PD-AAM-972

UNCLASSIFIED
CLASSIFICATION

PROJECT EVALUATION SUMMARY (PES) — PART I

Report Symbol U-447

1. PROJECT TITLE	2. PROJECT NUMBER	3. MISSION/AID/W OFFICE
Farming Systems Research	632-0065	USAID/Lesotho

4. EVALUATION NUMBER (Enter the number maintained by the reporting unit e.g., Country or AID/W Administrative Code, Fiscal Year, Serial No. beginning with No. 1 each FY) 632-83-2

☐ REGULAR EVALUATION ☒ SPECIAL EVALUATION

5. KEY PROJECT IMPLEMENTATION DATES			6. ESTIMATED PROJECT FUNDING	7. PERIOD COVERED BY EVALUATION
A. First PRO-AG or Equivalent FY 79	B. Final Obligation Expected FY 83	C. Final Input Delivery FY 84	A. Total $ 9,002,000 B. U.S. $ 8,278,000	From (month/yr.) April, 1981 To (month/yr.) December, 1982 Date of Evaluation Review January 11, 1983

8. ACTION DECISIONS APPROVED BY MISSION OR AID/W OFFICE DIRECTOR

A. List decisions and/or unresolved issues; cite those items needing further study. (NOTE: Mission decisions which anticipate AID/W or regional office action should specify type of document, e.g., airgram, SPAR, PIO, which will present detailed request.)	B. NAME OF OFFICER RESPONSIBLE FOR ACTION	C. DATE ACTION TO BE COMPLETED
1. Extend PACD to March 31, 1986 (two years) to allow projected training to be completed.	DIR/USAID/L & REDSO/EA	May 30, 1983
2. Consider two year fully funded extension of contract with WSU to March 31, 1986 to allow continuity of AID support to Research until new USAID project is operational.	DIR/USAID/L, REDSO/EA & AID/W	May 30, 1983
3. To encourage the formal approval by the PS/MOA of the research policy developed by the Research Division staff.	Project Officer USAID FSR Team Leader	May 30, 1983
4. Encourage and assist the MOA, to the extent possible, in the establishment of an Agricultural Research and Planning Coordinating Council.	Project Officer USAID & FSR Team Leader	May 30, 1983
5. Complete analysis of baseline survey.	FSR Team Leader	May 1, 1983
6. Assist the Director of Research in strengthening the Rural Sociology Section of the Research Division through timely use of project consultants.	Project Officer USAID/Lesotho & FSR Team Leader	Variable; 1st consultancy by July, 1983
7. Assist the Research Director in strengthening the linkages between Research, Extension, Agricultural Information and farmer clientele.	FSR Team Leader Project Officer USAID	May 15, 1983

9. INVENTORY OF DOCUMENTS TO BE REVISED PER ABOVE DECISIONS

- ☐ Project Paper
- ☒ Financial Plan
- ☐ Logical Framework
- ☒ Project Agreement
- ☒ Implementation Plan e.g., CPI Network
- ☐ PIO/T
- ☐ PIO/C
- ☐ PIO/P
- ☐ Other (Specify) _____
- ☐ Other (Specify) _____

10. ALTERNATIVE DECISIONS ON FUTURE OF PROJECT

- A. ☐ Continue Project Without Change
- B. ☒ Change Project Design and/or
- ☐ Change Implementation Plan
- C. ☐ Discontinue Project

11. PROJECT OFFICER AND HOST COUNTRY OR OTHER RANKING PARTICIPANTS AS APPROPRIATE (Names and Titles)

Mr. Carl Martin, Agriculturalist, REDSO/EA
Ms. Carolyn Barnes, Social Analyst, REDSO/EA
Mr. Dan Galt, Consultant, FSR Specialist

12. Mission/AID/W Office Director Approval

Signature: [signature]

Typed Name: Edna A. Boorady, Director

Date: March 31, 1983

AID 1330-19 (3-78)

8. ACTION DECISIONS APPROVED BY MISSION OR AID/W OFFICE DIRECTOR

A.	B.	C.
8. Review extent of transportation problem within the Research Division and effect on performance of contract team and provide recommendations on how to overcome this constraint.	FRS Team Leader USAID Project Officer	May 15, 1983

EXECUTIVE SUMMARY

Prepared By: James F. Dunn

Date: February 9, 1983

Project: Farming Systems Research

Country: Lesotho

Cost: R9,002,000 (US$8,278,000)

I. What Constraint Did the Project Attempt to Relieve?

The project is attempting to strengthen the institutional capability of the Research Division to conduct relevant and effective research and through this process improve the farming practicies which will lead to increased production and income for Lesotho's rural population.

II. What Technology Did the Project Promote to Relieve This Constraint?

Farming Systems Research is applied research and, therefore, to the largest extent possible is carried out on farmers' fields and in the range areas of the country. The project introduced simple technology and practices such as on improved ox-drawn maize planter, marking rotational grazing areas with beacons, proper spacing and plant populations of row crops, storage of fodder crops for supplemental feeding, etc. In the field and at research headquarters proper management and procedures related to conducting field trials were introduced. Recordkeeping systems were instituted both at headquarters and for on-farm data collection and management.

III. What Technology Did the Project Attempt to Replace?

In the case of the maize planter the project attempted to show that new or modified equipment with proper seed plates and placement of fertilizer in relationship to the seed would improve the stand and production. In other cases the technology introduced was entirely new.

IV. Why Did Project Planners Believe That Intended Beneficiaries Would Adopt The Proposed Technology?

Through the introduction of Village Agricultural Committees project personnel were made aware of what the farmers perceived as their most serious problems. Additionally baseline and farm management surveys were carried out to identify constraints to agricultural production and the resources available to farmers to overcome these constraints. In the final analysis, increased production and not returns would provide the greatest incentive.

V. What Characteristics Did the Intended Beneficiaries Exhibit That Had Relevance to Their Adopting the Proposed Technology?

One of the major characteristics is the relatively high level of literacy in the country (between 50-60 percent) which would facilitate transfer of knowledge and techniques. Additionally many rural residents have been exposed to a modern agricultural sector in the neighboring Republic of South Africa and have a greater awareness of technological change.

VI. What Adoption Rate Has This Project Achieved In Transferring The Proposed Technology?

First of all it must be recognized that even adaptive research coupled with verification trials, demonstrations and finally adoption by farmers takes many years. This project is in its fourth year of implementation. Nevertheless, during this recent evaluation it was evident to the evaluators that there was increased awareness and adoption of recommended practices on technologies by both farmers and researchers. One indication of the impact of the project was in the suggestion by the Permanent Secretary of the Ministry of Agriculture that "this project must now move beyond the boundaries of the three prototype areas and spread across the countryside because it has become obvious that farmers in these three areas are much more knowledgeable about improved farming practices and techniques."

VII. Has the Project Set Forces Into Motion That Will Induce Further Explanation of The Constraint And Improvements to The Technical Package Proposed to Overcome It?

Yes, the project has been successful in institution building and in promoting on-farm research recognizing the individual farmers' constraints, abilities and resources.

VIII. Do Private Input Suppliers Have An Incentive To Examine The Constraint Addressed By The Project And To Come Up With Solutions?

For the most part the constraint must be dealt with by the public sector (GOL). However, there are opportunities for small private input suppliers to contribute to overall agricultural development. A specific example of where a private firm has already expressed an interest is in the production of ox-drawn equipment such as the improved maize planter.

IX. What Delivery System Did the Project Employ to Transfer Technology to Intended Beneficiaries?

The project provided a TA team experienced in research and extension. The Farming Systems approach has been integrated into the Research Division which has resulted in direct involvement of farmers in field testing and demonstration. Additionally, there have been a number of training sessions for extension field workers as well as for Village Agricultural Committees.

X. What Training Techniques Did the Project Use to Develop the Delivery System?

There was a heavy emphasis on inservice training of research and extension staff utilizing seminars, field days, radio programs, printed materials and on-the-job counterpart training. Demonstrations were set up in farmers' fields and extension information sessions were held on a regular basis in the three prototype areas.

XI. What Effect Did the Transferred Technology Have Upon Those Impacted By It?

For the most part the effect has been positive as it has provided farmers with alternatives to traditional techniques and practices and through improved farming operations has increased production and income. Continued monitoring through the end of the project is essential to determine actual effect on net farmer incomes.

13. SUMMARY: Summarize the current project situation, mentioning progress in relation to design, prospects of achieving the purpose and goal, major problems encountered, etc.

The original project design was to assist the Ministry of Agriculture (MOA) to establish a farming systems research unit in its Agricultural Research Division. The external evaluation of the project in April 1981 suggested that the contractor should also provide some additional professional assistance to the agronomic research program being undertaken by the Research Division. Since the last evaluation, the Contractor has provided professional assistance to the MOA scientists in planning, designing and monitoring experiments in the Division's stations and on farm trials. The team's observations and review of the research trials and experiments during this evaluation indicate progress has been achieved in improving the quality of research work being carried out. As stated in the last evaluation, the time frame for developing a purposeful agricultural research division in the country will take 15 to 20 years. This team wishes to support that observation and encourages USAID to continue providing assistance to MOA for at least another 10 to 15 years.

The participant training program is progressing at a satisfactory pace, albeit at the early implementation stage the number of participants departing for academic training was less than planned in the project paper.

Support funds provided by the project for construction and commodities have been obligated with buildings completed and a small amount of laboratory equipment and materials being delivered to the Research Division in a couple of months. Progress in attaining the stated outputs is generally satisfactory, the team has noted some recommendations for improving the planning, designing and monitoring of the on-farm trials and demonstrations on the farmers' fields.

The MOA Extension Service input into the prototype areas has been somewhat deficient in that only one extension agent remains with the project from the beginning in 1979. As pointed out in Section 22 of the report, it is the team's judgment that the extension service should be a full partner of the project rather than having agents seconded to the Research Division. The contribution of data and information that was to be provided by the baseline study activity to the various offices in the Research Division has been less than desirable. We believe the baseline study component of the project has been carried out over a longer time-frame than what was originally intended by the project designers. This study should have provided information to the subject matter scientist in year two at the latest. Additional data have been collected especially by the Farm Management Unit, and work has progressed on identifying and classifying farm households according to availability of resources and agricultural production. Greater attention ought to be given, during the remainder of the project, to matching trials with potential adopter groups and data collection and analyses centered on information needed to identify technologies ready for demonstration and dissemination which are geared to different categories of farmers.

14. EVALUATION METHODOLOGY: What was the reason for the evaluation, e.g., clarify project design, measure progress, verify program/project hypotheses, improve implementation, assess a pilot phase, prepare budget, etc.? Where appropriate refer to the evaluation plan in the Project Paper. Describe the methods used for this evaluation, including the study design, scope, cost, techniques of data collection, analysis and data sources. Identify agencies and key individuals (host, other donor, public, AID) participating and contributing.

This evaluation was conducted to address (a) progress towards achieving project outputs and purpose, (b) actions taken on the recommendations of the external evaluation conducted in April 1981, and (c) actions recommended

during the final stages of the project and afterwards to strengthen farming systems research in Lesotho. This was a special evaluation not anticipated in the Project Paper.

The external evaluation team was composed of:

Cal Martin	REDSO/EA	Team Leader/Ag Specialist
Dan Galt	Consultant	Farming Systems Specialist
Carolyn Barnes	REDSO/EA	Social Analyst

The evaluation methodology included interviewing a large number of persons associated directly and indirectly with the project. (See Attachment A for a list of persons contacted by the evaluation team), one-day visits were made to each of the three prototype areas in Siloe, Molumong and Nyakosoba where the evaluation team saw on-farm trials and demonstrations, work centered on range management and supplemental feeding of oxen and dairy cows, talked with local extension agents, farm management record keepers and some participating farmers. The team also toured the research station and the sub-station at Mafeteng. In addition, the team reviewed project documentation and publications. Furthermore, the findings of the team were discussed with key persons in GOL, USAID and WSU. The evaluation was carried out January 11-24, 1983.

15. EXTERNAL FACTORS: Identify and discuss major changes in project setting, including socio-economic conditions and host government priorities, which have an impact on the project. Examine continuing validity of assumptions.

Discussion: The external evaluation team report of April 1981 noted several factors that it felt impinged on the setting of the project. These factors included a lack of agricultural sector policies, a specific agricultural research policy and establishment of a wide-based Agricultural Research and Planning Coordinating Council. While it has not been

possible to finalize the two policy papers and establish a wide base council, there has been progress in addressing these external factors. During the period from the last evaluation to now the Government of Lesotho (GOL) and USAID Mission have initiated an Agricultural Planning Project (632-0215) which is currently aiding the Ministry of Agriculture (MOA) in defining agricultural sector policies. It is anticipated the GOL will promulgate an agricultural sector policy sometime during mid-1983. The Research Division has drafted a policy paper which is now being vetted within the MOA. Discussions held by the team with various divisions of MOA indicate that a research policy might be finalized during 1983. The team believes it is important that a research policy be finalized as soon as possible so that a clear course of action is designed to direct agricultural research and determine decision-making procedures. A clearly defined policy will enable the GOL to establish guiding principles for conducting agricultural research and provide prudent guidelines to direct activities.

The establishment of an Agricultural Research Planning and Coordination Council has been pursued by the Research Division since the last evaluation; however, to date the Council has not been formalized. It is the opinion of the team that the MOA should formalize the Council as soon as feasible, so as to improve the prioritization of research activities and better coordinate the work of various subject matter divisions charged with conducting research. During interviews conducted by the team, a number of examples have been pointed out where similar types of experiments are being conducted which may complement or even duplicate efforts of other research endeavors. With financial support for

research work being referred to as a constraint, it appears to the team that establishing a Council composed of senior level divisional officers of MOA would be an appropriate mechanism for insuring relevant research activities were properly funded and minimizing the potential for duplication of experimental work.

It is noted in the Agricultural Research Division Annual Report of July 1981 to June 1982 that one of the problems listed has been limited budget support for agricultural research activities. We are aware of the world wide economic recession, however, it is hoped that the MOA will continue to provide adequate support for research on relevant food and cash crops and livestock so that production will not suffer due to the lack of research funds. The formalization of a Research Council may be an effective body to provide thorough documentation for research budgets and prioritize activities during these times when the country is facing financial constraints.

The team has found a high esprit de corps throughout the Research Division and believes the research being conducted on the station and farmers' fields is contributing to a body of knowledge needed to increase the country's agricultural production. Research is a long-term effort requiring long periods of time to develop a relevant technology and secondly it takes time to transfer this improved technology to farmers.

Recommendation 1:

It is recommended that the Project continue pursuing with the MOA the already initiated efforts to formalize the Agricultural Research Policy and the establishment of the Agricultural Research Planning and Coordination Council. Action to develop an implementable r search policy and a wide

based Council will help immensely to insure an efficient and effective research institution and provide the country with a relevant body of knowledge to increase agricultural production.

16. INPUTS: Are there any problems with commodities, technical services, training or other inputs as to quality, quantity, timeliness, etc? Any changes needed in the type or amount of inputs to produce outputs?

Discussion: The Project Paper outlined a number of inputs namely technical assistance, commodities, training, construction, other costs and GOL contribution. This report will address each of these categories.

A. Technical Assistance (TA)

The Contractor has filled each of the nine called for positions with well qualified and experienced scientists. Since the last evaluation there has been a turnover in six positions, namely the team leader, extension communication/information specialist, agronomist, social analyst, farm management specialist and administrative officer. It is noted that the MOA, Contractor and USAID did act on technical assistance recommendations of the last evaluation, that is the inclusion of the second agronomy position on the contractor team. As a result of this change in agronomy positions, we have found a considerable increase in the number of prototype area trials and higher quality experimental trials on the national research station. We believe the added emphasis to develop a body of knowledge in crop production has greatly improved the contribution to increase farm level production. In regard to the social analyst position, it is noted that the project has not provided the services of a social scientist on a consultancy basis since the last evaluation. We believe the input of a rural sociologist sometime in the past 18 months would have been beneficial to the work of the Rural Sociology Unit.

The current technical assistance team is composed of experienced professionals that work together in a collegial manner. We find the cooperative working environment of the team and the Research Division staff to be excellent which has resulted in a greater output than what was achieved during the early implementation stage. Furthermore, the total work time spent in the field has increased measurably over the years. As an example, some of the professionals are now devoting up to 75 percent of their time in the field.

At the time of this evaluation, the contractor has provided the following professionals to the project:

Team Member	Position	Arrived	Departed
1. S. Beckerman	Agr Extension	May 1979	July 1981
2. K.W. Brandon	Adm. Officer	May 1979	June 1981
3. E.E. Broadbent	Marketing Econ.	June 1979	Jan 1980
4. R.O. Butler	Team Leader	May 1979	August 1981
5. L.M. Butler	Social Analyst	Aug 1979	Sept 1981
6. A.G. Law	Agronomist	June 1979	Sept 1982
7. J.C. Plath	Agr Econ	Jan 1980	May 1982
8. J.C. Ballard	Team Leader	Feb 1982	-
9. E.W. Klosterman	Animal Management	Jan 1980	Second Tour
10. David Holland	Agr Economist	Aug 1982	-
11. Peter Wyeth	Marketing Economist	Aug 1980	Second Tour
12. Lou Ann Pasquan	Adm. Officer	June 1981	-
13. Gordon VanEpps	Agronomist	Sept 1982	-
14. Keith E. Wallace	Agronomist	Feb 1982	-
15. David V. Youmans	Agr Extension	Sept 1981	-
16. James A. Tiedeman	Range Management	Aug 1979	Second Tour

The position of Administrative Officer is scheduled for termination in April 1983. The evaluation team recommends that USAID, MOA and the Contractor consider extending this position for an additional year.

B. Training

The Project Paper set out a participant training program to support the development of trained personnel for the research institution through academic and short term training as follows:

	Fiscal Year					TOTAL
	78	79	80	81	82	
New Starts						
Long term - U.S.	4	4	2	-	-	10
Long term - Africa	-	2	2	2	-	6
Short term (external)	2	4	4	-	-	10
			TOTAL STUDENTS:			26
Short term courses in Lesotho	2	2	2	2	2	10
			TOTAL COURSES:			10

To date one participant has completed a masters degree program and returned to assume the directorship of the Research Division. In addition, another ten students have departed to the U.S. for academic training programs with one student attending a long term training program in Botswana. The Research Division and the Contractor are currently developing academic training programs for eight additional participants. These participants are scheduled to undertake MSc. and Ph.D. programs during calendar years 1983 and 1984. Training planned for the last eight participants will include the fields of Agronomy, Rural Sociology, Weed Science, Human Nutrition and Animal Science

The following table lists the students that are currently participating in long term academic training programs.

LESOTHO FARMING SYSTEMS PROJECT

LONG-TERM PARTICIPANTS:

CURRENT JANUARY 1983

NAME	DISCIPLINE	DEGREE	UNIVERSITY/COUNTRY	DEPARTURE DATE	COMPLETION DATE
Ntoanyane M.	Ag Journalism	B.S.,	U of MO--USA	August 1981	August 1984
Motsamai M.	Ag Econ Market	B.S.,	Fort Wright WSU--USA	August 1981	August 1985
Mamane T.	Agronomy	M.S.,	WUS--USA	September 1982	September 1985
Moima S.S.	Agronomy	B.S.,	U of Malawi	October 1981	October 1984
Moleko	Animal Science	B.S.	WSU--USA	January 1982	October 1984
Mokheseng E.	Animal Science	B.S., M.S.	WSU--USA	June 1979	June 1983
Jobo T.	Ag Econ Farm Mgt	B.S.,	Fort Wright WSU--USA	August 1981	August 1985
Ramakhula V.	Range Science	B.S.,	WSU--USA	January 1981	January 1985
Tshabalala M.	Rural Sociology	B.S.,	U of MO--USA	August 1981	January 1985
Nfoko S.	Horticulture	M.S.,	WSU--USA	September 1982	September 1985
<u>Long-Term Africa</u>					
Thabisi F.	Library	Diploma	Botswana	August 1981	August 1983

The short term (external) training program has provided training to nine participants with an additional two participants scheduled for training during 1983.

In summary, the MOA and Contractor have made satisfactory progress in executing the long term and short term extern. training programs. There has been some slippage in meeting the original goal of placing six participants in African institutions, since the intake of foreign students into African institutions has been very restrictive in recent years. This lower intake of foreign students into African institutions has prevented the MOA and Contractor from meeting the planned long-term African training program. The short-term program has progressed at a satisfactory rate with only two trainees remaining to be sent for training.

Recommendation 2:

It is strongly advisable, in the judgment of the evaluation team, to initiate action immediately to send the eight proposed participants on academic training programs. The dearth of highly trained professionals in the Research Division is a major constraint in developing relevant technology. Therefore any gap in the training of scientists will hamper the goal to develop a core of well trained professional scientists. In order to facilitate the long term academic training of research scientists it is suggested the USAID Mission extend the Project Assistance Completion Date (PACD) from April 1984 to April 1985. An extension of the PACD will permit the MOA and Contractor to develop academic training programs and place the proposed candidates in training programs during 1983. In our view this extension will provide the continuation of the urgently needed training programs without interruption. Also, as the MOA and USAID develop the second phase of the agricultural assistance program the

remaining, if any, required to complete the training of the eight participants can easily be made part of the new project. Trained scientists are essential in an agricultural research institution.

C. Commodities

The Project Paper planned a total of $381,500 for commodities. At the time of this evaluation, all commodities have been contracted with only some equipment for the soils laboratory remaining to be delivered during the next few months.

D. Construction

A total of $457,000 was planned for construction during the life of the project. The evaluation team was informed that all construction has been completed, with the last of three prototype field centers scheduled to be dedicated in February 1983.

E. Other Costs

The evaluation found no problems in the utilization of funds budgeted for other costs. It appears comments and recommendations of previous evaluations have resolved the earlier issues raised in expending funds intended for budgetary support.

F. GOL Contribution

The Research Division annual report of July 1981 to June 1982 notes that budget constraints in vehicle operation and other operating costs have reduced the MOA contribution to project activities. A report to the evaluation team stated that the GOL budgetary support to the Farming Systems Research Activity was M48,702 in 1981/82 and M33,250 in 1982/83. This sum of M33,250 is somewhat less than was planned for in the Project Paper. The low GOL contribution of budget support to the project has

hampered the implementation of trials and follow up required to supervise research activities. The team believes it can only point out that the GOL should be encouraged to provide more budgetary support. We hope the future allocations to research will be increased as national financial resources improve.

H. The team has reviewed the budget of $8,307,300 presented in the project paper. According to USAID Controller the unearmarked funds remaining in the project as of 31 December 1982 amounted to $2,420,045. The budget item for construction was found to be overdrawn by $249,879. Otherwise other budget items all have a remaining balance. The following table outlines the fiscal position of the project.

FSR PROJECT BUDGET

FY 1978-FY 1983

ITEM	TOTAL OBLIGATIONS	PROJECT EXPENDITURES EARMARKED AS OF 12/28/82	UNEARMARKED
Technical Assistance (Field)	$ 4,573,000	$ 4,425,000	$ 1,220,136
	$5,698,300	10,700[1]	
		42,464[2]	
Technical Assistance (Backstop)	$ 1,125,300	$ 4,478,164 - SUBTOTAL	
Training	$ 822,600	$ 45,822[3]	$ 452,789
		$ 323,989[4]	
Construction	$ 457,000	$ 706,879	(-$249,879)
Commodities	$ 381,500	$ 203,521[5]	$ 177,979
Other Costs	$ 947,900	$ 128,880	$ 819,020
TOTALS	$ 8,307,300	$ 5,887,255	$ 2,420,045

[1] USDA-PASA - Short Course

[2] A&E Contract

[3] AID Training funding

[4] WSU Contract Training funding

[5] AID funded commodities

17. OUTPUTS: Measure actual progress against projected output targets in current project design or implementation plan. Use tabular format if desired. Comment on significant management experiences. If outputs are not on target, discuss causes (e.g., problems with inputs, implementation assumptions). Are any changes needed in the outputs to achieve purpose?

Project outputs are discussed below in the order each item appears in the logical framework matrix of the Project Paper.

A. Farming Systems Research Unit

The 1981 project evaluation recommended formally abolishing the output of a Farming Systems Research Unit per se and shift the purpose of the project to institutionalizing an effective agricultural research capacity in the MOA. Importance was given to strengthening the institutional capacity in the MOA to conduct research on small holder agricultural production constraints as well as transfer relevant technology to farming communities. Although the purpose of the project has never officially been changed, all parties agreed that attention should be given to strengthening the overall program of the Research Division, rather than on establishment of a Farming Systems Research Unit. The expansion of the project to work with the entire RD has been good for research in general, but is responsible for some of the delay in farm-level implementation of trials. The delay attributable to this redefinition of project is caused by FSR staff and counterparts spending more time on non-FSR activities than would be the case if their activities were confined to an FSR unit. Again, such a dilution of effort is not bad, but must be considered when analyzing where the project should be at this time.

In spite of the change in focus from a unit to the entire Research Division, the evaluation team considers the objectively verifiable indicators for output A to be valid measurements of the expanded approach. The first objectively verifiable indicator (OVI) listed in the Project

Paper for this stated output is as follows: "Research priorities are being determined through the use of both social and economic benefit/cost techniques by 12/79". There is no evidence to show that either technique was ever empirically applied to selection of research priorities.

The second OVI listed is: "Farming Systems Research Section results are being published and disseminated to all relevant GOL divisions and other donor project activities by 12/79." A system for reporting results of research activities and trials has been established. The project has assisted in the publication of the following:

a) 30 extension circulars;

b) the revised Cropping Guidelines for Lesotho, 1981;

c) 7 annotated bibliographies of agricultural research activities in Lesotho;

d) 8 socio-economic research bulletins or reports;

e) 7 publications on rangeland and/or forage management;

f) 2 soil science publications;

g) 1 annual report, Agricultural Research Division, July 1981 June 1982;

h) [several] annual work plans, Agricultural Research Division.

The third OVI listed is "FSRS is benefiting from improved professional relationships with world-wide research institutions by 12/79." The Project has done a good job in initiating, maintaining and strengthening ties with some international research institutes. The major institutes emphasized by the Research Division are CIMMYT, various research stations in the Republic of South Africa, Washington State University and Utah State University. While the former has been helpful in both training and germ plasm provision the latter two have mainly provided either improved varieties or equipment.

The fourth OVI listed is "FSRL/GOL is pursuing or considering a program for replicating systems by 12/83." More specifically, "the farming systems section will be pursuing or considering a program for replicating farming systems after the project ends." One indication of the importance placed on this indicator by all parties concerned is the incorporation of the FSR unit into the entire RD as an overall support group for Division activities. Thus, a mechanism (the WSU research group) for replicating FSR is already in place in the RD. However, (1) the WSU group will not always be in Lesotho, and (2) the RD staff have not developed the complete FSR methodology for moving from a PA to the remainder of a District, nor of moving from a given homogeneous area to another (similar) area in another District. These problems can be thought of as the institutionalization of FSR and the development of the Lesotho FSR methodology, respectively.

Considering methodology, the "complete how to" of FSR, from the initial stages of problem diagnosis and farm-level testing to the final stages of demonstration and subsequent adoption, has yet to be developed for Lesotho. Since the 1982-83 crop year represents the first attempt at systematic on-farm trials, much of the planning necessary for subsequent phases of FSR will fall on the RD between the upcoming harvest and the 1983-84 planting season. This evolving methodology, when finished, will allow extension of FSR to other areas of Lesotho. Also, by relying on the many Basotho researchers, extension agents and farm record managers, the Lesotho method of FSR will be developed jointly between the contractor and the local staff. Such a joint development means that the skills to extend FSR to other areas of the country will be

left with Basotho researchers in the RD and the extension division. At this point, the evaluation team cannot judge whether development of such a methodology will be complete before 12/83.

Recommendation 3:

More effort be made to involve CIMMYT FSR outreach staff in the planning and methodological discussion phases of on-farm trial development for the 1983-84 planting season.

An effort be made to contact ICRISAT personnel, both in Hyderbad and those in outreach working in Africa. ICRISAT staff have developed considerable expertise in both FSR and semi-arid farming conditions. Th evaluation team feels that such expertise could be more directly applicable to Lesotho farming conditions than many other types of research.

Given the prevalence of animal-drawn farming implements and the stand established problems noted by the RD staff and the evaluation team, we recommend that consideration be given to procuring the services of a short-term consultant.

B. Farming Systems Program

The OVI is described as "Three systems using alternative technologies developed and tested in three physical environments by August 1980." The 1981 evaluation pointed to the serious problem posed to achievement of this objective by the lack of a reliable set of crop production recommendations for Lesotho. It set out recommendations for the development of a specific program of action and suggested specific actions by some specific units of the Research Division.

The number of on-farm trials currently in place is a vast improvement over the findings of the previous evaluation. Table 1-4 summarize the trials.

Table 1: NYAKOSOBA PROTOTYPE AREA

Type of Trial	Responsible Unit (or Person)	Number of Trials	Type of Trial (or Title)
ECT	RD	2	Enterprise combination
PAT	GS/AG	4	Bean variety X Fertilizer
PAT	GS/AG	4	Maize variety X Fertilizer
PAT	GS/AG	3	Sorghum (?)
PAT	AG	1 (?)	Maize weed wiper efficacy
PAT	EX	?	Communal vegetable garden (120 famili
-	RM	6	Rested range exclosures
DEM	RM	1	Brush control demonstration
-	RM	3	Perennial forage field
-	AS	1	Oxen feeding program (10 farmers)
-	AS	1	Rations for growing/feeding cattle (5 farmers)
-	AS	1	Beef cattle performance test (10 farmers)

KEY TO ABBREVIATIONS USED TABLES 1-4:

AG= agronomy unit
AS= animal science unit
BASP= Basic Agricultural Services Projects
DO= Deputy Director
DEM= demonstration trials
ECT=enterprise combination trial (demonstration)
EX= extension person working with research division
GS= WSU graduate student
OS= on station (location of trial)
PAT=prototype area trial exploratory
PC= Peace Corps
RD= research division
RM= range management person working with research division
A dash (-) indicates information was not obtained on type of trial.

Table 2: MOLUMONG PROTOTYPE AREA

Type of Trial	Responsible Unit (or Persons)	Number of Trials	Type of Trial (or Title)
ECT	RD	2	Enterprise combination
PAT	AG	1 (?)	Maize weed wiper efficacy
PAT	EX	2	Communal vegetable garden (92 families)
-	RM	12	Range condition trend analysis
-	RM	8	Rested range exclosures
-	RM	1	Brush control trials (3 replicates)
-	RM	3	Perennial forage field
-	AS	1	Beef cattle performance test (15 farmers)

Table 3: SILOE PROTOTYPE AREA

Type of Trial	Responsible Unit (or Persons)	Number of Trials	Type of Trial (or Title)
ECT	RD (?)	2	Enterprise combination
PAT	AG	1	Maize weed wiper efficacy
PAT	PC/EX	4	Communal vegetable garden (107 families)
PAT	PC	1	Water basin trap/vegetable garden (OS)
-	RM	1	Rested range exclosures
-	RM	3	Perennial forage field
-	AS	1	Oxen feeding program trial (10 farmers)
-	AS	1	Milk cow production/hominy chop supplement
PAT	AG (?)	1	Maize time of plowing
PAT	-	7	Sorghum variety (NK 300)

Table 4: AREAS OUTSIDE THE PROTOTYPE AREAS

Type of Trial	Responsible Unit (or Person)	Number of Trials	Type of Trial (or Title)
-	RM	4	Rested range exclosure
-	RM	3	Proper stocking of Special Use Areas (one each in Libibing, Sekantsi and Lebamang)
-	RM	1	Proper stocking/supplemental feed (near Lelubane with 9 sheep farmers)
-	RM	7	Range burning (Mangaung)
-	RM	9	Grazing system (Ha Mokela)
-	AS	2	Oxen feeding program (10 farmers each in Libibing and Majakaneng)
PAT	DD/EX	5	Maize/drought-resistant alternatives
-	DD/BASP	(20)	Fodder
-	DD/BASP	(14)	Fertilizer placement
-	DD/BASP	(12)	Fertilizer
-	DD/BASP	(20)	Variety
-	DD/BASP	(14)	Plant population
-	DD/BASP	(8)	New crops
		(24)	excluding DD/BASP trials (88)
		(112)	including DD/BASP trials BASP

The RD has recognized a problem that all researchers and evaluators have observed in the field: namely, the problem of poor stand. Specifically, the RD might wish to research these potential components of poor stand:

(a) germination percentage of all seeds planted on-farm;

(b) rate of seeding using mechanical seeders;

(c) plant counts to estimate emergence;

(d) seasonal observation of potential pest problems which may adversely impact stand establishment, including cutworms, rootworms, seedling rot pathogens, birds, rats or other rodents, and early stalk border and/or fall armyworm damage;

(e) seed/fertilizer placement versus depth of planting.

To address the seed/fertilizer placement versus depth of planting interactions, follow-up research could be done to investigate the possibility (raised by Joe Carvalho after observing the Nyakosoba trials) that seed plates currently in use are not always the correct ones. In addition, the RD may wish to obtain and use several BASP-modified Safim planters.

A simple depth-of-planting, seed/fertilizer placement trail could be designed for both the Maseru Experiment Station and the farms affected by spotty stands. Probably such a trial should be designed for maize in all PA s, and for maize and sorghum in Siloe. If the RD staff believes that soil insects may also be contributing to stand reduction, a simple soil insecticide versus no soil insecticide treatment could be added to such a trial. (For greater detail, consult Attachment C.)

The animal science component of the FSR program has been initiated in all three prototype areas. It was pointed out to the team that the animal science research staff made a deliberate decision to approach livestock production through researching a number of feeding methods. Since little

research on supplemental feeding has been conducted on research stations, the animal science staff decided to go directly to the farm and carry out the feeding trials under farmer conditions. This approach has been rewarding and provided a clear insight into what direction livestock research must take to solve farmer problems. A major effort has been launched to improve fodder production and provide supplemental feeds for oxen and dairy animals in addition to normal grazing. Another experiment to determine a simple ration for fattening immature cattle has been carried on in cooperation with the Lesotho Agricultural College.

The supplemental feeding trials have been primarily based on the utilization of hominy chop (a local by-product of corn milling) and the introduction of fodder crops such as sorghum, teff, millets, sudan grass and triticale. The animal researches have initiated one trial on the value of mineral and protein supplementation for ewes grazing under controlled conditions. It is the team's judgment that the animal science research is addressing a most pressing problem facing livestock growers. As stated to the team, during the review of the animal science research program, a principle objective of the work is to raise farmer interest in using known technology, such as supplemental feeding. The research feeding program is focused on oxen, dairy cattle, immature animals and sheep. We believe this focus is on target to meet the needs of the farmers.

The range management research section has continued its program of rotational grazing work in Nyakosoba. This rotational system appears to be working well and should be continued for a number of years to determine the benefits from controlled animal numbers and establishment of a rotation grazing system. The team observed "rested range enclosures" trials which are established in the three prototype areas. The perennial forage row trials were observed by the team in Molumong and apprised of the first year's production.

The Research Division has pursued range management research along the same lines as animal science, that is by conducting experiments on rangeland surrounding the village areas rather than on a government range experiment station. Research work planned and conducted under village control has provided the researchers with an insight into the many practical problems faced by farmers in utilizing communal rangeland. Furthermore, the establishment of proper stocking rates has influenced the type of research that can best be implemented under communal range conditions found in Lesotho. The range management unit has initiated a Village Group Ranch experiment with the Bushman's Nek Wool Growers Association. This experiment is comprised of 90 sheep grazing under a six pasture rotational scheme while another 90 sheep of the same group were grazed on communal pastures. Also this experiment included a number of additional factors where both lots of sheep were dosed for worms and vaccinated for puply kidney disease. In the team's judgment, the range management research has been focused on problems most keenly felt by farmers grazing livestock under communal range conditions.

In spite of the progress made on field trials and demonstrations, there seems to be a lack of agreement among RD staff and units as to these factors:

(a) what is the FSR methodology being employed by the RD?

(b) who is responsible for the field phase of each type of trial?

and (c) what routine seasonal observations should be recorded for each type of trial?

Recommendation 4:

The Research Division should keep the work focused on supplemental feeding of cattle and sheep with the view that livestock research is a long term effort.

Recommendation 5:

The Research Division should continue to focus its work on village level rangeland problems and coordinate experiments closely with the MOA Range Division to insure that village level trials complement the research on the cattle post grazing areas.

Recommendation 6:

The evaluation team feels some concern over the many concepts of FSR held by either WSU or Basotho staff in the RD. While we are very pleased with the effort to develop the Lesotho model of FSR, the fact remains that all station-generated and imported technology must be verified on a representative sample of Lesothoan farms selected from homogeneous agro-climatic regions before such technology is ready to demonstrate. More details on this issue are provided in Attachment 2.

Recommendation 7:

In a joint planning session, the WSU/Basotho staff should reach agreement on (a) their priority crops for each PA and (b) on which farmer problems are the most important for each crop. Design future farm trials should revolve around the crops factors.

Recommendation 8:

All 1983-84 farm trials should be planned jointly by all WSU and Basotho staff. During this session, each researcher proposing a trial should state briefly, for each trial, the objectives, methodology, data collection requirements and experimental design. Trial design should be approached from the viewpoint of the farmer; low-cost or risk-minimizing treatments (or levels of treatments) should be considered. Some potential

costs to consider are local availability of inputs such as transportation of locally-unavailable inputs, and potential labor constraints. Every effort should be made to consolidate trials whenever possible. Such consolidation fosters interdisciplinary interaction, saves planting space requirements on-farm, and speeds up data gathering. Field books should include a map of the trial, date of planting, relevant details of planting, varieties used (including farmer's variety), amounts and types of inputs used, and observations on soil type(s), slope of the site, recent cropping history, etc. After planting and emergence, a summary of each trial should be prepared, or each field book should be photocopied, so that a copy can be provided to the Director and/or Deputy Director of the RD.

Recommendation 9:

Considerable thought must be given to expanding farm trials beyond the prototype areas to other homogeneous areas of the districts where they are located. During the 1983-84 cropping season, one protogype area should be selected for this expansion effort. We suggest Nyakosoba (Maseru District) for its proximity to RD headquarters and relative ease of logistics compared with Siloe and Molumong. The experiences of the Deputy Director, Farm Management Unit, Range Management Unit, Rural Sociology Unit, and Animal Science Unit should be called upon in expanding the on-farm focus from the confines of the prototype area to the rest of Maseru District.

Recommendation 10:

To assist in assuring that farm trials reflect the underlying agro-economic characteristics of either a PA or a homogeneous area within a given district, we recommend that between five and ten farms be selected per homogeneous zone to host farm trials in 1983-84.

Recommendation 11:

In order to facilitate the orderly transition of farm research responsibility from the WSU researchers to Basotho staff, we recommend that the Deputy Director be given full responsibility for field coordination of all farm trials. To assist in such a transition, it is further recommended that a suitable candidate be selected as soon as possible from the current Maseru Experiment Station staff for training in station management. Perhaps such a candidate could then be sent to CIMMYT for a three to six month training course in station management.

C. Strategies for Reaching Farmers

"Alternative strategies for MOA farmer communication and education developed and tested by 08/80" is given as the OVI.

The project is experimenting with two new approaches to reaching farmers. First, under the initiative of the project, Village Agricultural Committees have been established in the prototype areas. Members are elected annually by the village community. The committee members annually receive training in certain agricultural technologies which they are supposed to adopt and provide advise to other farmers. Thus, the purpose is to encourage both demonstration and extension. Second, a group approach is being used on communal vegetable fields and grazing schemes. Particularly the work with groups on vegetable production and grazing appears to be innovative in Lesotho. While the fields are held as the communal property of the group, each participant has a role. On-site training was given to the group.

Both approaches being tested appear to have good potential. However, greater care must be given to monitoring through observations and interviews with others in the community. Visits should be made to the farms of

the Agricultural Committee members and former members to assess adoption of recommended technologies, and interviews conducted with neighboring farmers to assess if a demonstration effect has occurred or if advise had been obtained. Also, the members of the 1982-83 group vegetable fields should be observed next season to assess if the recommended technologies are being continued.

The Extension/Communications Unit should also consider testing a "dialogue" or "facilitator" approach by extension agents with groups of farmers and for use in training Village Agricultural Committees. Using this approach the agent or trainer would use a series of questions to encourage farmers to talk about their current agricultural practices and to analyze recommended technologies. In this way farmers would actively participate in assessing the feasibility of the recommendation given their individual situation,and constraints, including risk factors, would be discussed. This approach is likely to elicit greater receptivity from farmers rather than the conventional approach of telling farmers what they ought to be doing.

Recommendation 12:

Greater attention should be given to follow-up on farmers involved in the two strategies currently being tested to assess adoption rates of recommended technologies.

Recommendation 13:

Consideration ought to be given to testing a facilitator approach to communicating with farmers.

D. Trained Basotho Personnel

The OVI is stated as "Basotho person--l trained and assigned to 26 positions in farming systems research sections and complementary sections of Research Division by 03/84."

To date only one of the long-term participants sent to the U.S. has completed his/her program and returned to the Research Division. However, as noted in the INPUTS section, 10 people are currently studying outside Lesotho. Eight staff are being considered for long-term training beginning fall 1983, but funding will need to be assured after the planned project completion date of 04/84. The tardiness in securing qualified participants for the long-term training program during the earlier years of project implementation has contributed to this present difficulty. The short-term training program has progressed well. Some of the training was carried out by CIMMYT.

The evaluation team is satisfied with the MOA commitment of staff to the Research Division.

E. Research and Information Data Base

During the initial stage of the project, a formal baseline study was conducted in each of the protogype areas. To date, however, not all of the data have been analyzed. Further, the project has been collecting data, under the direction of the Farm Management Unit, on 117 farm households (30 each in Mokhotlong and Nyakosoba and 57 in Siloe) since the 1980-81 crop season. For each of these farm households an inventory exists of farm equipment and tools and household residents plus data for each field cultivated. Crop enterprise budgets were calculated for five crops covered in the 1980-81 season and which followed traditional practices. The 117 farms were chosen to reflect several categories of

farmers, stratified by their access to resources. A considerable quantity of data is now available from these farm records and attention should be given to ways to expedite data coding and processing.

Other units of the Research Division have also been involved in enlarging the data base. The Marketing Unit, for example, has been conducting research with both a national and household focus. Attention has been given to the impact of marketing and pricing on production, with special consideration of fruits and vegetables. The Extension/Communication Unit in cooperation with the Rural Sociology Unit has collected information from members of the Village Agricultural Committees. The Range Management and Rural Sociology units have collaborated on information collection efforts. However, it is crucial that the data collected be analyzed and taken into consideration when determining priorities for crop, livestock, and range trials and demonstrations.

The 1981 evaluation pointed to the need to understand why farmers do what they do. To date little attention has been given to the reasons for the practices followed by the farmers: a sufficient amount of information exists on what farmers do but not why. For example: Why do farmers plow in the spring only? and What is the rationale for planting certain crops on specific plots and for the allocation of labor and other inputs on each plot? Collection of information on the Whys requires a very well designed research effort including identification of techniques and questions appropriate for eliciting reliable information. (See Section 23, Rural Sociology Unit for further elaboration.)

Recommendation 14:

Each WSU and Basotho RD staff member should have access to the final analysis of the baseline data. If such a possibility does not exist in

the near future, we recommend all units (with the exception of livestock, which has summarized the data collected relevant to livestock issues, analyze their section of the baseline data. However, the only information necessary (except in the case of rural sociology) for assisting in farm trial development or refinement is:

(a) Frequency of predominat crops/animals;

(b) Frequency of farmer-listed problems in each predominant crop/animal;

(c) Grain storage responses and problems.

Recommendation 15:

The farm management unit should stop collecting routine farm records at the beginning of the 1983-84 (September) growing season. We further recommend the farm management unit concentrate on those farms which are involved in systematic farm trials during the 1982-83 growing season. Such farm record data could then be collected on

(a) those farms which host farm trials, if such trials are designed so as to include a large enough check to allow for economic comparison, or

(b) an equal number of farms with trials and farms without trials.

Recommendation 16:

Consideration be given to collection of complete labor profiles on a stratified sample of households.

Recommendation 17:

The Rural Sociology Unit should give top priority to research aimed at understanding farmers' rationale for specific crop and livestock practices and intra household decision-making related to key variables. The services

of a short term consultant ought to be procured to assist the unit to plan this study.

F. Agricultural Research Library

The Project Paper called for an adequate library to support farming systems research to be in place and coordination established with the Agricultural Planning Library by 12/79.

The library at the RD, staffed mainly by project personnel, has absorbed the LASA (Lesotho Agricultural Sector Analysis) library, and is actively collecting materials related to agricultural development in general and FSR in particular. The library is on several international agricultural development mailing lists, and is continuing to seek additional sources of FSR materials. It has in excess of 2300 agriculture related volumes, and 80 periodical subscriptions, which include several relevant professional journals. The library facility is well-utilized by RD staff, and is especially appreciated by Lesotho Agricultural College staff and students. In the case of the latter group, current college regulations prohibit circulation of library books to students. Therefore, the RD library is often their only source of resource material for term papers or in-depth studies of certain topics.

18. PURPOSE: Quote approved project purpose. Cite progress toward each End of Project Status (EOPS) condition. When can achievement be expected? Is the set of EOPS conditions still considered a good description of what will exist when the purpose is achieved? Discuss the causes of any shortfalls in terms of the causal linkage between outputs and purposes or external factors.

According to the Project Paper, the purpose of the project is to create more productive agricultural enterprise mixes which are (1) acceptable to farmers; (2) sensitive to farmers' management ability; (3) appropriate to resource availability; and (4) protective of the land base. The major EOPS

condition for the project is: "that at least five percent of the farmers in the project's prototype areas will be using the systems developed". This implies that, in absolute terms approximately 146 farm households will have to have adopted an improved agricultural technology recommended by the RD by the end of the project in March, 1984.

Progress toward the EOPS condition of a five percent adoption rate is slower than anticipated at the beginning of the project, but several improvements have been made since the last external evaluation. For the first time, the Director of Research and the current Project Leader have been able to pull the RD staff together to meet and work as a multi-disciplinary team. In addition, the RD now has farm trials in each prototype area. As stated in the OUTPUTS section, the two types of farm trials are enterprise combination trials (ECTs) and prototype area trials (PATs). There are two ECTs in each PA, and more than 20 PATs in any given PA.

There is also a difference between on-farm trials and adoption of improved farm technology. At this time, several of the livestock/animal improvements may be finding acceptance; it is still too early to say if the communal vegetable gardens will be repeated by the villagers (although they did look promising); and it is impossible to predict what type of adoption will be generated by the agronomic ECTs and PATs. In the case of all agronomic trials observed by the evaluation team, significant adoption probably cannot be expected to occur before the 1984-85 or the 1985-86 cropping season. Again, verification and demonstration must occur before adoption can be expected.

19. GOAL/SUBGOAL: Quote approved goal, and subgoal, where relevant, to which the project contributes. Describe status by citing evidence available to date from specified indicators, and by mentioning the progress of other contributory projects. To what extent can progress toward goal/subgoal be attributed to purpose achievement, to other projects, to other causal factors? If progress is less than satisfactory, explore the reasons, e.g., purpose inadequate for hypothesized impact, new external factors affect purpose-subgoal/goal linkage.

Discussion:

The goal stated in the Project Paper is divided into two parts, namely national goal and sector goal. The national goal is "to improve the quality of rural life" and the sector goal is "to increase rural income from agriculture".

The findings of the evaluation team would indicate that the prototype farm trials will eventually provide proven technologies to increase agricultural productivity. To date, however, little evidence can be found that farmers cooperating with the FSR program have increased their net farm income. The team believes that the Farm Record Program working with 120 farmers will provide a review of how the project trials and demonstrations will effect farmer incomes. Trials conducted this crop year on the six enterprise combination farms will be analyzed by the farm management economist to determine the potential for increasing farmers' incomes. As evidenced during this crop year 1982-83, drought cycles do occur which impact on the farmers' ability to adopt improved technology. This drought factor must be taken into consideration when developing new technologies. Furthermore, the relative size of the prototype areas has restricted the project's ability to increase incomes on a large scale, i.e., three districts of the country. We believe the prototype areas have served as a "laboratory" for farmer testing of improved technologies; however, the second phase of the USAID assistance to the MOA should be expanded to cover four or five of the more productive agricultural districts in the country. A production

program of this magnitude will be a better demonstration as to how the FSR approach of linking agricultural research, extension and the farmer in a joint effort will increase incomes from farming and provide a better nutrition level in rural households.

20. BENEFICIARIES: Identify the direct and indirect beneficiaries of this project in terms of criteria in Sec. 102(d) of the FAA. Summarize data on the nature of benefits and the identity and number of those benefitting, even if some aspects were reported in preceding questions on output, purpose, or subgoal/goal.

The Project Paper envisaged that the initial beneficiaries would be farmers who indicated both a willingness and ability to try improved farming techniques with the associated risks. It was implied that this initial group would be composed primarily of the relatively better-off farmers. The ultimate target group was described as "those farmers or farmer groups who indicate a reluctance to improve traditional agriculture due to a lack of resources, financial or physical, or knowledge that change is possible." The project design tended to overlook the importance of classifying farmers on the basis of resources and/or farming system practiced and the need to develop agricultural recommendations for each group. The Project Evaluation of April 1981 recommended:

(1) "Working jointly with RD staff and USAID the Contractor team should: (a) analyze and synthesize the available data related to Farming Systems (including that generated by the RD); (b) identify and classify Farming Systems types; (c) identify the immediate beneficiaries of the Project (based on GOL policy and USAID growth-with-equity considerations); and (d) establish which farming systems and which potential beneficiaries will receive priority in research activities."

(2) "Identify and disseminate a few proven technologies as soon as possible to give the farming systems appraoch more credibility."

Since the 1981 evaluation, annotated bibliographies have been written and printed, and some technologies demonstrated. However, there has been some confusion about which technologies need to be tried and validated on farmers' fields and those "proven" as ready for demonstration and dissemination. The choice of communal vegetable fields for both demonstration and testing of an extension strategy appears to have been sound. The number of participants on each field in relationship to number of households within the community indicates a readiness and willingness of the women to improve vegetable production. The project provided the seed and the wire fencing around each field was a grant from the GOL. In Molumong each participant contributed approximately $10 as a membership fee to cover the cost of additional inputs. Banded together the women were able to obtain from their local chiefs a piece of land near to a (usually) permanent source of water. In contrast, as individuals Lesotho women normally only plant a small plot of vegetables around their house which is dependent on rainfall and water recycled from other household uses. Further, evidence indicates that the vegetable garden participants are not necessarily members of the relatively better-off households, whereas the others cooperating in trials and demonstrations are the better-off farmers.

Since the last evaluation, progress has been made on identifying and classifying households within the prototype area on the basis of physical resources which influence farming practices and on conducting trials/demonstrations which represent a range of complexities and of requisite

resources. It is the judgment of the evaluation team that the persons responsible for research related to livestock have been particularly sensitive to working within the context of Lesotho farmers and in close collaboration with some on research trials. The extent to which each trial on the research station and substations and each trial and demonstration on farmers' fields is related to a potential adopter group needs to be better understood by some RD researchers. The more technical lessons learned in the field, information from various studies and the farm record program and field observations direct research towards the circumstances and priorities of different categories of farmers, the more likely that the project will achieve its purpose. The interrelationship of agriculture and livestock to households' meeting their fuel needs has been neglected, although especially female farmers classify fuel as a priority need and report that fuel collection absorbs a significant portion of their time. This ought to be taken into consideration in the future.

Crop budgets are being devised based on data from the farm record system which includes the six farmers participating in the enterprise mix demonstrations. Prior to the completion of the project, economic analyses based on data from farmers' fields ought to be carried out on other technologies and practices which the RD identifies as technically successful prior to classifying these as ready for demonstration and dissemination. In fact, it would behoove the RD not to classify any technology as ready for demonstration until an economic analysis has been conducted based on data from on-farm results.

To date the project has benefitted several categories of people. First are the RD personnel who have been sent for long term and short term

external training. Out of the group of 12 already sent for long term training, 42 percent are women; and 33 percent of the 9 short term participants have been women. Further, among the eight persons proposed for future long term training, 50 percent are women. The proportion of women to men sent for training reflects the overall sex ratio (40 percent female) among RD professional personnel. In general, the RD administration and staff demonstrate a relatively high level of commitment to research work which will benefit Lesotho farmers and hence the training received by the individuals should ultimately be reflected in more applicable and improved agricultural recommendations to Lesotho farmers.

Second, approximately 400 farmers have been involved directly in project trials and demonstrations. Most of these are women who are members of communal vegetable production groups: 92 in Molumong, 107 in Siloe and 120 in Nyakasoba. Although almost none of the women in Siloe and Syakasoba will benefit this season from a vegetable crop because of this year's severe drought, the participants have gained knowledge from the training received and, more importantly, have acquired claims to a plot near a source of water, which in most years is adequate for vegetable production.

Third, some 220 people have attended courses held by the project. About 100 members of Village Agriculture Committees, established by the project, have annually attended a course on improved agricultural methods. Also, in 1982, 10 heads of divisions and District Agricultural Officers and 10 forestry students from the Lesotho Agricultural College were trained in communication skills; 10 District Extension Officers and 20 Subject Matter Specialists participated in a course on Professional Improvement in Agricultural Extension; 28 Area Extension Officers and 6 Extension Assistants were trained in Extension for Improvement of Farming Systems.

Furthermore a number of Basotho students and professionals have taken advantage of the improved library resources and an additional group has received information from radio programs, circulars, bulletins and reports produced by the RD.

Although more than five percent of the households in the prototype area have been involved in project trials and demonstrations, the project staff will need to monitor the continued use of some of the technologies to identify those which the farmers perceive as feasible and beneficial and the spread effect. For instance, attention should be given to monitoring the members of the communal vegetable fields during the next agricultural season.

Recommendation 19:

Conduct an economic analysis based on data from farmers' fields prior to classifying a technology as ready for demonstration and dissemination.

Recommendation 20:

Continue work on classifying farmers and adapting recommendations to physical resources of each group.

Recommendation 21:

Give greater attention to monitoring, to assess adoption rates.

21. UNPLANNED EFFECTS: Has the project had any unexpected results or impact such as changes in social structure, environment, health, technical or economic situtation? Are these effects advantageous or not? Do they require any change in project design or execution?

The evaluation team believes it has covered the unexpected results and other notable impacts on the project in sections 22 Lessons Learned and 23 Special Comments or Remarks.

22. LESSONS LEARNED: What advice can you give a colleague about development strategy, e.g., how to tackle a similar development problem or to manage a similar project in another country? What can be suggested for follow-on in this country? Similarly, do you have any suggestions about evaluation methodology?

EXTENSION:

1. The MOA officials contacted during this evaluation have all expressed concern regarding ways and means for improving the mechanisms of linking together the agricultural research, extension, information divisions and the farmer. The current arrangement described in the Project Paper of having extension agents seconded to the Research Division, has proven to be less than satisfactory. In the team's judgment, it would appear that the national extension service should have been integrated as a full partner into the Farming Systems Research Project rather than seconding a number of agents to the project. It is important that the extension agents, the district level subject matter specialists, and the national extension staff play a major role in planning, implementing and monitoring the on-farm research trials and demonstrations. Project officers are currently holding monthly meetings to develop a systematic means to liaise between research and extension. These joint meetings have been beneficial in executing the Research Division's program in the prototype areas. However, in the opinion of the team, the extension service regards the prototype activities as part of the research program rather than an integral part of the extension service. Based on these observations and discussions

with MOA officials, the lesson to be learned is that the extension service should be made a full partner in the staffing, designing, implementing and monitoring of any activities being placed on the farmers' fields. Also, we believe the new agricultural project being developed by MOA and USAID must include assistance for the extension division in the areas of technical assistance, participants and commodities. The role now being played by the Research/Extension liaison office in the Research Division is of initial importance and should be continued as a means to provide better communications between the MOA Research and Extension Divisions.

2. Prototype Area Versus an Administrative Subdivision.

As directed by the Project Paper, this project has focused on the development of a farming systems research effort in a designated area called "prototype". In other words a small homogeneous area with a unified indigenous farming system being practiced by practically all farmers. This limited area has meant that only a small portion (1.0 to 1.5 percent) of the 240,000 households in the country are potential beneficiaries of project activities. It would seem that the second phase of the USAID assisted FSR project should be designed to cover a number of administrative subdivisions, i.e., districts. Use of a district as the bases for implementation will permit the MOA to devote its entire extension service resources in each administrative subdivision to participate with the research division in conducting on-farm research trials as well as placing a number of extension demonstrations on farmers' fields. In the process, more staff will receive on-the-job training. Furthermore, it is possible on a district basis for the MOA to focus a large amount of other financial and human resources on a single activity to increase agricultural

production. In addition, concentration on an entire district reduces the chances that one group of farmers will be favored by receiving demonstration production inputs and technical advise while other farmers receive few inputs and technical advise.

23. SPECIAL COMMENTS OR REMARKS: Include any significant policy or program management implications. Also list titles of attachments and number of pages.

1. International Agricultural Research Centers

The Research Division and the Contract team have developed professional and other scientific relationships with the agricultural research institutions located within the Republic of South Africa. To date, MOA has been obtaining some genetic plant materials and improved technologies from the Republic. It appears that linkages with the International Agricultural Research Centers such as ICRISAT, CIMMYT, CIP, ILCA and CIAT should receive some additional attention. It is suggested that a select number of research professionals of the Research Divison and the Contractor team undertake a visit to ICRISAT for the purpose of reviewing available genetic material and studying the approach being taken regarding farming system research work. The CIMMYT, ILCA and CIP have outreach offices in Nairobi, Kenya that can provide information and professional consultation in the areas of maize, wheat, potatoes and livestock. The ILCA has instituted research work on the role of livestock in the farming systems in many African countries which should be of interest to the MOA research program The dry bean variatial research program would benefit by obtaining a small quantity of bean cultivars through the outreach program of CIAT.

2. Extension of FSR Project

The evaluation team understands there is a possibility that the development and approval of a new USAID agricultural development assistance

project could be delayed until FY 1984 or even FY 1985. If this is the case, the team recommends strongly the USAID commence action immediately to extend the PACD for this project from April 1984 to April 1985. Extending the project for one year will also involve amending the Project Paper and contract so that additional funds are made available for implementation activities such as technical assistance, participant training and other ongoing operational costs. We believe an extension of the Farming Systems Research project is highly desirable as implementation has gained a fair level of momentum which can be easily lost should the contractor depart the country in April 1984. Moreover if there is a gap in the technical assistance of one year or more, it could easily take two years of the contractor's time to bring the project activities back to the same level of impetus that is occuring at the time of the evaluation. We believe it is critical for the project to maintain the current level of implementation momentum.

3. Future Project

In regard to a second phase of a FSR project activity, it is suggested that financial and technical assistance should be provided on a near equal basis to each of the research and extension divisions. It is believed the current project somewhat neglected the development of the district and national extension service. As an example, project funds were unavailable for inservice training costs to hold workshops with district level subject matter specialists and other district agents to participate in routinely conducted workshops. Field extension outside of the prototype areas were not provided with a means of transportation, i.e., motorbikes. While the Research Divison provided funds for printing and distributing extension circulars, the Agricultural Information Office was constrained financially in the amount of extension materials produced for its farmer audience. The second phase of the FSR project should include funds for in-country

training and the printing and distribution of circulars and the development of other educational materials for agents and subject matter specialists. Farmer training costs such as food and demonstration materials should be included in any new USAID initiative. The up-coming project may wish to assess the recurrent project costs issues and be prepared to fund a share of both the research and extension division budget requirements.

It is assumed that USAID will continue providing assistance at the current level to the Research Division.

4. Reporting

During the evaluation, we noted that the Contractor is providing a quarterly report to the MOA and USAID. It is our judgment that Research Division and USAID review the need and value of quarterly reports with a view of revising the reporting schedule to coincide with the crop cycle. Reports based on actions to be taken at the beginning of a crop cycle such as on-farm trials, demonstrations, experiment station trials, etc. with a final report depicting the results at the end of the cycle appears to us to be a much better use of professional talents. Since reporting takes considerable work time, is a mid-crop cycle report really worth the effort?

5. Rural Sociology Unit

The role of the Rural Sociology Unit vis-a-vis other units ought to be clarified. In some instances the Unit is being asked to administer questionnaires primarily designed by other units. It is suggested that the Unit should serve in an advisory capacity to others and be responsible for carrying out qualitative studies. The 1981 project evaluation pointed to the need for research on <u>why</u> certain practices are followed, but this has yet to be done. It is recommended that the research planned on decision-

making in households headed by women whose husbands are working in South Africa be expanded to cover a range of decisions related to agricultural practices and that this research be classified as top priority for the Rural Sociology Unit. It is suggested that the services of a consultant be secured to assist the Unit in designing the decision-making study. Special attention ought to be given to getting a consultant who (a) will also be an advisor to the RD Rural Sociologist when she is sent for MA studies or (b) has previous experience in studies on rural household decision-making in the Third World, preferably Africa.

It is currently planned that the Rural Sociologist, who has a BA degree in sociology from the National University of Lesotho, be sent for MS training in the U.S. beginning September 1983. This presents two issues: (a) the best university program for her and, (b) the gap created by her departure. For the latter it is recommended that the RD plan for procuring the services of a consultant for approximately 2 months to meet any identifiable gaps in 1983-84. Otherwise, it is suggested that the current research assistant in the Rural Sociology Unit continue any unfinished work and assist the extension unit in monitoring adoption of recommended practices in the PAs.

It is strongly recommended that the Rural Sociologist be enrolled in a MA program in anthropology with faculty who have field research experience in Africa and who have applied research focus. It is suggested that contract be made with the University of Florida because of its Africa and farming systems research expertise, to see if a suitable program can be arranged.

Also the Research Divison should consider sending the Rural Sociologist to Swaziland and other neighboring countries to learn more about the sociological research component of other farming or cropping systems research projects.

The evaluation team has prepared a supplement describing a methodology for conducting farming systems research. This supplement has been provided to the Research Divison and the Contractor to stimulate internal discussion towards a more integrated approach to the multi-disciplinary research effort.

Attachment A

LESOTHO FARMING SYSTEMS RESEARCH PROJECT

Persons contacted by the Evaluation Team:

Government of Lesotho, Ministry of Agriculture

Peete N. Peete	Minister of Agriculture and Marketing
John Kao	Permanent Secretary
R. Mochebelele	Director, Technical Services
Winston Ntsekhe	Director, Research Division
Obed Selikane	Director, Extension Division
Musi 'Matli	Deputy Director, Research Division
Abraham Sefeane	Research/Extension Liaison
Thope Matobo	Rural Sociologist
E. Mofoka	Research Officer, Agronomy
E. Pomela	Research Officer, Agronomy
N. Moletsane	Marketing
I. Matela	Administration
Mr. Nqhai	Acting District Ag Officer
M. Khalane	Farm Management
B. Kafathu	Extension Agent
E.T. Lephoi	Farm Management
Mrs. M. Kao	Extension Agent
T.E. Malataliana	Extension Agent
L. Moiloa	Farm Management
B. Molise	Farm Management
D. Mathaba	Soil Laboratory
M.M. Kotsokoane	Senior Research Officer, Horticulture

Washington State University

James Ozbun	Dean, College of Agriculture
J. Clark Ballard	Team Leader
E.W. Klosterman	Animal Management
J.A. Tiedeman	Range Management
P.W. Wyeth	Marketing Economist
D. Holland	Farm Management Economist
J. Carvalho	Graduate Student
K.E. Wallace	Agronomist
G.A. Van Epps	Agronomist
D.V. Youmans	Ag Extension
Lou Ann Pasquan	Administrative Officer
Cheryl Valdivia	Librarian
Wayne Bath	Campus Coordinator

USAID Mission

Edna A. Boorady	Director
Barry Hill	Ag Development Officer
James Dunn	Project Officer

Other

Judith Gay	Sociologist
A. King	Lesotho Agricultural College

Attachment B

F S R METHODOLOGY

Every nation implements FSR differently. FSR as implemented in Lesotho has been integrated into the RD of the MOA. As such, it is characterized by a fairly complex interaction of technical, economic, social and political factors. However, regardless of the complexities of the underlying interactions, FSR should proceed through the following seven phases:

Phase No.	Year	Phase Purpose
1	1	Collect and analyze the agro-socio-economic data necessary to allow researchers to design set(s) of farm-level trials
2	1	Initiate farm-level trials
3	1-2	Analyze and revise farm-level trials for second year trial preparation
4	2	Implement verification trials
5	2-3	Analyze and revise verification trials for third year trial preparation
6	3	Implement demonstration trials (either with, or by, extension)
7	3-4	Analyze demonstration trials

At some point in FSR implementation (at phase 2,4 or 6), extension must be phased into the project. By phase 6 at the latest, all trials should be under the field management of extension, while the agronomic and economic analyses of the trials will normally be carried out by research staff.

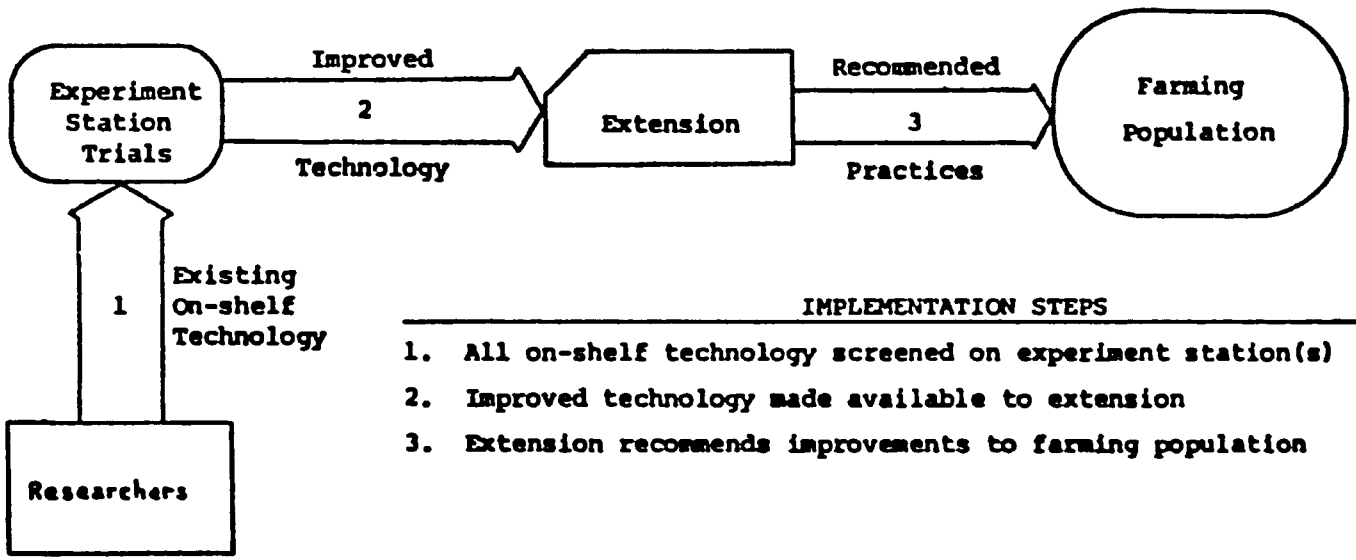
The major advantage of FSR over traditional research is that a more efficient filtering of available technology takes place. This more efficient filtering process leades to technological improvements which are more closely tailored to a homogeneous group of farmer's agro-ecological and socio-economic realities.

Figure 1 presents the traditional flow of technology from the experiment station to the farm level, while Figure 2 shows how such a technology flow is modified and made more efficient by FSR. The relative thickness of the technology flow arrows indicates the amount of potentially-useable technology. Potential technology is reduced by the steps in the research process to the point where recommendations are finally made which fit farmer's conditions. However, using FSR, the same step (implementation step 8, Figure 2) is typified by a much narrower arrow. This narrower arrow indicates that much more potential technology has been eliminated because it is impractical for agronomic, economic or social reasons at the farm level. Remaining technology is much more tailored to the conditions faced by the farming population (Figure 2).

There are several significant differences between the types of farm-level trials conducted under FSR. Phase 2 trials are characterized by testing promising experiment station technology. They generally consist of several farm sites ($\pm$6) to ensure statistical representability in a given homogeneous zone (Figure 3); one to four trials per farm; one to four replicates per trial per farm; a relatively large number of treatments per trial (usually four to ten); and small plot and trial size (Figure 4). Verification (Phase 4) generally consists of an intermediate number of farms ($\pm$10) (Figure 3); one, or at most, two trials per farm; one, or at most, two replicates per trial; an intermediate number of treatments per trial (two to four); and intermediate plot and trial size (Figure 4). Finally, demonstration (Phase 6) generally consists of a large number of farm sites (15-30) (Figure 3); one type of trial per farm; one replicate per trial; few (one or two) treatments per trial; and large plot and trial size (the latter may be 10-25% of total farm size) (Figure 4).

This step-wise process allows on-farm screening and elimination of all treatments which are (a) agronomically no better than the farmer's practice, (b) economically too expensive (or with unfavorable B/C ratios), (c) too labor intensive, or, (d) socially unacceptable. In addition, responsibility for trial management

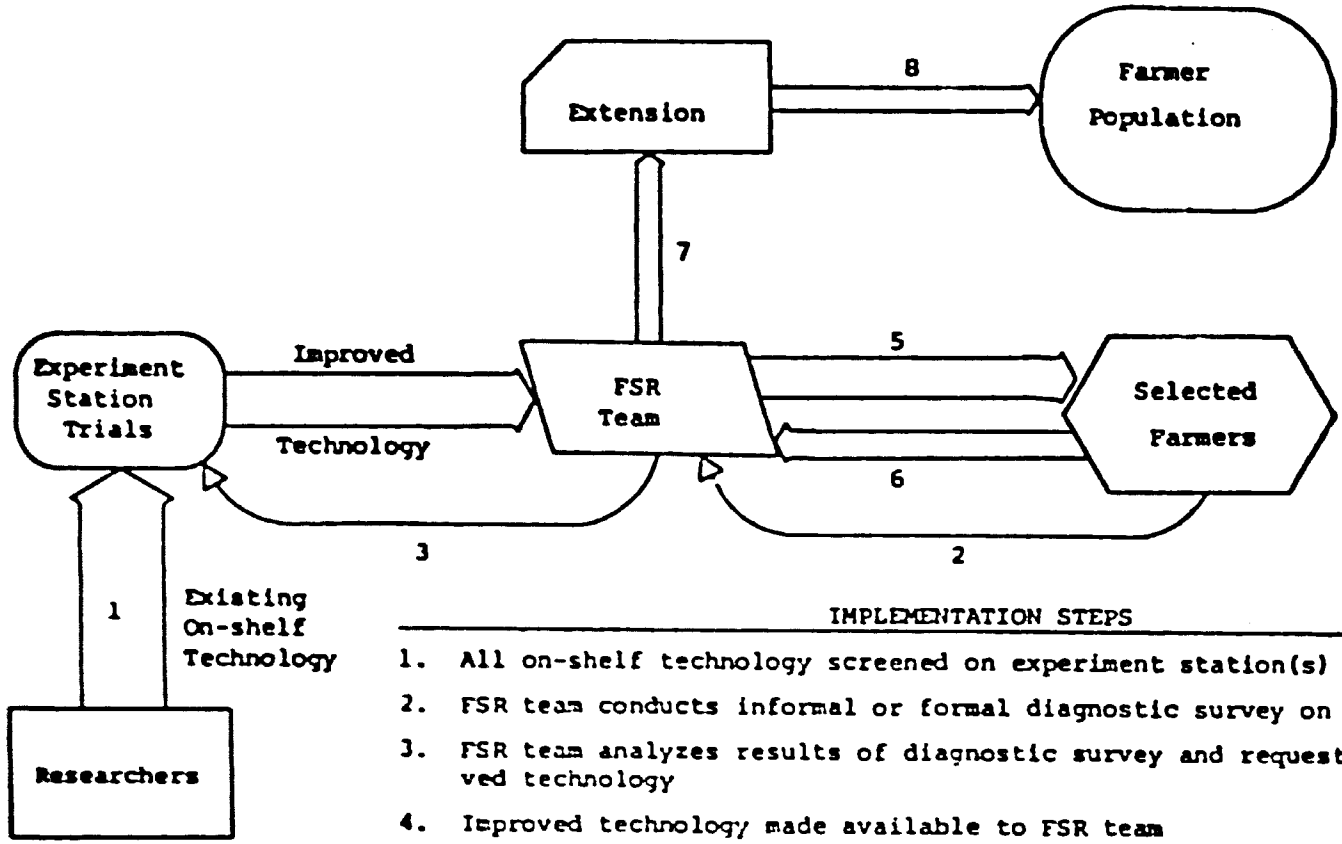
FIGURE 1. Flow Diagram Of Traditional Agricultural Research



IMPLEMENTATION STEPS

1. All on-shelf technology screened on experiment station(s)
2. Improved technology made available to extension
3. Extension recommends improvements to farming population

FIGURE 2. Flow Diagram Of Complete FSR Methodology



IMPLEMENTATION STEPS

1. All on-shelf technology screened on experiment station(s)
2. FSR team conducts informal or formal diagnostic survey on pre-selected farms
3. FSR team analyzes results of diagnostic survey and requests specific improved technology
4. Improved technology made available to FSR team
5. FSR team places farm (observation) trials in fields of selected collaborators
6. Improved treatments are analyzed, refined and verified
7. Verified improvements are made available to extension
8. Extension recommends verified improvements to farming population through the use of demonstration trials

Technology Flow

Socioeconomic Data Flow

FIGURE 3. General Comparisons Of Trial Design, Testing, Verification And Demonstration Phases Of FSR

PHASE:	II[1] Design	III[2] Test	II Design	IV[3] Verify	II Design	V[4] Demonstrate
STEP:	Design Trials →	Farm (Observation) Trials →	Analysis & Redesign →	Verification Trials →	Analysis & Redesign →	Demonstration Trials
		COMPARISONS OF SOME FARM TRIAL COMPONENTS, BY FSR PHASE				
Number of farm sites:		Several (± 6)		Intermediate (±10)		Many (15-30)
Types of trials:		1-4		1-2		1
Size of trials:		Small		Intermediate		Large (10-25% of farm)
Number of treatments:		Several (4-10)		Intermediate (2-4)		Few (1-2)
Size of plots:		Small (2.5-25 m^2)		Intermediate (10-200 m^2)		Large
Number of replicates:		1-4		1-2		1

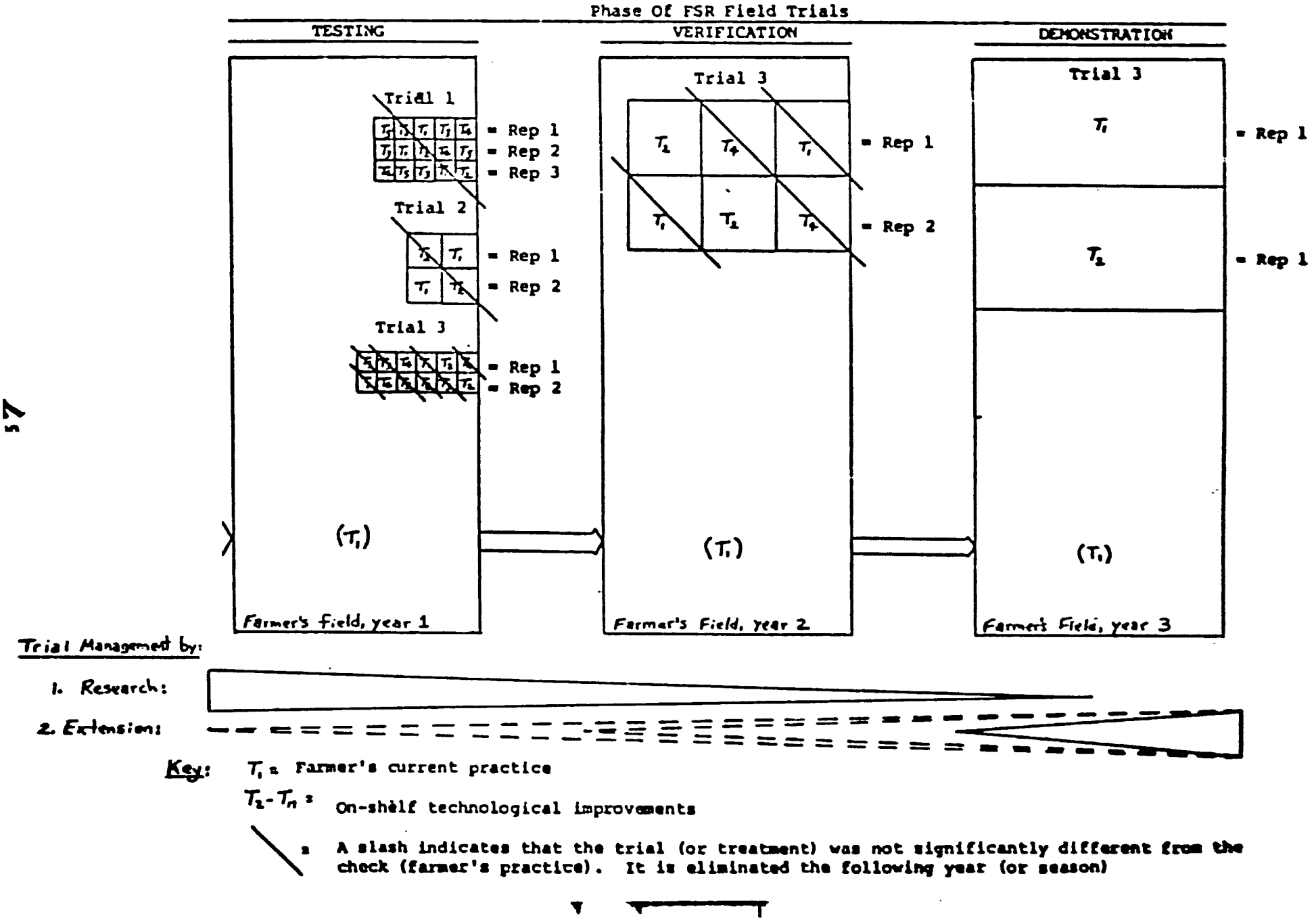
[1] II. Design Phase: this falls between steps 4 & 5, FIGURE 2.

[2] III. Testing Phase: this falls between steps 5 & 6, FIGURE 2.

[3] IV. Verification Phase: this falls between steps 5 & 6, FIGURE 2.

[4] V. Demonstration Phase: this is step 8, FIGURE 2.

FIGURE 4. Size And Complexity Of Three Phases Of Farm Trials During Implementation Of FSR



Key: T_1 = Farmer's current practice

T_2-T_n = On-shelf technological improvements

\ = A slash indicates that the trial (or treatment) was not significantly different from the check (farmer's practice). It is eliminated the following year (or season)

can be phased over from research to extension at any of three phases: immediately before Phase 2 (testing), Phase 4 (verification), or Phase 6 (demonstration), depending on the particular extension situation in any of the PAs. Phasing in extension responsibility is indicated by the relative thickness of the management arrows for research and extension at the bottom of Figure 4. By demonstration (Phase 6), extension should have full responsibility for field trial management, as shown by the solid management lines for extension (Figure 4).

No systematic set of replicated agronomic farm trials has been planted in farmers's fields to date. In fact, the September, 1982, planting season marked the beginning of the serious farm trial effort of the RD. These trials consist of two basically different types of trials:

(1) Enterprise combination trials (ECTs), and

(2) Prototype area trials (PATs).

Each contains two ECTs, while the number of PATs varies according to the PA (Tables 1-3, Outputs Section).

The existence of the ECTs at this stage in the project represent a response to pressures to produce evidence that production-oriented research has developed an improved system in each PA. RD staff members are under no illusion that the ECTs currently in place have been perfected, or that they even contain the correct technological inputs at the correct levels. Rather, an ECT combines all of th cultural practices recommended as agronomically optimal by the RDs revised Cropping Guidelines for Lesotho, 1981, for a given crop according to three elevation criteria: (a) lowlands, (b) foothills and (c) mountains. These trials are currently called demonstration trials (Phase 6). The optimal agronomic practices were determined by RD trials conducted mainly on the Maseru Experiment Station (and various sub-stations) by RD staff and expatriate researchers.

The PATs are simpler trials than the ECTs, usually exploring one or two components of potential technical improvements. Examples include the trials

under the supervision of Joe Carvalho in Nyakosoba, and the agronomy weed trials in Nyakosoba and Siloe. The only examples of PATs being replicated across farms are the Carvalho trials and the communal vegetable gardens.

Neither the ECTs nor the PATs are replicated trials on-farm. Thus, there is no way to block for farm heterogeneity (e.g., soil type differences, slope, etc.), nor can missing plot data be estimated. However, these points are less important than is the fact that most PATs and all ECTs lack check plots. A check plot may arbitrarily be defined as the normal practice of the collaborating farmer for FSR work. From the view point of statistical analysis, omission of a check plot means that the RD cannot state that the improved technology being compared to the farmer's practice is superior to that practice, even if, in fact it is.*

The evaluation team believes the RD has skipped at least one, and sometimes two, necessary steps in the process of technology transfer. Verification (Phase 4) is consistently skipped, and testing (Phase 2) has been skipped in the case of some ECT treatments. While the ECTs consist of agronomically sound enterprise combinations under research station conditions, such package trials are not put in place, either by research or by farmers, witout a cost increase over the traditional practice. Nor has their agronomic superiority been tested (in some cases) or verified (in all cases). Verification is vital to establishing the fact that agronomic superiority is not confounded with either a single season's weather conditions, or with station versus farmer management practices. Even if the yields are greater with an improved enterprise combination, there is no guarantee that the economic benefits to the farmer are greater than his costs, unless

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* This point is particularly important with respect to the ECTs. These trials occupy 100% of the collaborating farmer's field. Since the farmer does not plant any of the field to his own practice, no side-by-side comparison of yield can be made. If such ECTs were always completely effective in boosting farmer yield, such an omission would not be too serious, especially if the B/C ratio for such trials was consistenly quite favorable. However, based on the mixed evidence of ECTs in Nyakosoba and Siloe, and the negative evidence in Molumong, such an omission was probably an error of judgment and agronomy staff turn-over right at planting time.

economic analyses are conducted on a series of such trials which statistically represent the underlying homogeneous factors which were used as criteria for the initial selection of the farm trial areas.

There are some problems associated with prematurely denoting any trial a "demonstration". The costs of some inputs may be quite high, or the inputs may be locally unavailable. There is also the possibility that the incorrect combinations of practices or levels was selected for the local situation. However, two additional problems may be more serious or more likely to occur.

The first problem is the potential erosion of credibility. If the FSR trials are poorly planted or poorly managed, if sites poorly suited to the micro-environment of each farmer's field, the local farmers' practice may outyield (or have a higher B/C ratio than) the improved practice. In such case, farmers, extension agents and perhpas even higher government personnel may begin to lose confidence in the capability of the research staff to conduct meaningful on-farm trials.

The second potential problem is really a two-pronged dilemma. The first prong is that farmers rarely adopt all components of an improved enterprise combination, because of cash flow problems at the beginning of the planting season, higher perceived risk, etc. The second prong is that the ECT, by definition, includes optimal levels to allow an estimate of which may provide the farmer with the greatest marginal rate of return. Nor can such an estimate be made, given the design of the trial. Farming systems trials, in contrast, can be designed to provide an approximate answer to the question of which component may give the farmer the greatest marginal rate of return. (Again, an example of a potential trial for the Nyakosoba PA is provided as Annex

The implications of the preceeding discussion imply a greater effort in on-farm trials next planting season. This means more work for RD staff. Probably the management of several types of farm-level trials which are replicated both on-farm and across a representative sample of farms, will require more

manpower than is currently available to the RD. There are three partial solutions to the manpower shortage:

(1) the farm management unit cuts back on the number of farm record books it manages and spends more time in trial monitoring and evaluation;

(2) it may also imply that extension needs to be involved in the farm trial work through the DAO in each district; and

(3) it would be desirable to form a link with LAC with regard to agricultural students assisting with farm trial management and data collection in exchange for independent study credit and access to trial and other farm-level data.

ATTACHEMENT C

EXPLORATORY FARM TRIAL DEVELOPMENT WITH EMPHASIS ON STAND ESTABLISHMENT ISSUES

When initiating farm trials, a good method to quickly screen for which limiting factor is least expensive to recommend to farmers, for the gain in production it yields them, is to design a modified factorial trial. For purposes of illustration, assume that, in Nyakosoba maize, the RD staff observes that poor stand and weed control seem to be very serious problems, while the farm record books (and the baseline survey) indicate that cutworms and stalk borers, respectively, are mentioned most frequently as problems by farmers in the area. The treatments that the RD staff might consider for amodified (limiting factor) factorial trial are as follows:

T1 = farmer's normal practice = check plot.

T2 = use of modified Sefim plow, at a proper depth of planting, for greater separation of seed and fertilizer.

T3 = use of either better, more timely or more frequent hand weeding; or the application of the most efficacious herbicide as determined by the 1982-83 weed trials in maize (subject, of course, to reasonable cost and local availability).

T4 = application of a soil insecticide (or bait) at time of planting which is efficacious against cutworm and is locally available at a reasonable cost.

T5 = whorl application of a contact insecticide efficacious against stalk borer, timed according to observed evidence of feeding damage at small instar levels.

While a complete factorial trial of this type would require 16 plots for one replication (2^4), this modified factorial requires only five plots for one replication and ten for two. A B/C analysis of each treatment in the trial will allow the research group to recommend to limited resource farmers which one of the suggested improvements offers the greatest potential marginal rate of return under his or her cropping conditions.