of agricultural services is a prominent feature of donor and GRZ policies at the present time. CF is arguably the most prominent manifestation of this policy to date. Agribusiness firms, notably Lonrho Cotton, are playing leading roles in the promotion of CF. The proposal of Agribusiness Forum, representing a number of agribusiness firms, has been submitted to MAFF seeking support to extend CF to 100,000 farm families in 12,300 existing groups (Agribusiness Forum, 1999). Acceptance of this proposal would be a major benchmark in public-private sector relations in the provision of agricultural services. One school of thought argues that the Ministry is not interested in a head on competition with the private sector for fear that the position of public sector extension would be eroded further in the process. Staff attrition, which is already a serious problem for MAFF, could accelerate as opportunities for trained agriculturists in the private sector expanded. Preliminary indications are that MAFF is unlikely to accept the proposal.

CFU leadership has been active in exploring areas of possible convergence of interest between MAFF and agribusiness firms, both through the Agribusiness Forum and through participation in the ASIP consultative group which meets monthly. NGO and Agribusiness leadership roles in CF have been regarded as threatening by some in MAFF. Criticisms from MAFF research and extension staff has focused on the limited evidence from formal research trials that CF is appropriate beyond limited areas of the country and a perceived lack of flexibility in the package and promotional methods. The technology has been imported from outside, notably from Zimbabwe, and should have been tested here prior to dissemination. While there certainly is a need for adaptive research (as discussed above), such criticisms (as well as some of the responses from the agencies promoting CF) are somewhat disingenuous. CF incorporates a number of rather basic crop husbandry and land management principles, some of which have, in fact, been tested in Zambia in the past (R. Vernon, personal communication). The considerable amount of work on farming systems, land management and crop husbandry practices which has been carried out by the research services in the country over the past 3 decades should be recognized and selectively drawn upon by all parties in efforts to improve the quality of CF packages.

6. Findings and Recommendations

ECAZ has collected and analyzed a considerable amount of information relating to the impacts of CF. Stakeholder appreciation of ECAZ's efforts has been quite limited to date. Most of their information is not in a form which is readily accessible to stakeholders. It is in the interests of all concerned that the final versions of the ECAZ reports be strong and useful products for CF stakeholders.

Recommendation 1*:* Priority attention should be given to the finalization of one or more ECAZ final reports incorporating the team's findings on CF and covering their SOW. Two stand-alone documents might be most effective. The first should be a short (20 page) report covering the major findings and making recommendations to CF stakeholders on ways forward. The main report would cover the team's SOW, but organized to provide support for the major points in the short volume. The team should consult with a small group of interested stakeholder representatives on the structure and content of the short report in particular.

The consultant has provided detailed comments and suggestions to ECAZ team members related to recommendation 1. A considerable effort will be required to produce a quality report, including consultation with stakeholder representatives. To the extent that this is done, several of the findings and recommendations that might have been included in this section relating to the work of ECAZ will hopefully be out of date and unnecessary.

Recommendation 2: A decision on whether and how to continue the impact monitoring of CF should await the finalization of the ECAZ report and responses from the stakeholders on the recommendations in that report. The program of future work should be developed in consultation with stakeholders. Specific attention should be given to the issues of greatest concern to different groups of stakeholders and to the consultative arrangements and reporting formats which can be most useful to them.

The qualifications of the ECAZ team appear generally consistent with the requirements of their SOW. However, additional experience and continuity in the socio-economics area would have been desirable, especially in view of the importance given to C/B comparisons in the SOW. In addition, the coverage of environmental monitoring to give attention to such areas as water quality and quantity (level of water table) and changes in weed species in addition to soils.

The information collected by ECAZ does include insights into why farmers adopted or did not adopt CF practices, although many of the responses are predictable. The baseline database was assembled two years after the initiation of CF promotional activities in the areas monitored. The information included in the database does not lend itself to making full impact assessments, at least in its present form. It is understood that disaggregated data relating to specific areas and farming systems will be included in the final report. A number of agencies, including SCAFE, SCC and MAFF/ASIP are collecting information related to monitoring and assessing impacts, but there is little coordination among these efforts at present.

Recommendation 3: The emphasis place on impact assessment should be reconsidered, given the importance of other concerns, notably adaptive research, and the possibility of selectively

combining and synchronizing data collection and analysis efforts for CF. MSU might be asked to propose arrangements for assessing socio-economic CF impacts as part of its contract.

There are several problems with the current set of C/B data assembled by ECAZ which have been brought to the attention of the two ECAZ team members responsible for this work. It is not clear how easily these problems can be corrected, but an effort to do so should be made as part of the production of the final report. Beyond improving the specific C/B calculations, there is serious question about the utility of this form of analysis in understanding farmer acceptance of CF and its potential impacts.

Recommendation 4: CF stakeholders should reconsider using yields (returns to land) as the principle criteria for assessing the performance of CF technologies since land is not generally a limiting factor in Zambia. C/B analysis also has significant limitations. Gross Margin Analysis is the most straightforward C/B method for Zambian smallholder conditions. An effort should be made to better understand how farmers in different areas and situations assess technologies and translate these considerations into an additional set of criteria for assessing performance. Possible candidates include returns to labour (particularly during the peak labour period); and extent to which a technology increases or decreases flexibility in the allocation of resources.

ECAZ has collected information on farmer adoption of CF. It is understood that this information will be disaggregated by area and related to prevailing farming systems in these areas. In particular, differences between Central and Southern Province will be noted. Since nearly all of the adopting farmers covered by CF surveys are part of formal groups participating in supervised credit schemes where adoption of CF is a requirement, the current adoption rates are of limited value.

Recommendation 5: Data should disaggregate and presented by province or district. Discussions of differences between areas should feature in ECAZ's final report and the implications of these differences for CF promotional efforts. More effort should be made to identify and monitor farmers adopting CF who have not been assisted through supervised credit programs. Farmers abandoning CF should be routinely interviewed to determine the specific reasons.

The ECAZ work provides useful information on the impacts of CF on soil quality. The timeframe of a single year made it difficult to reach definitive conclusions, but findings thus far suggest that CF practices can have positive impacts on soil quality, notably by concentrating P in the planting basins. However, the basins are not suitable for sandy soils and are quite difficulty to establish where there is plow pan. CF impacts on soil organic matter would only be measurable after at least 5 years.

Recommendation 6: Monitoring of CF impacts on soil quality should continue, preferably as a component of the adaptive research program for CF. Adaptive research should explore alternatives to practices such as potholing for us in areas with sandy soils and hard plowpans.

The effectiveness of the adaptive research supporting CF promotional efforts is likely to be critical to its acceptance by significant numbers of farmers. There is considerable variation in the

farming systems and soil conditions throughout Zambia. One set of practices is highly unlikely to fit all conditions.

Recommendation 7: Adaptations of CF technologies to better suit local conditions should be an on-going effort. Adaptive research support for CF should be considerably strengthened through the recruitment of a research coordinator and the engagement of other research and promotional staff, including farmers, to undertake adaptive trials in all areas where CF is being promoted. Use should be made of existing farming systems teams and adaptive research capacities in various organizations. Most adaptive research should be carried out on farm to allow farmers in different locations to assess technologies and assist in developing alternative methods where needed. On station research needs for CF might be met on a regional basis through collaboration among national and regional research organizations and networks.

Commercial concerns are playing increasingly prominent roles in the promotion of CF, reflecting a growing appreciation, particularly among cotton agencies, that the health of the entire farming system has important consequences for cash crop production. Out grower programs that require the use of CF as a condition for credits can accelerate adoption of CF. However, the out grower approach is only effective where there is a strong cash crop component which is not currently the case in several parts of the country. It remains to be seen whether the intensive supervision commercial concerns give to the promotion of specific cash crops will carry over to the range of CF practices and whether the adoption rates will hold up as supervised credit is withdrawn. The experience of CLUSA illustrates the importance of strong farmer groups and links to agribusiness concerns in the promotion of cash crops and CF.

Recommendation 8: The participation of agribusiness concerns should continue to be sought in the promotion of CF, in areas where a strong cash crop potential exists. MAFF should consider targeting those areas and groups where this is not the case. NGO involvement in group formation and strengthening should be encouraged as a prerequisite to CF and cash crop promotional efforts using supervised credit.

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Annex I:

ECAZ Scope of Work

The overall task is to provide periodic reports which describe the following:

- **Adoption Rates**

1. In the areas monitored, how any farmers have adopted, either independently or with the assistance of the CFU, Conservation Farming methods? How much hectarage is planted with CF methods, in absolute and relative (i.e., as a percentage of total hectarage) terms? What crops are being planted with CF methods?

2. How many farmers that have been exposed to CF extension messages have not adopted CF?

3. According to farmers, why are they adopting CF? Why are they not adopting CF? In other words, what are the advantages and disadvantages of CF, as seen by the farmer, especially as compared to conventional cultivation methods.

- **Impact: Costs**

4. What is the impact of CF methods on labor utilization and allocation within the farm family? Is there any special impact on women and children in the farm labor cycle or other social impacts, positive and negative, on the traditional status of individual family members?

5. What are crop pest and weeding problems which are encouraged and/or discouraged by CF?

6. What is the impact of CF adoption on the use of off-farm inputs (fertilizer, herbicide, insecticide, seed) and draught animals, as compared with prior conventional practices?

7. What other costs are associated with farmer use of CF? Are there some costs associated with CF that are not necessary with conventional tillage? What are they?

- **Impact: Benefits**

8. As compared with conventional tillage, what are actual increases (or decreases) in yields and hectares cultivated resulting from farmer use of CF?

9. What is the impact on farm profitability of CF? How does CF compare with conventional tillage in terms of farm profitability?

10. How useful is CF in reducing the negative effects of drought?

11. Is there evidence that CF is preventing/correcting soil problems and raising soil fertility? Is CF increasing the soil's ability to retain moisture? Is CF resulting in more impact from fertilizer application? What is the evidence? What determines whether CF prevents soil erosion or enhances soil fertility?

12. If conservation farming increases farm productivity and household food security, what elements of CF are most important? Alternately, how do the different elements of CF reinforce each other to have optimum impact?

13. What crops in agricultural regions I and II benefit most from CF? What farm families benefit most from CF (i.e. in terms of labor make-up, using hand hoes, or animal traction, female-headed households, location, market access, etc.)? Why?

- **Sustainability**

14. What inputs (fertilizer, seeds, insecticide, herbicide, plows, spare parts, labor) are essential for successful use of CF? Are these inputs affordable? Are they accessible on a consistent basis?

15. What role is crop diversification playing in the adoption of CF? What role is CF playing in the crop diversification? What is the impact of crop rotation, low rainfall crop varieties and any marketing, storage or pest problems in the sustainable use of CF?

- **Recommendations (These issues should be reviewed annually.)**

16. Based on monitoring results and interviews with key informants, provide an overall assessment, on an annual basis, of the economic and environmental soundness and sustainability, and resource-use efficiency, of CF methods. What are the key determinants of CF impact, positive and negative?

17. Are there any complementary production techniques (agro-forestry, plant varieties) or other CF techniques which have been observed as beneficial but are not widely used? How can their use be encouraged?

18. What are the most effective means of extending CFU messages in terms of cost and impact? How effective are outgrowers schemes? How effective are CFU partnerships with NGO's? partnerships with MAFF staff? How can CF extension be improved?

To respond to the tasks previously noted the contractor shall develop the data collection, analytical and reporting tools required to put in place an information system. This shall require undertaking the following:

1. Development of a CF baseline database that describes participating rural family social, economic, and farm characteristics such as:

a) family structure (disaggregated by gender and age);
b) income sources (both on-farm and off-farm sources);
c) farm size (i.e. area under cultivation);
d) soil type;
e) geographical location;
f) farm productivity (measured by output per hectare based on immediate past harvest);
g) farm profitability (measured by revenue less costs of marketed commodities);
h) number/types of (cash and food) crops grown;
i) important CF complementary assets (cattle, implements, on-farm processing equipment, spray packs, storage for marketing); and
j) other variables identified by the consultant.

This database should provide the foundation for impact monitoring.

2. Development of a results and impact report format that generates for USAID, ZNFU/CFU, MAFF and other collaborating institutions concise information on adoption rates, costs of CF methods, and benefits of CF methods. Consideration should be given to the appropriate rate of monitoring system expansion and sustainability. The presentation of information should include graphics that track impact over time.

3. Training of enumerators and field support staff in collaborating agencies including on-site visits and regular follow-up reviews to assure data quality and integrity.

4. Establishment of analytical basis, through models and approaches which yield relevant findings on a timely basis, i.e., not requiring more than several weeks between receipt of data and publication of analytical results.

5. Exploring opportunities for lessons learned dissemination through public and private media such as the Ministry of Agriculture's National Agricultural Information Service, the Zambian Farmer Newspaper, and daily newspapers.

Annex II:
Scope of Work for the Consultancy Mission

Purpose: To Improve Conservation Farming Impact Monitoring

To assess the quality of ECAZ conservation farming impact monitoring and recommend how monitoring can be improved the consultants will:

1) Review background documentation including USAID's 1998 Agricultural Sector Assessment, USAID's 1998 Biodiversity and Forest Threats Assessment, the ECAZ Conservation Farming Purchase Order Scope of Work, ECAZ Quarterly Reports, the Conservation Farming Handbook, and other documents.

2) Interview ECAZ, ZNFU/CFU, NORAD, SIDA, CLUSA, SCAFE, Swedish Cooperative Center, LONRHO, GART, donor, government, and private sector reps (input suppliers, agroprocessors) and others to obtain their opinions of conservation farming and conservation farming impact monitoring. Is the current approach to monitoring fulfilling their needs? Should it?

3) Assess and describe ECAZ CF monitoring personnel. How are personnel chosen? How are they supervised? Is ECAZ staff technical background and training appropriate for the monitoring work? Is there consistency from one quarter to the next in the personnel working on the monitoring?

4) Assess ECAZ monitoring data including their initial establishment of a baseline database. Does ECAZ monitoring have the capacity to accurately describe the impact of conservation farming? Will current assessment methods accurately indicate why farmers adopt conservation farming? Why or why not?

5) Describe how accurately ECAZ monitoring defines the socioeconomic characteristics (gender, resource endowment, family size, etc.) of conservation farming adopters. If monitoring results are inaccurate, how can monitoring be improved?

6) Assess ECAZ monitoring results with regards to the costs and benefits of CF and how CF affects small farmer profitability. How can small farmer reasons for adoption (increased yields, more effective use of labor, reduced risk of credit default) be quantified effectively to illustrate increased rural incomes? Is comparable information on the costs and benefits of conventional farming accurate? Why or why not? What are the major variables in assessing the costs and benefits of conservation farming (input costs, output prices, risk valuations)? What can be done to improve the calculation of conservation farming costs and benefits?

7) Describe how conservation farming might affect agribusiness-small farmer business relation. Are agribusinesses more or less likely to buy from small farmers using conservation farming? Why? Can ECAZ conservation farming results affect agribusiness decisions on buying from or

providing inputs to small holders? Can ECAZ monitoring illustrate the impact of conservation farming on the risks of crop failure?

8) Describe how accurately ECAZ monitoring calculates conservation farming adoption rates and follows adoption or expansion from one year to the next. Can this aspect be improved? How can adopters who are not part of a formal CFU initiated extension effort, but who adopted CF due to CFU extension, be captured?

9) Describe how ECAZ monitoring of soil condition changes due to conservation farming might benefit small farmers. How can soil conditions be monitored? Are the monitoring costs worth the soil condition knowledge benefits in terms of small farmer incomes?

10) Describe how ECAZ measures the impact of conservation tillage on different soil types? Is the ECAZ approach adequate? How can ECAZ effectively evaluate the suitability of different soil types for conservation farming? Discuss the importance of time frame, site selection, on farm or on station research in assessing CF impact on soil quality (bulk density, organic matter, pH, etc.).

11) Describe which CF research aspects are best investigated on-station and what aspects are best tried on-farm? Describe the institutional arrangements necessary to effectively develop, link and implement on-station CF research with on-farm trials. Describe the nature of technical backstopping that can be provided by research stations. Do the existing research institutions (GART and UNZA) posses the necessary infrastructure to provide appropriate technical backstopping?

12) Assess whether ECAZ's approach to monitoring CFU extension is effective. Does the ECAZ approach accurately inform the CFU and other stakeholders of the effectiveness of CFU extension? Should it? Should ECAZ monitor CFU extension? Does ECAZ monitoring measure the impact of extension messages on female farmers? Can this be improved? Should it be improved? If appropriate, how best can ECAZ monitoring help to improve CFU extension?

13) Based on the findings under 1-12, and other findings that the consultants may find appropriate, make recommendations on how USAID can work with ECAZ and other partners in improving the accuracy of CF impact monitoring? If training is necessary, develop a training plan. If further technical assistance is necessary, develop scopes of work for the technical assistance. If new institutional linkages are necessary, describe them and plan how they can be developed.

Annex III:
Persons and Organizations Contacted

Aquagro Ltd.
- A.V. Shankar (Chief Executive)

CARE
- Regis Mary Gwaba (Monitoring, Evaluation and Research Unit)

Conservation Farming Unit (CFU)
- Peter Aagaard (Coordinator)
- Dutch Gibson
- Daphen C. Mwanja (Senior Field Technician)

Cooperative League of the USA (CLUSA)
- E.B. Banda (District Coordinator, Chibombo)
- Lyle Brinneman (consultant)
- G. Chikumbisho (Lead Animator, Lubundi Depot)
- H. Habwali (Lead Animator, Mumambila Depot)
- Alex Kamalata (Facilitator, Lubundi Depot)
- Michael Mailloux
- K. Milimo (Chairman, Lubundi Depot)
- W. Mwika (Chairman, Mumambila Depot)
- Luka Nkhoma (Facilitator, Mumambila Depot)
- Ron Phillips (Director)
- Jessica Farmer
- Julliet K. Mumba

Department of Research and Special Services
- Mukolabai Ndiyoi (Farming Systems Agronomist)

Environmental Conservation Association of Zambia (ECAZ) Impact Monitoring Team
- Patrick Chibbamulilo (M&E, Financial Specialist/UNZA)
- Albert Chipeleme (Team Leader, Tillage/Land Resource Management/UNZA)
- Michael N. Isimwaa (Resource Economist)
- Tamara KambiKambi (Agronomist/UNZA)
- Obed I. Lungu (Soil Fertility and Land Management Expert/UNZA)
- Lovemore Simwanda (Chairman, ECAZ)

FINNIDA
- Esko (Program Coordinator, Luapula Project)
- Markku Laamanen (Counsellor)

Food and Agricultural Organization (FAO)
Charles Chileya (Program Coordinator)

GTZ/Luso Consult
Anthea Dickie

Golden Valley Agricultural Research Trust (GART)
Stephen Muliokelo (Director)
Douglas S. Moono (Agronomist)

International Service for National Agricultura1 Research (ISNAR)
Howard Elliott (Dep. Director General)
Francis Idachaba (Dep. Director General)
Michael Levinsohm (Senior Research Officer)
M.M. Rahman (Dir., Institutional Development and Governance)
Richard Vernon (Officer, MIS)

Kasisi Agricultural Training Centre
Brother Paul Desmaris (S.J.)

Lonrho Cotton
Dave Clements

MAFF/SCAFE
Roy M. Chiti (National Coordinator)
Par Oscarson (Reporting and Monitoring Adviser)

MAFF/USAID Crop Forecasting Study
Tom Cusack (Team Leader)
John Keyser (Agricultural Economist)
George Ohesh (Marketing Economist)
Nangana Simwinji (Gender and Socio-Economics Consultant)
Jeff Wright (Crop Forecasting Specialist)

Michigan State University (MSU) Project
Jones Govereh (Research Fellow)
Joyce Kanyangwa-Luma (Team Leader)
Michael Weber (Co-Principal Investigator)

Ministry of Agriculture, Food and Fisheries (MAFF)
A.K. Banda (Director, Planning)
Guy Kahokola (A/Chief Planner)
Russel M. Mulele (A/P.S.)
Layton Mwale (Dep. P.S., Acting Director of Field Services)
Geoffrey N. Naysto (Block Extension Officer, Chipepo Block)
Netherlands Embassy

Bink von Walsem (Agricultural Advisor)

Norwegian Embassy
Gudbrand Stuve (Second Secretary, Ag/Nat. Resources)

Programme Against Malnutriton
Felix Chizhuka (Manager, Drought Rehabilitation Project)

Swedish Cooperative Centre (SCC)
Henrietta Kalinda-Chilumbu (Development Advisor)

Swedish International Development Agency (Sida)
Margaretha Sundgren

United States Agency for International Development (USAID)
Cris Muyunda (Project Management Specialist)
Morse Nanchengwa (Ag. Specialist)
Walter North (Director)
David Soroko (ADO)

World Bank
Alex Mwanakasale (Ag. Operations Officer)

World Vision International
Amos Y. Kalawe (Director Field Programmes)
Tierto Niber Baba (Programme Advisor)
C. Masi (Project Manager, Integrated Agro forestry Project, Chipata)
Martin Silutongwe (Program Associate)

Zambia National Farmers Union (ZNFU)
Songowayo Zyambo (Ex. Dir.)
Daniel P.S. Mulwanda (Projects Officer)

Zambian Women in Agriculture
Mrs. Makote (Chairperson)

Zamseed
Winter M. Chibasa (General Manager)
Bhola Nath Verma (Research Extension Liaison Officer)

Other
Frank Van Dixoorn (former First Secretary, Netherlands Embassy)

A3: 4

Annex IV:
Itinerary

1999

June	17	Leave Los Angeles, CA
	18	Arrive The Hague, Netherlands
	21	Leave The Hague
	22	Arrive Lusaka
July	8	Visit to Golden Valley Agricultural Research Trust (GART)
	20	Visit to two CLUSA depots in Monze area, Southern Province
	22	Visit to two CLUSA depots in Chibombo area, Central Province
	23	Visit to Women's Field Day, Lukanga Area, Central Province
Aug	10	Leave Lusaka
	11	Arrive London
	15	Leave London, Arrive Missoula, Montana

Annex V:
Adaptive Research and Extension for Small Farmers: Lessons from Maize Research and Development Efforts In Sub Saharan Africa

The following sections are abstracted from an ODI network paper #55, ***The Meaning of the Maize Revolution in Sub-Saharan Africa: Seeking Guidance from Past Impacts*** *by Elon Gilbert, Overseas Development Institute, Jan. 1995, London. Although the Maize Research Impacts in Africa (MARIA) study on which the paper is based was carried out in the early 1990s (Gilbert, Phillips et al, 1994), the findings and lessons appear generally relevant to current conditions in Zambia, as well as other countries in the region.*

Considerable progress has been made in developing a range of innovations that are collectively capable of sustaining further advances in maize production and productivity in a broad range of ecologies throughout the region. Most of the impacts to date have been associated with the adoption of the first generation of innovations, particularly improved germplasm which performed better even without major shifts in other production practices. However, these have still not spread fully throughout the region: Yields remain considerably below potential, and many farmers have not yet adopted the new varieties. The cessation of civil war, unrest and lawlessness, reforms in input delivery, and the opening of isolated areas will assist in creating opportunities for farmers who have not yet had the option of using one or more new varieties to date. In addition, reforms and infrastructural improvements (roads and communications) in some countries may improve the chances for successful development of hybrid seed industries.

Research has increasingly turned its attention to the next generation of problems. There has been a diversification of themes and assessment criteria guiding germplasm improvement that better reflects the heterogeneity of farming systems and maize production in the region. Yield stability through pest and stress tolerance is receiving more attention. Themes other than breeding, including soil fertility management, are the focus of increased efforts. Although progress will probably not be as dramatic as before, this will be at least partially offset by the improved targeting of research efforts that are taking place in response to FSR and other linkage activities.

This section examines the prospects for the development and transfer of maize-related technologies in Africa, specifically from the perspective of the potential users of the technologies which research institutions will develop and extend over the next decade. The discussion focuses on three related areas, namely

- How farm families assess technologies;
- Dreams and research themes;
- Refocusing research priorities.

A. How do Farmers Assess Technologies?

In terms of future research themes, there is a need to assess the appropriateness of specific themes for each situation throughout Africa. Further, the resulting agenda will exceed the capacities of individual NARS and regional programs in most instances. Hence, the necessity of prioritization and cooperation across national boundaries to achieve even a modest coverage with available resources.

The choices among research themes should be guided by an enhanced understanding of how farmers assess technologies. This is something proponents of farming systems research (FSR) have intoned for more than a decade, but the message has been given new meaning and urgency by the increased emphasis being placed on impact. Further, the impact studies are suggesting that to understand impact is more complex than many of us had imagined.

What are the lessons from experience and what do they tell us about how farm families assess innovations?

First, most resource-poor farm families throughout Africa are primarily interested in saving resources, particularly labor during the peak labor period, rather than in returns to land. David Norman demonstrated this point more than 20 years ago in his research in Nigeria (Norman et al, 1980); and it has been made frequently since, notably by Peter Matlon (1987) in Nigeria and Burkina; by Haugerud and Collinson (1990) for Rwanda; and by Alan Low (1986) for Southern Africa. Yet there are still problems in digesting the implications of this in research themes and assessment criteria.

According to Low and Waddington (1991), this problem is not restricted to on-station research by any means: in the majority of FSR projects examined, yield per hectare was being used as the principal or sole assessment criteria for on-farm trials, in spite of the fact that the descriptive and diagnostic work strongly pointed to returns to other factors as being more important.

It is commonly argued that there is a strong convergence between returns to land and labor. There is indeed a fair degree of convergence for germplasm viewed in isolation. However, there can be major divergences in the area of crop management, where e.g. time of planting or spacing can be strongly influenced by labour constraints.

The desire of farm families to save resources has an additional dimension that must be considered. Many farmers assess a technology in terms of the extent to which they might be able to shift resources (land and labor) currently devoted to maize production into some other activity, hopefully while still at least maintaining current levels of maize production. That activity might not be related to agriculture at all or even to generating income from other sources. Sending children to school is perhaps the most common example.

A second consideration that is very important to farmers is flexibility. Does an innovation increase or decrease flexibility in terms of the timing of specific operations, notably planting and weeding? Possibly the best example of an innovation which increases flexibility is an early maturing variety, such as the Katumani composites that were developed and successfully extended in portions of

eastern Kenya in the 1960's and 70's.

Another illustration of the role of maize in saving resources and increasing flexibility is the growth in the popularity of early maturing maize as a substitute snack food during the early harvest period in West Africa. Labor that women in particular expend in preparing food is reduced at a time when they are particularly busy with farming activities. Green maize can also be sold to generate cash at a time when it tends to be in short supply for many rural families.

Flexibility is important in space as well as in time. If innovations for maize allow a Kenya farmer to shift some good quality land out of maize and into a higher value crop, possibly by moving the maize to a less productive field or just reducing area, that is progress. This was the response of Family 1 in the example above. Resource productivity increases, the farmer is happy, yet by standard measures of impact, nothing happened.

B. Dreams and Research Themes

The dilemma we face in trying to develop and extend improved technologies for maize, is that many, if not most, of our clients are not interested in devoting more resources to maize production, especially if maize production already consumes the major portion of available land and labor. This is not simply a matter of a farm family wanting to produce enough to meet their own needs or reduce food purchases. Increasing numbers of farm families are consciously opting to depend on the market for significant portions of their staple food requirements, and allocating resources to other activities.

Many of them would rather not be farmers at all. If there is no escaping that, then at least they do not want all their children to be farmers. We can argue that this "dream" is unrealistic, that there is no possibility of the cities and non-farm employment of absorbing more than a small fraction of the rapidly growing population. Yet having at least one family member become part of that small fraction remains an important part of the dreams of many rural families. In short, Africans strongly support structural transformation. This should not be hard for Americans, in particular, to understand in the light of the history of rural areas in this country.

The major thrust of these arguments suggest that for much of sub-Saharan Africa structural transformation is proceeding without anywhere near the same degree of agricultural intensification that took place in other regions, notably Asia. This is not encouraging news for proponents of certain types of crop management research, particularly those that require either greater inputs in labor and/or reduce farmer flexibility. Even high yielding cultivars that must be planted at a specific time to perform are unlikely to find more than a small niche in most farming systems in the region. Conversely, pest and weed management approaches which give farmers the option of reducing labor time required during the peak labor period could be very attractive.

One school of thought (not a particularly politically correct one) argues that the constraints upon research and development efforts to serve small farmers in Africa that don't want to be farmers are so great that they are doomed to failure, especially if we measure success primarily in terms of maize production. The best that can be hoped for, according to this line of logic, is that the spread of resource saving innovations will accelerate the transformation process, letting the majority of

farm families get on with whatever they really want to do, and increasingly turning control of the land over to more "progressive" farmers.

Progressive farmers are not all rich by any means, although several are headed in that direction. Most of them face the same resource constraints of the majority of their neighbors. They are all good managers. Many of them are also increasing resources devoted to agriculture while many of their neighbors are going in the opposite direction. When it comes to trying out new technologies, they are in front of queue. Some FSR practitioners argue that this group is atypical and should be excluded from technology testing. Don't bother to try. They will get the seed anyway, one way or another. For this group farming is definitely part of their dream and they are likely to be the principal beneficiaries of future technological change, particular the innovations associated with intensification.

Technology development and transfer for maize and other commodities should build upon people's dreams and draw energy from them, rather than trying to force models of intensive agriculture across a very diverse set of clients. In some countries, or more correctly parts of countries, intensification involving the use of improved varieties and practices for maize is indeed taking place on a large scale, notably in Malawi. However, this is not likely to be the case in most areas.

The critical point here is that in attempting to help specific segments of the population (e.g. poor, low resource farm families in marginal areas), their dreams, rather than simply our assessments of their fates, should be taken into account. The implicit assumption that most poor families see a more intensive farming system in their futures is questionable at best. Catering for those who are saving resources from agriculture to allocate elsewhere will continue to be a somewhat frustrating clutter of false starts and partly adopted packages, until their objectives and dreams are more specifically addressed by new technologies. This means that rural primary education, non-agricultural activities (the informal sector), migration and remittances should be better taken into account in development programs for rural areas. At the same time, innovations for agriculture can play critical roles in the transitions which individual families are attempting to make.

Further, we should accept that important differences exist among farm families, large and small, as managers which guide their decisions about technologies and resource allocations and indeed the patterns of structural transformation which are in progress throughout the region. The best managers will survive and thrive as the major beneficiaries of the next generation of technologies. It is probably impossible for agricultural research alone to significantly alter this process, even with a better targeting of innovations.

C. Refocusing Research and Development Priorities

The important question to consider, especially as funds become more limiting than in the past, is how available resources should be distributed across research themes and institutions to achieve the greatest impact? A major problem in addressing this question is that technology development and transfer are parts of an inter linked process involving strategic, applied and adaptive research together with dissemination of results. Further, the number of pressing issues is almost unlimited.

However, to argue that more of everything is needed does not help the research manager, research team leader, or decision-makers in governments and funding agencies who must make increasingly difficult choices. There are many suggestions for new approaches and studies, but few candidates for a lower priority status. Given the manner in which decisions are often made at the funding agency and research and development institution levels, it seems probable that there is scope for improving overall performance (meaning impact), even with current and prospective resource levels. Such an adjustment can be accomplished by shifts in resources among research themes and institutions at least as much as by searching for efficiencies in the current set of activities.

i) **Breeding or Crop Management?**: Particular emphasis should be place on early maturing and pest resistant cultivars, rather than those which require high levels of management. The bottom line is that farmers should be offered choices - a mix of maturation periods in particular, but also alternatives on storage and processing characteristics. The short duration variety that is routinely picked green and roasted can be different from the longer cycle variety that is left to dry in the field and stored. Different characteristics are also required when maize is intercropped with other commodities. While it is not feasible to mount breeding efforts to meet the individual needs of each farmer, systems by which rural communities can be involved in the identification of characteristics which are suitable for them at an early stage can provide guidance to varietal improvement programmes[35]. Breeders in particular should monitor these developments closely so as to be able to make any necessary adaptive adjustments as quickly as possible. Further, such monitoring will be instrumental in providing feedback to guide the next generation of research themes[36]/.

A second area that should be considered for priority attention is expanding the range of choices for improving soil fertility management for small, low resource farmers. The relationship between improvements in crop management, particularly soil fertility, and improved cultivars has been well established, but most farmers in the region are not using inorganic fertilizer on their maize, despite generations of efforts to promote fertilizer use, most notably under the auspices of the FAO. In addition to providing farmers with the means to assess more systematically the fertility status of their own fields, they might be offered additional options, including intercropping, rotations, and nitrogen-fixing trees in the context of extension programs focusing on improving fertility management (Blackie and Jones, 1994). The work being undertaken by the Maize Research

[35] Involvement of farmers in defining criteria for breeding programmes themes has been used with some success by the CIAT Bean Improvement Program (Ashby, 19??).

[36]/ A variation of this approach is being pursued by the SADC/ICRISAT Sorghum and Millet Improvement Program serving countries in Southern Africa.

Team of the Department of Agricultural Research in Malawi with support from the Rockfeller Foundation is especially noteworthy in this regard.

Both of these suggestions imply a shift in attention away from breeding and possibly from research generally. Carried to an extreme, such a shift would be a serious error. Continued breeding is essential simply to maintain the progress that has been achieved. Further, advances in crop management will open up new possibilities and problems which can best be addressed through the development of improved germplasm.

ii) **Marginal or High Potential Areas**?: Another important dimension of the debate on research priorities concerns the balance between efforts for marginal and high potential areas. Lipton and Longhurst (1988) argue that marginal areas have tended to be by-passed by research and development efforts focusing primarily on high potential zones. As a consequence, inter-regional income differences have widened and producers in marginal areas may actually be worse off as a result of lower market prices for such commodities as rice and wheat. Byerlee and Morris summarize the arguments in favor of greater attention to marginal areas as follows:

- "Returns to research may no be higher in marginal environments than in favored environments because the incremental productivity of further investment targeted at favoured environments is declining.

- A large number of people currently depend on marginal environments for their survival and increasing population pressure is forcing more people into these areas.

- The people who live in marginal environments are among the poorest groups of the population; therefore increased research investment in these areas is justified on equity grounds.

- Many marginal environments are characterized by a fragile resource base, so for these areas special efforts will be needed to develop appropriate production technologies that will sustain or improved the quality of the resource base over the longer run." (Byerlee and Morris, 1993, p382)

Somewhat contrary to expections, the authors found that in the case of wheat world wide and in India, marginal environments were, if any thing, getting more than their "fair share" of research resources[37]. Although such an exercise has not been carried out for maize in SSA, the findings from MARIA and other studies suggest that the results might be different. First, there is a strong historical bias in maize research and development efforts toward a relatively few, higher potential areas, notably the highland areas of Kenya and the better maize producing areas in Southern Africa. Efforts elsewhere have been modest and episodic for the most part, traceable in part to the secondary position of maize throughout most of Western and Central Africa.

[37] The authors use a modified congruency analysis to compare actual allocations to research between favored and marginal environments with an index of production which takes account of i) rate of expected research progress; ii) strength of local research effort; and iii) incidence of poverty.

Second, maize has expanded into marginal areas in many areas inspite the absence of innovations specifically suited for these conditions in many instances. The qualified success of the Katumani composites developed specifically to avoid drought in semi-arid areas in Kenya illustrates the considerable potential of maize in marginal areas (Sarch and Gilbert, 1995).

Finally, although SSA as a whole has a relatively large area which has classified as "very suitable" for maize production, most countries lack the infrastructure and general socio-political and economic conditions necessary to take full advantage of production packages designed to optimize productivity in high potential environments. Partially as a consequence, the research agendas for the very suitable, but stress prone areas such as Angola and Southern Sudan become more like those for marginal areas. The decision by some research organizations, including CIMMYT, to emphasize the development of OPVs as opposed to hybrids in many countries reflects an appreciation of the constraints imposed by socio-economic and political conditions. Hence, the need to refine the distinctions between marginal and favored areas for SSA as a first step in assessing the convergence between current research resource allocations and production potential for the two environments.

Maize has made significant progress in replacing sorghum and millet in semi-arid zone throughout the region during the past 30 years. However, there are serious questions about the desirability of trying to further develop maize packages for many of these areas as opposed to emphasizing improvements in sorghum and millet and other more naturally adapted strategies. Recent progress by the SADC/ICRISAT Sorghum and Millet Improvement Program in developing improved varieties for Southern Africa could reverse the trend toward maize among the coarse grains.

iii) **Research, Extension or Policy Reform?**: Beyond the questions of resource allocations among research topics, is the broader issue of the relative importance that should be given to research, extension and policy reform in short and medium terms. One school of thought argues that productivity levels are considerably below the potential of available technologies and that a combination of extension and improvements in the efficiency of input and output markets can lead to rapid progress. The alternate view is that further adjustments in the technologies themselves is the most cost/effective approach since attractive innovations can spread by themselves. Further it is argued by some that massive doses of extension and subsidies can at best induce temporary changes, but will be unable to compensate for the short comings in the innovations themselves (Byerlee et al, 1994).

The MARIA study finds substantial support for both these positions, confirming that research, extension and policy reform - particularly in relation to input and output markets - are all vital ingredients of successful development efforts. However, examination of past experiences (and simple logic) suggest that the balance among the three elements might vary considerably from place to place and over time. Further, the distinctions between research, extension and input marketing could become progressively blurred as a consequence of adjustments in strategies for research and extension of national and international agencies; and broader participation by the private sector, including NGOs and commercial firms. Choices will be guided more by what is needed and what appears to work, rather than the formal mandates of a given institution[38].

[38] Contracts for performing specific services that require additional capacity are an increasingly important

Although generalizations about the relative emphasis that should be placed on research, extension and policy are of limited value, one clear priority does emerge, namely the dissemination of existing technologies into areas which either currently grow maize or possess suitable conditions for its expansion, but which, for various reasons, have been isolated from maize research and development efforts. Experience in a range of diverse situations across Sub-Saharan Africa strongly suggests that farmers will incorporate one or more of these varieties into their farming systems, even though they will not initially, at least, discard their own varieties. In essence, emphasis in the near term should be placed on horizontal diffusion of existing varieties and hybrids, even at the expense of some reduction in efforts to develop new technologies (Gupta, 1989).

As peace is restored to those parts of Africa such as Mozambique, Angola and Ethiopia which possess large areas suitable for the use of existing improved maize cultivars with minimal adaptation, maize production should expand dramatically as it did in Zimbabwe following independence in 1980 (Rohrbach, 1989). These "surges" are often one shot affairs, but can provide new life for disabled research and extension services and enable them to maintain some of the momentum. A renewed confidence and sense of direction among national institutions may also provide the basis for healthier, more productive interactions among national, regional and international research institutions. In any event, it is clearly in the interests of all concerned that these surges take place and are exploited to the full, even if the historic divisions of labor among the various actors are somewhat blurred in the process. The Mozambican refugees who are now returning in large numbers from Malawi, Tanzania and other countries should have the option of using improved varieties of maize and other commodities. To a certain extent this is happening of its own accord, but the process could be accelerated.

Institutional Paradigms. Whatever research themes it is decided to pursue, the need will remain for viable research institutions. Enhanced credibility, particularly at the NARS level, is an essential part of improving and sustaining institutional viability. However, fresh thinking is needed on the institutional paradigms that may be better suited to the conditions that are likely to prevail in SSA at least through the year 2000.

In the near term the research community is faced with trying to do more with no more or even less. It probably means making hard choices about the number and size of institutions. A certain degree of "down sizing" may be healthy (Eicher, 1989). In many instances the performance levels of NARS have not responded to major institutional development efforts. The conditions which fostered achievement and creativity in maize research in specific countries (e.g., Kenya and Zimbabwe) prior to 1980, tend to be the antithesis of those currently found in the public services of most African countries. Structural adjustment policies aimed at controlling the scope and scale of government activities generally thwart the capacities and performance levels of research services, while in several other countries, civil unrest has brought virtually all research activities to a halt. Frequently, national researchers leave key NARS institutions as fast as they are trained.

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feature of research and development projects in several countries. Although not without problems, contracting mechanisms offer considerable possibilities for collaborative efforts involving two or more government and private organizations.

Numbers seriously understate the impact of attrition on the quality and quantity of research by NARS, since those leaving include a high proportion of the most able.

These conditions have led some donors, to question the utility of further support for agricultural research. Reductions in assistance to NARS have tended to convert negative appraisals into self-fulfilling prophecies. There is a serious danger that the considerable progress already made in developing the next generation of innovations for maize and other commodities will be dissipated in the process - especially at the adaptive end of the research spectrum. While classic forms of the Green Revolution are unlikely in SSA, there is substantial scope for further improvements in productivity through the research now in progress as well as the selective use of innovations already available. This is particularly true in countries which have been insulated from technological change by isolationist and perverse policies (Guinea), civil war (Mozambique, Sudan, Angola, Ethiopia), or neglect (Congo).

Is the glass half full or half empty? Despair is perhaps the easiest conclusion to reach. Yet that conclusion ignores the fact that significant progress has taken place in selected countries and commodities, often in the face of adversity. The qualified success of maize in Africa provides evidence that substantial benefits can and did flow from the investments in agricultural research. What might have happened if conditions had been more favorable? If only some of the negative factors had not been present? Zimbabwe, during the immediate post-independence period (1980-85), is a good illustration of the dramatic results that are possible when there is a strong confluence of favorable factors.

Using hindsight, the MARIA study has shown that major efficiencies could have been realized in research investments. As with education and curative medicine, our institutional models for NARS were probably inappropriate for most of SSA. Yet quality research that resulted in positive impact took place in a variety of conditions and structures. For given periods of time, windows existed which fostered scientific creativity, as illustrated by the recent development of semi-flint hybrids in Malawi (Smale, 1993). More attention should be given to the lessons from these successful experiences in designing the next generation of research and development for the region.

The appropriate balance among national, regional, international research institutions as well as research agencies in developed countries is a subject that is receiving increasing attention as the competition for dwindling resources increases. A comprehensive discussion of this issue lies considerably beyond the scope of the present study, but MARIA as well as the experiences with other commodities in the region offers lessons which might be considered in developing guidelines.

First, there will be a continuing role for NARS in this process, but the nature of that role is likely to differ substantially between countries depending on their policies, priorities, and capacities. Fresh frameworks for structuring SSA agricultural research are likely to emerge as individual NARS gain a better understanding of their comparative advantages and the means by which they can both enhance their participation in, and their service from, regional and international institutions and networks. New paradigms are particularly needed for the smaller NARS who are particularly vulnerable to effects of reductions in resources (Gilbert, Matlon and Eyzaquirre,

1994). New models must, above all, offer hope. They must change the negative or even cynical perceptions that researchers, national governments, and donors currently have of their NARS.

Second, approaches to strengthening NARS should give special attention to improving their performances in the face of adversity. Conventional approaches routinely seem to require better political and socio-economic contexts than much of Africa is likely to offer before the end of the century. Rates of research failure can be reduced through efforts to eliminate debilitating interruptions in staffing and resources for high-priority activities.

Third, the lessons from maize revolution reaffirm the value of involving farmers both in the determination of the research themes and assessment criteria as well as in the testing and adaptation of innovations to local conditions. The emerging institutional paradigms should continue efforts to broaden participation in agricultural research and extension, particularly among farm families themselves.

Finally, the new frameworks should emphasize human resource management systems which are guided by accountability, stewardship of innovations, performance, and above all creativity. Traditional distinctions between research and extension are likely to become less relevant in the process. Although training should continue, the focus should shift to enhancing the performances of staff at post. National and regional and international research institutions can collectively produce the innovations which will move Africa forward. Towards this end, ways must be found to open more windows for the best of Africa's researchers to be creative in order to accelerate the flow of innovations required for development.

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Annex VI:
Monitoring of Soil Conditions[39]

This annex addresses items in the SOW for the consultancy mission specifically relating to soils, notably points 9 and 10. At the request of the consultant, Dr. Obed Lungu of the Soils Department, UNZA, and member of the ECAZ specifically concerned with soils prepared the following responses to the questions in the SOW. The account is comprehensive and quite frank regarding some of the problems which Dr. Lungu encounter. Accordingly, the consultant decided to include these notes in their entirety.

Monitoring of soil condition changes. Monitoring changes in soil condition over time generates important data that can be used to take timely corrective soil management measures to improve soil fertility or check further soil degradation. Knowledge of the soil condition will benefit small farmers who are resource-poor to apply only those amounts of inputs and at frequencies that are absolutely necessary. For instance, where there is high residual fertilizer from past fertilizer applications, the farmer can choose a different fertilizer formulation which is cheaper because less of the sufficient nutrient would be applied.

Where soils are acid, crop yields will be limited regardless of fertilizer application, unless lime is applied to improve the soil condition (pH). Furthermore, anticipated benefits (savings in nitrogen) from use of legumes in crop rotations will be severely reduced in acid soils because biological nitrogen fixation will be limited.

The significance of soil organic matter in tropical soils is greater than that of any other soil property except moisture supply. Soil organic matter is the key to nutrient and water retention capacity in these fragile soils. Although chemical fertilizers still appear to be necessary for high crop yields, they are not always sufficient in the long-term to assure sustainability of agricultural systems, unless they are complemented by organic and biological soil management (Lungu and Chinene, 1993). Research is revealing the influence of type of land use e.g. practices on the stored quantity of soil organic matter. Herein lie the benefits of cost-savings on fertilizer inputs.

How can soil conditions be monitored? The only way to know whether or not changes are occurring in soil due to Conservation Farming practices is to make regular and systematic measurements of sensitive indicators of soil quality. The data generated affect the decision to amend (or not to amend) the soil. Without this information, one would be operating in a "black box" not knowing the balances, optimal levels of fertilization or the implications of the adopted management strategies for the sustainability of the practices. Furthermore, there would also not be any reference or baseline data against which to gauge improvements or decline in soil quality.

It is not necessary to repeat field experiments at every site, on every soil type and with every crop type and variety. A lot of the basic information required to develop CF production packages can be extracted from previous research reported in the literature. In Zambia, soil types, agro-ecological zones and crop fertilization regimes are fairly well defined to enable effective agro-

[39] Prepared by Dr. O.I. Lungu, Soils Department, UNZA.

technology transfers from other places.

However, monitoring is a different necessary process that will generate data on the status of the soil over time, enabling judgement on the impact of CF practices on particular fields and soil types. Soil reaction (pH), nutrient content (N, P), soil organic matter and soil bulk density are very dynamic soil properties and are good indicators of changes in soil quality, in this case under CF practices.

From measurements of soil pH we can infer a lot of information on soil fertility (ionic concentration, nutrient availability and soil biological activity). Measurements need not necessarily be taken every year because normally only small changes in pH occur over short a short period. Besides even with corrective application of lime, the effect would be expected to last at least three years. Therefore, it would be adequate to check the pH of the topsoil (0 - 3 cm) every 3-5 years.

Maintaining high levels of soil organic matter is desirable for sustaining soil productivity. Data from field trials is revealing the influence of type of land use on the stored quantity of organic matter. Like all other soil properties, the stocks of soil organic matter are spatially variable, making it difficult to extrapolate results from one specific site to another. Besides, soil organic matter content changes very little in the short-term (<5 years).

It can therefore be measured once in 5 years to check the status. If it declines to dangerous levels, perhaps a decision can be taken to fallow the land, or to plant a green manure giving high biomass yield such as velvet beans or sunhemp (*Crotolaria* spp.). Where available, farm yard manure can be applied, and this can give an immediate response in increased soil productivity.

Large qualities of nitrogen, potassium and phosphorus are required by crops which remove large quantities of these nutrients every season. In order to maintain soil productivity, these nutrients must be replenished at amounts at least equivalent to their removal rate. Therefore, these nutrients are a major source of cost in fertilizer input (basal fertilizer). Monitoring the levels of these nutrients is necessary, and this can be done after harvest and before planting so that the fertilizer regime of the next crop takes into account the residual effects of previous fertilization. CF also utilizes legumes in rotation with cereals to fix atmospheric nitrogen, which promotes N banks in soil. The accumulation of N from this process can be quantified through monitoring so that N fertilizer application rates are rationalized to save costs.

Do the benefits of soil monitoring justify the costs? Currently, small farmers seldom have their soils tested. They use generalized fertilizer recommendations, which may not only be costly but also inefficient. In a normal season and under the small farmer conditions, this may not be a big problem because the amounts of fertilizers applied are in any case, below the optimum for the soil type and crop variety target yield. Following a drought, however, (P, K) would account for quite substantial savings in P and K fertilizer requirements for the next crop.

Timeliness of soil management decisions can save huge costs on soil rehabilitation later (the old adage “a stitch in time saves nine” is true here). Most soil quality indicators such as pH, organic

matter content and soil compaction (high bulk densities) will not be reflected by crop yields until irreversible, or costly damage has been caused. It is from this perspective that monitoring of soil quality and knowledge of soil condition can yield benefits especially for the resource-poor small farmer.

In order to be practical, low-cost and benefit many small farmers, soil tests need to be scaled down to the absolute critical minimum numbers of samples and parameters measured on each sample. In this regard, it would be desirable to identify major soil types for a large group of farmers using similar management practices so that one soil sample becomes representative of the soil type, enabling the analysis to be extrapolated to this sampling domain. For all practical purposes, the error inherent in using this approach on fertility management should be minimal compared to the "blanket" fertilizer recommendation based on agro-ecological zone.

Field extension officers can be trained to identify soil types, delineate boundaries, based on simple easily observable soil features, and to take soil samples. Soil testing can be done for pH, soil organic matter and bulk density every 3-4 years when measurable changes are expected. Nutrient contents, particularly nitrogen and phosphorus should be determined after crop harvest and before planting. With some short training and using some affordable field soil testing kits, extension officers can make pH measurements quickly in the field. Then, they can give lime recommendations where necessary using conversion tables integrating soil type, pH and crop. The error involved in estimating the lime requirement using this approach would be practically comparable to that by more elaborate laboratory techniques.

Measurement of Impact of CF on Different Soil Types. The impact of CF practices on different soil types was measured by the difference in dynamic soil properties between CF and non-CF fields at a particular sampling time. In each comparison the soil type and crop were constant. The dynamic soil properties indicative of changes in soil quality that were measured were soil reaction (pH), organic matter and plant available phosphorus. Soil samples were obtained from 0 -30 cm depth in CF and non-CF maize. In CF fields, the sample was taken from the centre of the planting basin and on the planting station in the non-CF field. At one site a soil sample was also obtained at 30 cm from the centre of the basin. All CF fields were in the second year of the practice.

Adequacy of the Monitoring Approach. The limitation of this approach is that these measurements were not made on the same fields that were surveyed and characterized during the second phase of the work (2nd quarter). Therefore, changes in the dynamic soil properties due to CF practices over time could not be determined because there was not an initial soil condition status as reference. Monitoring CF practices on a particular soil type and under specified management practices over time would have provided realistic measurements of the impact of CF.

Soil characterization which was done in November, 1999 generated baseline data on the initial fertility status of the soil and evaluated soils for their suitability and capability for CF practices. A wide range of soil analyses were made, and the results showed that the major soil constraints are soil acidity (low pH), low soil organic matter and plant available phosphorus. Using these baseline data and monitoring changes in these parameters on the same fields over several seasons under CF practices would have produced the desired measure of CF impact. This work was not

carried out due to delays in going out to the field, resulting limited time to complete the work before submitting the report.

Evaluation of Suitability of Different Soil Types for CF. CF practices are not suitable for all soil types (ECAZ, 1999, Vol. 2). Sandy soils are too permeable to retain water and are inherently poor in nutrient retention capacity (low cation exchange capacity, CEC). However, clays are not only too hard to work using handhoes in the dry season (August/October), but are more susceptible to waterlogging due to slow permeability especially in very wet weather.

Very elaborate and sophisticated methodologies for evaluating suitability of different soil types for different soil management practices such as CF exist. In the second quarter of this work (November, 1998), detailed soil surveys of farms were carried out, and several soil properties such as soil texture, depth, drainage, slope, erosion hazard were examined in order to determine the suitability for CF. This approach is costly and the field work too time-consuming to benefit resource-poor small farmers. The approach that is required for these groups of farmers is one that is simple, low cost and has a high benefit potential to the target group.

This could be achieved through training farmers and extension workers to identify soil types using simplified guidelines that can be developed. Material for these guidelines should also be obtained from the indigenous knowledge of the local people. There is indication that local people have some useful knowledge of the soils they farm, but this has not been organized, or documented in any easily retrievable form.

In addition, a lot of already existing soil survey data can be used to develop these guidelines without necessarily having to resort to conducting new surveys. Where these data exist for an area, the soil requirements for CF can then be watched to the soil properties provided by the land in order to obtain the soil suitability class. The International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT), a collaborative project with the University of Hawaii (IBSNAT, 1985) produced baseline soils data on the major benchmark soils in all the three Agro-ecological Regions of Zambia. This data set could be used in addition to that obtained from localized soils surveys and the information cross-checked and correlated with indigenous knowledge of farmers.

Importance of Time frame, Site Selection on Farm or on Station Research in Assessing CF impact. The impact of CF practices on soil quality can best be assessed where the variables in the practice can be controlled and their effect measured. Some of these variables such as the costs and benefits are best evaluated on-farmer under farmer circumstances in order to give realistic benefits to the small farmer. This work should be conducted over several seasons in order to properly account for the seasonal variability in costs of inputs and prices of produce and for the vagaries of weather. Other critical variables are soil type, crop variety and management practice. These must be well defined so that regular and systematic measurements can be made and the data unambiguously interpreted. Field soil and agronomic experiments require at least three seasons in order to produce reliable data that take account of vagaries of weather and other variable factors over time. Besides, some indicators of soil quality such as soil reaction (pH), organic matter, and bulk density can only detect changes in soil condition after at least five years using a soil management practices.

Research questions. The following are some of the research questions that might be addressed on-station where a greater degree of control of experimental variables I required:

1) Sandy and other soils that are not suitable for CF are quite widespread and may be the only ones that are accessible to the small farmers. How can the benefits of CF be bestowed on these soil types?

2) The demand for labour on CF practices is likely a major constraint to adoption of the practices by handhoe small farmers. Would traction combined with the use of some drawn equipment to prepare CF planting basins help alleviate the labour constraint associated with the practice?

3) Does ripping, or can any other minimum tillage practice give the same, or similar benefits as CF practices? There are not trials in Zambia comparing ripping alone and CF practice. What is commonly observed in the field is that ripped fields are also potholed, suggesting that small farmers view the two practices as giving different benefits.

4) Is the field layout of planting basins/potholes adequate for optimal plant populations? The size of planting basins and their arrangement, especially under farmer conditions could be variable and compromise high plant populations.

5) How can we increase the utilization of the accumulated residual phosphorus on high P-fixing soils where it is unavailable for plant uptake? Phosphorus is the most common deficient nutrient in tropical soils after nitrogen. Unlike N, however, which can be obtained through biological nitrogen fixation by legumes e.g. cowpeas in CF, P must be supplied through chemical fertilizer which must be purchased. Because large amounts of P can be fixed in some soil types, the accumulated residual P is unavailable to plants, and annual P fertilizer applications become a necessary additional recurrent cost.

Conclusions

The twelve (12) months duration of the project was not adequate time to make proper measurements of the impact of CF on soil quality. This period represents only one cropping season. Since the CF package is tested over a successive three-year period, it would have been desirable to monitor changes in soil properties over this same period. Cumulative effects of CF practices would have been better evaluated.

In the second phase of this work, carried out before the 1998/99 cropping season commenced, soil characterization of selected CF and non-CF farms was carried out. Soil types suitable and not suitable for CF were identified, and the initial, or baseline soil fertility status of the soils established. Unfortunately the same fields were not selected after crop harvest in June 1999 when soil sampling was done again. Farmers in the third year with CF practices were being sought, and those used in the baseline study were not picked.

Consequently, monitoring of the impacts of CF practices on soil properties, in the strictest sense of the term, was not done in this investigation. Only a comparison of soil properties between CF and non-CF fields was made. The data revealed distinct differences between CF and non-CF, especially with respect to the amount of plant available P in planting basins. The more than two-fold increase in P over non-CF values suggests that P accumulates in planting from chemical fertilizer applications. The result represents a saving on purchase of chemical fertilizer for the next crop to be planted in the same planting basins the following season. This saving could be quite significant for the resource-poor small farmer.

In some soils this accumulated P does not remain available for plant uptake. It is fixed by soil components. High contents of free iron and aluminum combined with soil acidity favour P fixation and create P deficiency. Therefore, in highly weathered acid soils the residual value of P from previous applications of chemical fertilizers is very low, meaning that chemical P fertilizer must be applied with every planted crop. There are no savings on cost of P fertilizer in this case.

Recommendations

1) Knowledge of soil condition is key to improving soul fertility, arresting further degradation of land and assuring sustainability of agricultural systems. There is need to increase this knowledge among small farmers, and the following are the recommendations to achieving this:

   (a) Develop simple, low-cost methods of identifying soil types and of monitoring changes in soil quality that can benefit small farmers.

   (b) Train extension workers and lead small farmers in identifying soil types suitable for CF practices and in monitoring changes in soul quality.

2) Appreciation of the impact of CF on soil quality cannot be measured without defining the soul quality criteria and their thresholds. This information can be assessed from research at well-defined locations and from experiments conducted under specified measurable conditions. The following research questions should be investigated to provide this information:

   (a) Traction. Can traction combined with the use of some implement substitute for hand hoe land preparation?

   (b) Does ripping give the same benefits as CF basins?

   (c) Unsuitable Soil Types. How can the benefits of CF be bestowed on sandy soils and others not suitable for CF practices?

   (d) Plant populations. How can planting basins and potholes be arranged in the field to optimize plant populations and therefore ensure higher crop yields?

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