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LESOTHO RENEWABLE ENERGY TECHNOLOGY PROJECT

SECOND YEAR ANNUAL REPORT

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PREFACE

The Lesotho Renewable Energy Technology (RET) project (project number 632-0206) was approved by the U. S. Agency for International Development (AID) in August, 1979. In February, 1981, Associates in Rural Development, Inc. (ARD) was selected and contracted by AID/Washington to provide technical assistance to the project. ARD's field team--Mr. Jay Stryker, the project coordinator; Dr. Judith Gay, the field supervisor; and Mr. Gary Klein, the laboratory supervisor--began work in April, 1981.

The RET project is scheduled for a three-year life with AID funding, which includes ARD's technical assistance, and financial and technical staff counterparts contributed by the government of Lesotho (GOL). It is part of the Appropriate Technology Section (ATS) of the Ministry of Cooperatives and Rural Development (MINRUDEV).

The first year annual report for the Lesotho RET project was published May 31, 1982. This second year annual report covers the progress of project operations from June 1, 1982 through May 31, 1983.

Mr. B. Kanetsi, an ATS engineer, explains the advantages of a photovoltaic (PV) panel to the Honorable Minister of the Ministry of Cooperatives and Rural Development, Mr. Vincent M. Makhele, and the ministry's Permanent Secretary, Mr. S. T. 'Mota.

I. SUMMARY

The Lesotho RET project has two primary purposes:

- as a pilot project, it is intended to determine whether certain selected RETs are socially acceptable and technically feasible for conditions found in Lesotho; and
- it aims to build a corps of trained personnel within the ATS, a part of the MINRUDEV's technical section.

During its three-year life, the project is designed to help make the ATS a functional institution for addressing rural and renewable energy problems. The project's primary focus is the rural poor--helping them meet their energy needs through energy conservation and the use of renewable resources. However, the growing urban and peri-urban areas have increasing energy demands, especially for imported fossil fuels. Thus, the project's secondary focus is identifying ways to conserve energy or use substitutes for imported fuels.

The project's design in logical framework format is presented in Appendix A. A comparison of planned and actual outputs shows that the project is meeting all 10 of its goals, due in large part to the dedication of ATS and RET staff members, and AID and GOL support. Despite certain staffing shortages, budget cuts and delays in obtaining materials, the project's pilot phase has demonstrated that certain RETs can meet the needs of the Basotho people.

Lesotho's barren lowlands have few burnable shrubs. Women must walk considerable distances from their homes to collect fuel--a time-consuming task.

Imported forms of energy, such as coal, are becoming increasingly important, particularly in the urban sector. This, in turn, represents a growing drain on the national balance of payments and vulnerability to external political pressures.

Simple technologies that are easy to build--e.g., stone paolas, retained heat cookers and food dryers--can make an immediate improvement in the daily lives of the Basotho. In addition, technologies that are not built by users but purchased, such as metal stoves and energy-efficient housing, have generated much interest. Many Basotho were previously unaware that energy and money could be saved by using owner-built or commercially available devices. However, now that the initial stages of dissemination have begun, the project is finding itself hard pressed to meet the demand for training courses, lectures and printed information. Follow-up field surveys show that the Basotho are indeed accepting the ideas put forth by the project--for example, one comment about the stone paola was, "This is a Basotho thing, why hadn't we thought of it."

The stone paola conserves precious fuel, can be built using local materials and existing skills, and is easily maintained by the owner.

II. INTRODUCTION

A. Project Background

The Lesotho RET project paper was written in 1979. ARD's field team began work in April, 1981, and the project was well underway by June, 1981. The RET project involves a counterpart training program for the ATS and a pilot effort for developing, testing and disseminating various energy-saving technologies. The ATS was founded in 1978 for the express purpose of helping meet the needs of rural Basotho. With this mandate, it was logical for the RET project to operate within the ATS.

The project paper envisioned a major RET research and development laboratory with associated support services in Lesotho's capital, Maseru, as well as three regional training centers, where a Peace Corps volunteer (PCV) would work with the local people through a regional Farmers' Training Center (FTC). This plan was modified early in the project for two reasons:

- a lack of ATS staff, and
- the logistic difficulties inherent in establishing three widely separated rural centers.

At the beginning of the project, there was a small ATS workshop in Maseru with one Mosotho staff member. Most of the project's first year and first half of the second year were devoted to energy-related data collection and analysis (see Section IV.A) and institution-building, which included staff recruitment, training, and the construction and equipping of the Maseru and regional centers (see Section III).

Initial data collection showed that the mountainous Mokhotlong District had the most severe fuel shortages and the greatest need for development assistance. Since the project paper also identified Mokhotlong as the district for the RET project's initial rural effort, it was a logical starting point. The development of other regional centers was postponed until later in the project's life.

The Mokhotlong FTC was unable to provide the RET project with office and workshop facilities, but a rural clinic in Malefiloane (20 kilometers southeast of Mokhotlong town) was able to provide the needed space, materials and local assistance. In addition, an energy survey conducted there in 1977 afforded historical baseline data. During the project's first year in Malefiloane, construction was begun on a workshop and a small energy-efficient office/hostel, based on one of the project's solar house designs. In addition, local staff were recruited to aid in collecting data, establishing the workshop and developing technologies.

Despite the location of workshop and testing facilities in Malefiloane and the day-to-day involvement of villagers in project activities, it was decided that an office should also be established in the district's commercial and administrative center, Mokhotlong town, during the project's second year. This second regional center facilitated the coordination of extension activities throughout the district. In addition, the FTC was subsequently able to provide space for training, so courses for agriculture, nutrition and village health workers were conducted there during the second year.

By the middle of the second year, the ATS/RET institutional structure was in place and energy-related survey work had been completed. The project turned its attention to its primary task--implementing a process for the development, field-testing and initial dissemination of RETs.

The project's technology selection, design, development and dissemination process (see Section IV) involves a "learning laboratory" approach that can be applied by the ATS to the development of other technologies in the future. It is based on a series of decision points that lead to eventual acceptance of a technology for widespread dissemination, further efforts at its modification or abandoning it in favor of a more promising device. Briefly, it involves villagers, Basotho staff members and skilled professionals in needs identification, followed by the selection, design, adaptation and testing of appropriate technologies and effective dissemination strategies. A fundamental constraint on the process is that technologies must be selected in response to people's expressed needs, as indicated by social and energy surveys, and suited to the local social, cultural, economic and technical conditions and infrastructure. In addition, the RET project should promote technologies that require minimal government or donor support once dissemination has begun. Thus, transferring production and distribution to the private sector, providing support for extension workers, and disseminating conceptual information about RETs to the public at large so that individuals can acquire and use them knowledgeably are important steps in the process.

Many RETs that have been proven in other countries require adaptation to Lesotho's special local conditions, which are generally temperate, dry and mountainous. For example, fuel-saving stove designs from tropical countries do not take into account a need for space heating, but Lesotho's cold winters and high altitudes make a stove that can also warm the house and its occupants highly desirable. The combustion of dung fuels at high elevations also had to be considered.

Early in the second year, the project identified four major areas where RETs could meet expressed needs:

- cooking,
- water heating,
- space heating, and
- year-round availability of food, through both production and preservation.

Major activities during the second year were aimed at addressing energy-related needs in these four areas. Section V discusses the priority technologies selected to meet these needs, and progress made in their development and dissemination.

Section VI describes future directions anticipated for the RET project during its third year.

B. Implementation Schedule

The implementation schedule for the RET project has undergone several revisions since the project paper was written due to delays in ATS staffing and the availability of adequate workshop space, the early attrition of PCVs, and a reassessment of the actual outcomes of training personnel. Figure 1 shows the implementation schedule for the project's second year. The redesign of activities also altered the project's implementation chronology (Figure 2) in that several activities were changed and many occurred ahead of schedule. The evaluations conducted in 1981 and 1982 were of great help in clarifying project goals, and the resulting three-party discussions between AID, ARD, MINRUDEV and RET project personnel served to streamline many procedures.

Figure 1

PROJECT IMPLEMENTATION SCHEDULE FOR SECOND YEAR

Activity	5/82	6/82	7/82	8/82	9/82	10/82	11/82	12/82	1/83	2/83	3/83	4/83	5/83
testing laboratory construction	X → X												
architectural drawings	X →	→ → → →	→ X										
workshop construction	X →	→ → → →	→ → →	→ → →	→ → X								
Malefiloane stove development/dissemination	X → →	→ → → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → X
data analysis	X → →	→ → → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → X
project monitoring information system	X → →	→ → → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → X
ongoing MINRUDEV and PCV technical training program	X → →	→ → → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → X
first regional training center--Mokhotlong	X → →	→ → → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → X
cooking device design	X → →	→ → → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → X
village implementation process	X → →	→ → → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → X
training workshop-Maseru	X → →	→ → → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → X
food-for-work program					X → →	→ → →	→ → →	→ → →	→ → →	→ → X			
new Peace Corps staff orientation					X → X								
micro-hydroelectric consultation					X →	→ → →	→ → X						
dissemination plan						X →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → → X
FTC training courses for extension workers							X → →	→ → →	→ → →	→ → →	→ → →	→ → →	→ → → X
solar house monitoring										X →	→ → →	→ → →	→ → → X

Figure 2

PROJECT IMPLEMENTATION CHRONOLOGY

Activity	TIMELINE MONTHS Project Paper	Actual
Sign RET Project Agreement	D	D
AID/W Release Request for Proposal	D + 2	D + 8
Support Services Prime Contract Award; Project Begins	D + 6 C*	D + 18 C*
Contractor Start-Up Period -- Staffing	C + 2	C + 1
Project Staff Orientation/Planning, U. S./Lesotho	C + 4	C + 2
Program Organization and Procurement	C + 4	C + 3
Staff Training -- Language	C + 6	C + 3
Staff Training -- Evaluation Process	C + 7	C + 3
Staff Training -- Technologies	C + 7	C + 3
Village Meetings, Presentations and Survey Begin	C + 7	C + 4
Village Energy Technicians (VETs) Trainees Selection	C + 7	redesigned
Train Appropriate Technology (A. T.) Unit	C + 7	redesigned
Train First Group of VET Trainees at RET Rural District No. 1 (Mokhotlong Farmers' Training Center)	C + 8	C + 13
Set Up RET Research Laboratory in Maseru	C + 8	redesigned
Begin Construction of Village Demonstration Units (continue throughout program)	C + 11	C + 13
Begin R&D Unit Pilot Project	C + 14	C + 9
Solar House Construction	not applicable (redesigned)	C + 13
R&D Unit Pilot Project--install methane digester plant at Masianokeng Feedlot.		redesigned
Formal program evaluation conference		C + 10
Evaluation of MINRUDEV ATS Unit training and administrative capabilities.		C + 13
First Annual Report		C + 15
MINRUDEV ATS Unit assumes responsibility for training and survey activities.		C + 15
Second R&D Pilot Project--feasibility study of 3- to 5-kw hydroelectric system to replace diesel electric generator located at clinic in Ha Lejone-Rampais areas.		C + 18
RET Project Evaluation		C + 23
Second Annual Report		C + 27

*The lapse of 18 months between the signing of the project agreement and the award of the contract obscured the comparison of the timeline put forth in the project paper and the RET project's actual chronology presented in this figure. Thus, the starting point for both timelines was reset to C when the contract was awarded and the project begun.

Lesotho's rough mountain roads impede the transportation of materials and staff to remote village areas for survey, technology testing and extension work.

III. INSTITUTION-BUILDING

During the first half of the second year, much of the project's effort went into establishing a firm institutional basis for its energy-related activities so that they can continue beyond the life of the RET project. This involved recruiting and training personnel, establishing and equipping office and workshop facilities in Maseru and the regional centers, and working closely with the MINRUDEV to strengthen the ATS. The institution-building process laid the foundation for the main activities undertaken during the second half of the year--the selection, design, development, testing and preliminary dissemination of technologies.

A. Project Staff

During the second year, the number of RET staff members grew to its present level of over 25 people who regularly work on project activities in the Maseru office and workshop or at the regional centers. ARD's project coordinator, field and laboratory supervisors, and administrative assistant continued their efforts during the RET project's second year with the addition of a stock and supply manager. Despite financial difficulties experienced by the GOL during the past year, the ATS now includes eight well-qualified Basotho staff members. (Appendix C presents the personnel roster for 1982/1983.) The MINRUDEV has also provided watchmen as well as office and workshop helpers.

A secretary helps integrate the project's administrative procedures with those of other government organizations.

Unfortunately, a government freeze on additional hiring prevented the ministry from adding additional personnel at the technical assistant level for laboratory research and development, field testing and extension. Thus, ARD found it necessary to hire Basotho staff members on a temporary basis--four for the Khubetsoana workshop and three to work at the Mokhotlong and Malefiloane regional centers. This enabled the RET project to develop an energetic, able, mobile staff, and extend project activities until such time as the ATS expands and/or interested village leaders, local producers and extension workers from various ministries are trained.

Three new PCVs joined the project during its second year, while one PCV and a Danish volunteer completed their tours of duty. However, two of the new volunteers resigned for personal reasons. The third joined the ATS staff in establishing the new regional center in Mokhotlong town. The other two PCVs, who arrived in 1981, continued to work at the Malefiloane center on construction, technology development and staff training. Another volunteer from a church-based organization continued the work he began during the project's first year--developing a small research and extension center in the Butha-Buthe District.

B. Consultants

Consultants provided important assistance in the research and development of particular technologies, feasibility studies, planning and initiating dissemination activities, and staff training. The project paper shows 20 person-months of short-term hire for consultants. During the RET project's first year, five months of consultant time were provided, while a total of 22.75 months were provided during the second year. Thus, as of the end of the second year, 27.75 months of consultant time had been used, but there are still some fund remaining for consultant time during the third year. The RET project was able to realize an additional 1.5 months of consulting time for a micro hydro feasibility study, supported by the National Rural Electric Cooperative Association (NRECA) under their cooperative agreement with AID ST/EY.

Consultant Services During the Second Year

Consultant	Person-Months	Focus of Consultancy
Dr. G. Burrill	1.5	project evaluation and technology assessment
Mr. D. Norris	2.25	energy-efficient housing
Mr. F. March	1.25	economic evaluation of RETs
Ms. M. Thomas	6.5	fuel-efficient stoves
Mr. G. Burket	6.5	fuel-efficient stoves
Ms. E. Morgan	3.25	dissemination of RETs
Mr. H. Geller	.25	stove testing
Mr. R. McGowan	1.25	solar engineering/monitoring

To follow up on work on energy-efficient housing begun during the project's first year, Mr. David Norris, a noted solar architect, spent two months at the RET project from June to July, 1982. He visited typical rural and urban houses, and consulted with many Basotho, ranging from sophisticated contractors, architects and housing experts to young people interested in building their own homes. Mr. Norris prepared booklets on applying the principles of passive solar design in Lesotho and detailed plans for energy-efficient houses, in both traditional and modern styles. He also conducted several staff training sessions and seminars for local contractors and architects.

Two brief consultancies involved energy-related feasibility studies and training ATS/RET staff members to conduct such analyses. Mr. Fred March, an ARD consultant on the economic aspects of energy systems, trained personnel in the economic analysis of renewable energy systems, prepared a guide for such training and helped the RET project assess the economic potential of various technologies being considered to meet the energy-related needs identified for Lesotho.

The second feasibility study concerned small-scale hydro power, and was performed under the auspices of NRECA by Mr. Bard Jackson of NRECA and Dr. Martin Johnson, a principal associate of ARD, during November, 1982. They worked closely with Mr. B. Kanetsi, an ATS engineer, and provided training in all aspects of planning small hydro power systems. In addition, they presented a seminar for engineers and planners from several government ministries and prepared a detailed report on the potential for small hydro power development in Lesotho.

Mr. Norris, an ARD housing consultant, worked with project staff members to determine local preferences before developing plans for energy-efficient houses for Lesotho.

ARD stove consultants, Ms. Margaret Thomas (associated with the Aprovecho Institute) and Mr. Glenn Burket, provided invaluable assistance during their consultancy on fuel-conserving stoves, particularly in developing and testing stone paolas, earthen stoves, retained heat cookers and the RET metal stove. They also helped create testing, training and extension procedures for these and other fuel-conserving devices. Ms. Thomas and Mr. Burket lived in Malefiloane and worked with RET staff members for six months while the center there was being completed and staffed. As a result, they contributed to developing staff capabilities, efficient procedures and the meaningful involvement of villagers in the technology development process. This consultancy was a logical follow-up to the stove development work begun by Mr. Ianto Evans (another ARD consultant) and the RET staff during the project's first year.

A portion of the ATS/RET project staff and Ms. Thomas, a stove consultant, gathered around a prototype stone paola, built during a staff training session at Khubetsoana.

A brief visit by another ARD stove consultant, Mr. Howard Geller, followed. He spent two weeks training the RET staff in the latest international stove efficiency testing procedures as well as sharing his experiences with portable metal stove designs from other parts of Africa and Asia.

Much of the initial work on institution-building and preliminary technology development was completed by the middle of the project's second year. At this time, Ms. Erika Morgan, a public education consultant, arrived to help the RET project focus its efforts, skills and resources on the next step--disseminating appropriate energy-related technologies. Ms. Morgan trained staff members in extension work, and assisted the project in formulating dissemination plans and beginning production of the materials needed to facilitate an effective national educational campaign on renewable energy concepts and technologies.

Ms. Morgan helped train the RET staff in planning and evaluating dissemination activities and developing public education materials.

C. Staff Training

During the project's second year, a major portion of staff training was provided by consultants who worked with staff members on a regular basis, conducted special seminars and training courses, and prepared training materials. As new staff members were recruited and hired, their initial orientation and training were provided by other RET staff members, senior Basotho professionals, experienced PCVs, and consultants available at the time. In addition, special short-term consultants were also brought in to help with staff training on particular topics--for example, a skilled Mosotho sheet-metalworker and a Peace Corps expert on marketing, pricing and business practices. Besides the orientation of new staff members and special training sessions, on-the-job training was a regular part of the project's daily routine.

Several levels of staff meetings were held to provide opportunities for training, the coordination of project activities, and learning by participating in the process of planning implementation and evaluation activities. "All-staff" seminars were held twice a year that were devoted to technical

discussions, training, project planning and administrative matters. The decision to conduct many of these sessions in Sesotho resulted in greater participation by Basotho staff members, language learning opportunities for the expatriate staff, and more useful discussions about how to present technical training and extension information in Sesotho. Bimonthly meetings of the coordinating committee involving all the RET centers were introduced during the second year, as well as more frequent meetings at each center of project activity. Important features of the staff training program included work on skills in leadership, conducting meetings and planning project activities.

Basotho staff members participated in a few training opportunities outside Lesotho during the project's second year. The project paper and budget do not provide for training abroad, but it is hoped that this situation can be changed during the third year.

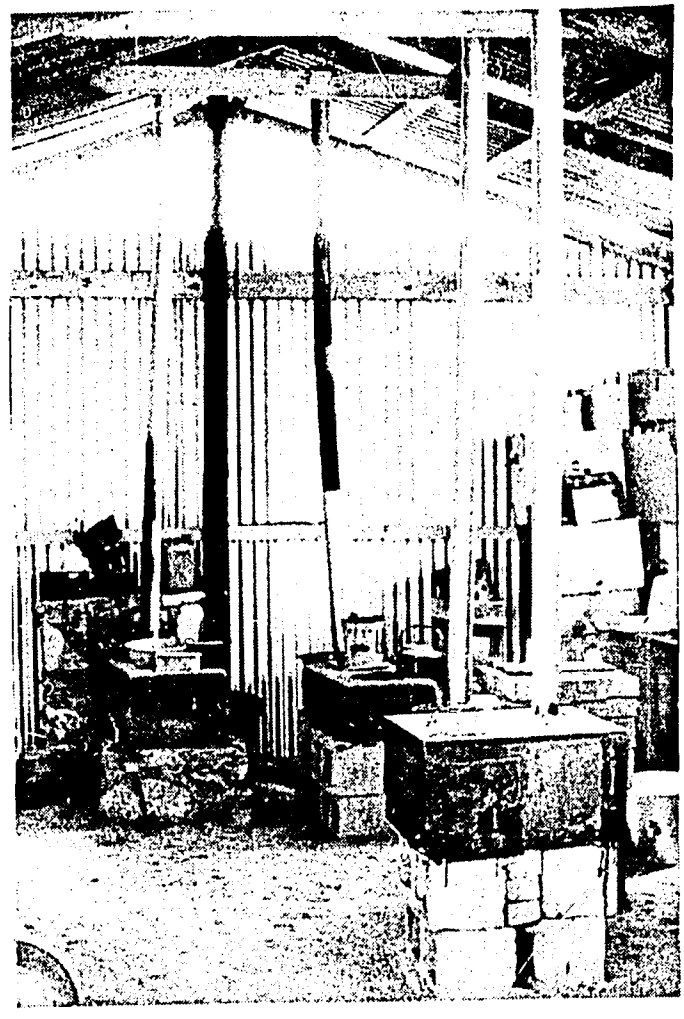
Mr. B. E. Kanetsi, an ATS engineer, attended a conference in Rome, Italy during June, 1982 as an advisor to the Minister of Water, Energy and Mines. He helped draft a program on new and renewable energy sources for the United Nations as a follow-up to the Nairobi energy conference of 1981. As a training experience, the conference introduced this senior staff member to the complexities of international energy planning. In May, 1983, he also traveled to the Netherlands for two months of training in rural energy planning.

In September, 1982, two ATS staff members attended a rural development technology exhibition in Bulawayo, Zimbabwe. They exhibited various technologies being developed in Lesotho, saw a variety of devices from other countries and talked with many others who are working on similar projects throughout southern Africa.

D. Facilities

To provide a base for project activities, considerable time and money were spent during the second year to construct and equip workshop facilities and build or rent office space in both Maseru and for the other regional centers. The ATS' original small workshop was moved to a new location in Khubetsoana, five kilometers outside Maseru at the end of the first year. At this new, larger site, the building was expanded in addition to the construction of a stove testing shed and a watchman's house with passive solar design features. The open space at the site is utilized for testing and demonstrations. Most of the construction, site development, equipping the facilities for research and development, and establishing workshop procedures occurred during the first half of the project's second year.

Staff members erecting supports for the ATS workshop in Khubetsoana.

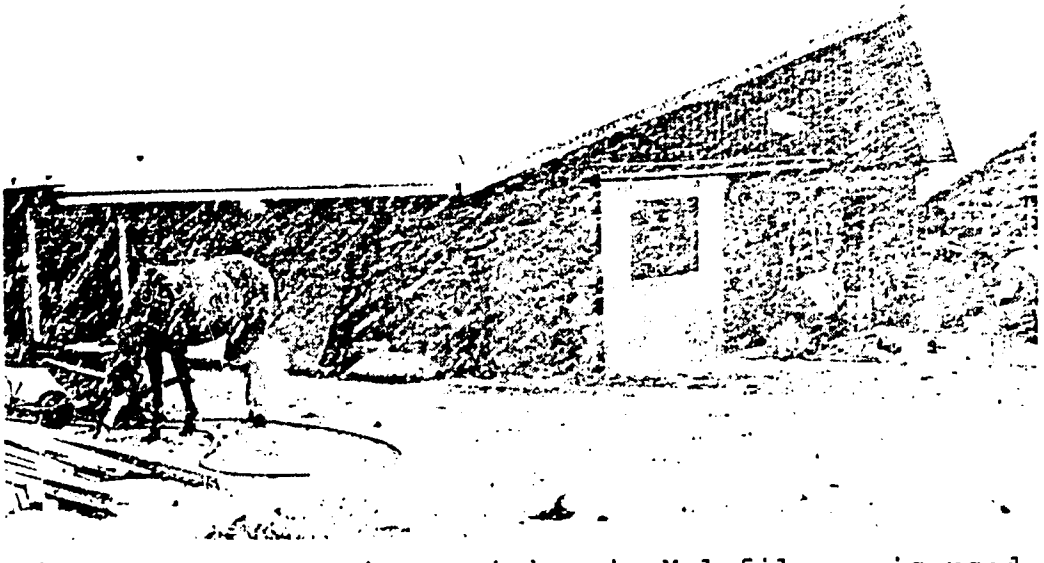


Stove testing shed used extensively for the development and testing of new stove designs for the lowlands.

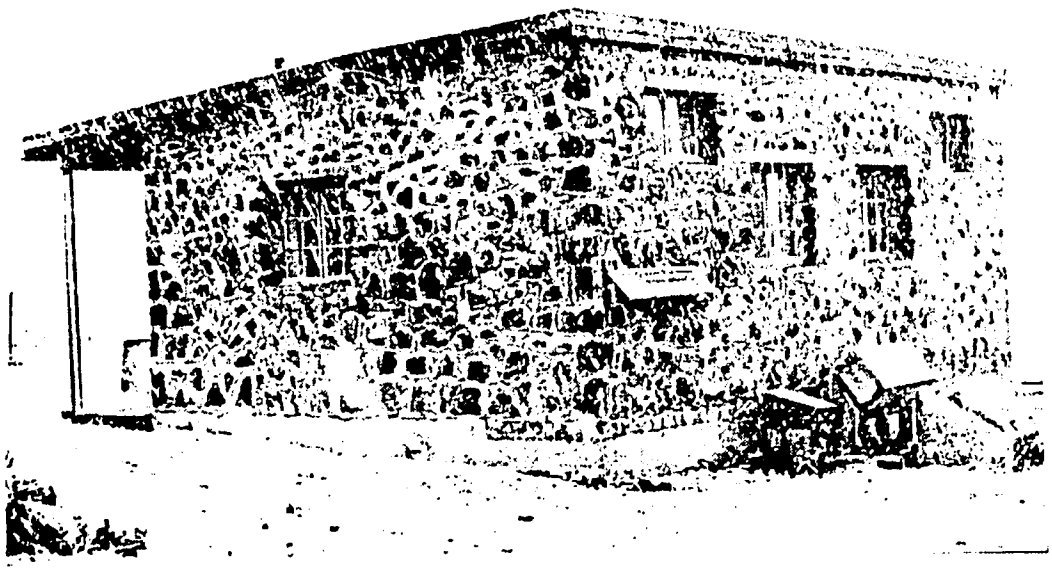
In Maseru, the RET office continued to work out of rented accommodations, although the ministry had hoped to build an office complex at the Khubetsoana site. However, improved library space, filing capacity and the project's own photocopier enhanced operations in the Maseru office.

In Malefiloane, construction of an energy-efficient workshop was completed during June, 1982, and a demonstration passive solar house, designed to serve as an office and hostel, was finished at the end of the project's second year. In addition, a simple stove testing shed was built early in the second year. These three buildings are the base of operations for the stove development program, initial stove training courses and demonstrations, and the work of local artisans, carpenters and metalworkers.

The watchman's house at Khubetsoana includes a "sun-wall," a passive solar heating feature that is easily constructed.



The energy-conserving workshop in Malefiloane is used for training, testing, production and dissemination activities in the Mokhotlong District--large east and north windows provide a comfortable working space even when the mountain weather turns snowy.



The passive solar house that serves as an office and hostel for the project's Malefiloane center--note the photovoltaic panel, which provides power for radio communications with other RET project centers, as well as the small demonstration food dryers and solar water heaters.

As the ATS/RET staff expanded, a need was felt for a simple office in Mokhotlong town, the headquarters of Mokhotlong District, to serve as a center for coordinating demonstrations, training courses and other extension activities. Here, as well as in Butha-Buthe, single rented rooms provided bases for RET project operations that were readily accessible to ministry officials, local individuals and groups.

The acquisition of several horses and constant vehicle maintenance were required to provide transportation between the regional centers and reach villages for testing and extension work. A radio communications system linking the centers in Malefiloane and Mokhotlong with Khubetsoana was set up in January, 1983 and greatly facilitated the coordination of project activities.

IV. TECHNOLOGY SELECTION, DESIGN, DEVELOPMENT AND DISSEMINATION

The RET project has evolved a process for technology development, from perception of an energy-related need to promoting widespread use of a technology which meets that need. This process (graphically presented in Figure 3) served as the basis for most of the activities undertaken during the project's second year, after the institutional base was established (see Section III), and guided the development of each priority technology. (Section V summarizes the status of each of the priority RETs.) The process is basically linear, but allows for feedback at major decision points so that technologies can be modified, new ideas introduced and decisions made about production, dissemination and follow-up.

A. Needs Assessment and Technology Matching

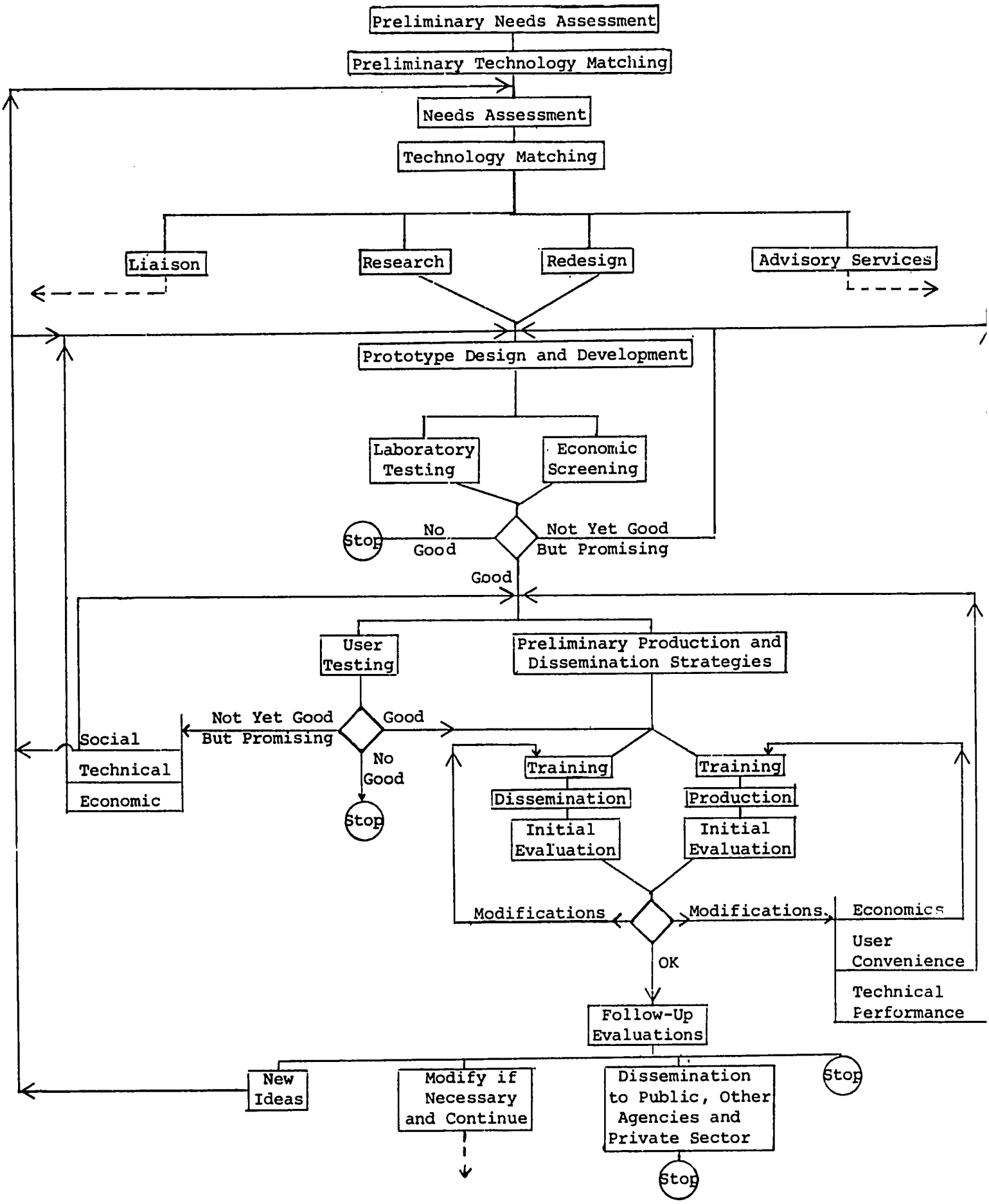
A preliminary needs assessment and technology matching was carried out midway through the project's first year, based on the RET staff's in-country experience, observations, early data collection, and discussions with villagers and rural development workers. Candidate technologies were selected for initial prototype development, but most of the project's efforts during the first year were aimed at institution-building.

An extensive village energy survey was conducted in the Mokhotlong District from March to June, 1982. Five enumerators spent one week in each of six villages collecting a variety of information on villagers' current energy resources and uses, perceived needs and energy-related socioeconomic conditions. The survey was also designed to gather detailed data relevant to the design of candidate technologies, and provided information on village life and institutions that will guide subsequent dissemination activities. As a result of the survey, the project decided to focus on four primary village needs that could be addressed by appropriate RETs--cooking, water heating, space heating, and increasing the year-round availability of food through improved production and preservation practices.

Given the village energy survey data and additional information presented in The Economics of Improved Energy Technology in Lesotho (notes for a seminar in economic evaluation, conducted by Mr. March in March, 1982) and The Social Feasibility of Renewable Energy Technologies (Ms. Mamello Khoboko and Dr. Gay, 1982), all the relevant RETS were considered and priorities set for prototype design and development. (See Technology Development Status Reports, Mr. Klein, October, 1982.)

Figure 3

TECHNOLOGY SELECTION AND DEVELOPMENT PROCESS



ARD's field supervisor, Dr. Gay, analyzes village energy survey data.

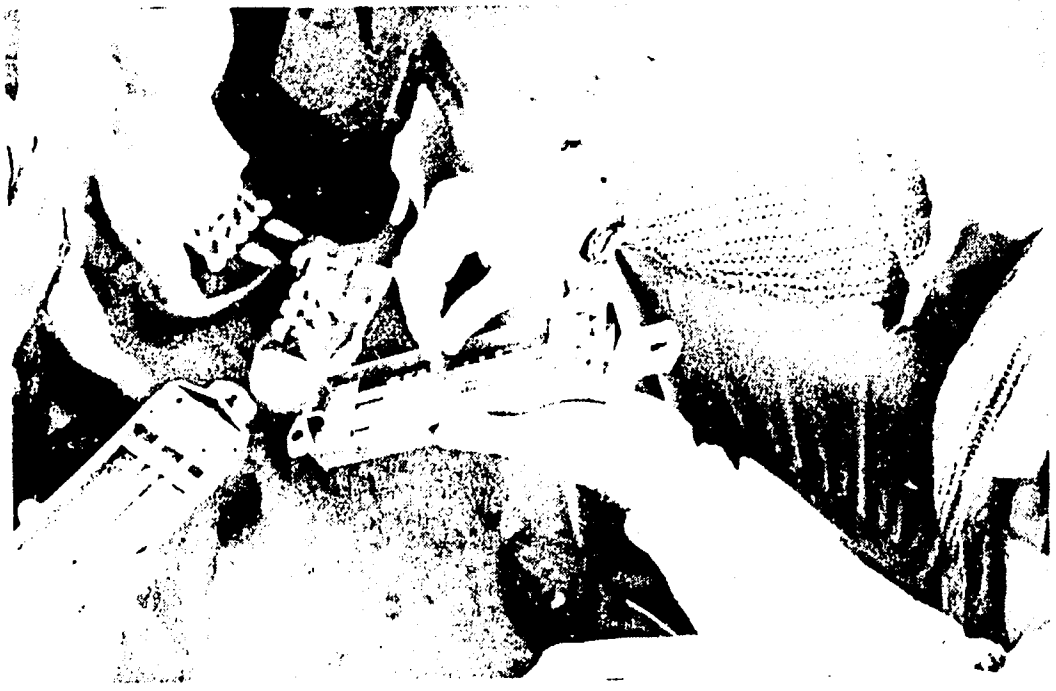
B. Prototype Design and Development

Ideas for RETs to address identified needs came from many sources. Often, traditional Sesotho devices or practices provided the starting point for an improved technology. In other cases, the project modified RETs developed by commercial enterprises or other organizations to suit Lesotho's climatic, geographic, technical, social and economic conditions.

Some technologies required extensive research and modification (e.g., fuel-efficient stoves and paolas), while others required less basic research, but had to be redesigned for local conditions--grow-holes, food dryers and energy-efficient building designs. For technologies that are already commercially available (for example, photovoltaic systems and large solar water heaters), the project acted solely in an advisory capacity.

The prototype design stage encompasses not only laboratory testing and further economic screening, but also consideration of the level of effort needed for research, development, testing and dissemination. The criteria for moving a technology past this stage include adequate performance, expectations regarding durability and maintenance, and estimated production and distribution costs.

ARD's laboratory supervisor, Mr. Klein, and ATS engineering assistants developed test forms for analyzing stove performance.



RET staff members were instructed in the proper techniques for thermal measurements.

C. User Testing

During the project's second year, some candidate technologies remained in the prototype design and development stage, while others were redesigned given the results of laboratory tests and/or social or economic screening. Some proved ready for the next stage in the technology development process--user testing.

A limited number of stone paolas, metal and earthen stoves, food dryers and grow-holes were constructed and placed in homes, schools or other locations where information on their performance while in use could be gathered. Toward the end of the second year, the RET project began to develop detailed procedures for collecting data from users. Specifically, users were queried about fuel savings, operational and maintenance difficulties, frequency of use and suggestions for design improvements. By the end of the year, some devices were deemed ready for the next stage of the technology development, while others appeared to require redesign and further testing. As with all other stages in the process, a technical, social and economic screening of each device was conducted after user testing to determine whether the technology was ready for the next stage of development.

D. Preliminary Production, Training and Evaluation

Once a device has satisfactorily passed through all the preceding stages of the technology development process, the project must ensure that it will be available to anyone who wants one. Thus, after user testing, RET/ATS staff members begin training producers to copy the final design. Devices that reach this stage are grouped into two basic types:

- those that can be built by someone with no specialized skills or equipment, sometimes from inexpensive kits that provide essential materials; and

- those which users will have to purchase from trained artisans who produce them in a workshop or factory.

During the second year, the RET project began to develop training courses and instructional materials, and identify sources of construction supplies. Training courses in the construction of stone paolas, earthen stoves, retained heat cookers and simple food dryers were initiated, as was specialized instruction for artisans in the manufacture of RET metal stoves, metal grates for stone paolas, and covers for grow-holes and food dryers. The extension activities listed in Appendix B detail the courses held in each locality.

ATS/RET staff members develop a quality control checklist for the RET metal stove.

E. Dissemination

The final stage of the technology development process entails widespread diffusion of energy-conserving ideas and proven technologies. This stage cannot be undertaken for any technology until all the requirements of the previous stages have been satisfied and the device is available through normal channels. At that point, the dissemination effort can build upon the demand generated by public education programs and media development for the device and/or the training needed to construct it.

Once training courses have been successfully developed and introduced in limited areas near the project's regional centers, dissemination activities can address a more general, national audience using proven training programs, printed materials and radio broadcasts. Individual village specialists, as well as a variety of extension workers and community group leaders, are already being trained to multiply the efforts of the limited RET staff when the project mounts a dissemination campaign to reach the general public.

The development of a detailed dissemination plan that integrates all of the project's technical and extension activities was a major undertaking for the RET staff and ARD's

public education consultant, Ms. Morgan, from January through April, 1983. The plan outlines a tentative schedule for the preparatory steps that must be completed for each major group of technologies before widespread dissemination can begin.

A training course in earthen stove construction is conducted in a village home near Maseru--teaching users how to build devices is an integral part of the project's dissemination program for some technologies.

The RET project has developed a variety of educational materials, including posters such as these from series that show how to build grow-holes and stone paolas.

A staff member explains the finer points of a computer program that analyzes a building's energy performance at a seminar for local architects held at Maseru's Hotel Victoria.

V. PRIORITY TECHNOLOGIES

Midway through the second year, project staff members evaluated the status of all candidate technologies to determine which ones would be addressed by the RET dissemination program. In deciding which technologies to disseminate, the staff took into consideration each device's technical "readiness," probable ease of dissemination and potential for benefiting the project's target population--the rural poor. This process led to a prioritized list of technologies that address one or more energy-related needs. The following subsections summarize the status of each device, beginning with the one most likely to achieve the greatest degree of success--the stone paola.

A. The Stone Paola

Cooking outdoors over an open fire is the basic cooking method used by rural Basotho. Some homes have stone windbreaks, often in the shape of a cross or the letter "C", that help shield the fire and pot from the wind. The design of the stone paola was derived from this local "technology." The term "paola" comes from the Sesotho name for a bucket or pail that serves as a brazier and is commonly used to enclose a fire and support a cooking pot.

The traditional cooking method in Lesotho's mountains--an open fire of straw and dung under a three-legged, cast-iron pot. The children huddle close to keep warm despite the acrid smoke and danger of burns. A metal bucket for carrying fire indoors and an old, blackened, food aid tin for heating water sit to the left of the fire.

The opening of a C-shaped windbreak usually faces away from the prevailing wind direction, and it encloses a large enough hearth to accommodate one or two cooking pots and allow a person to tend them. The stone paola closes the "C" and fits the sides of the cooking pot closely (usually a gap of only two centimeters). There are openings in the side of the paola that permit the cook to tend the fire and remove ashes, as well as providing adequate oxygen for combustion at Lesotho's high altitudes. The pot sits down inside the paola and rests on triangular supports approximately 25 to 30 centimeters above an iron grate.

The performance of stone paolas is remarkable. Combustion is improved by the grate and the fact that the fire is contained in a small firebox where adequate, but not excessive, amounts of air can be introduced in a controlled manner. Heat transfer is increased because radiant heat from the fire is focused on the bottom of the pot, and the flames and smoke pass close to the pot's sides, undisturbed by the wind. As a result, cooking on a stone paola saves fuel and time, produces less smoke and reduces the danger of burns, which are common with an open fire.

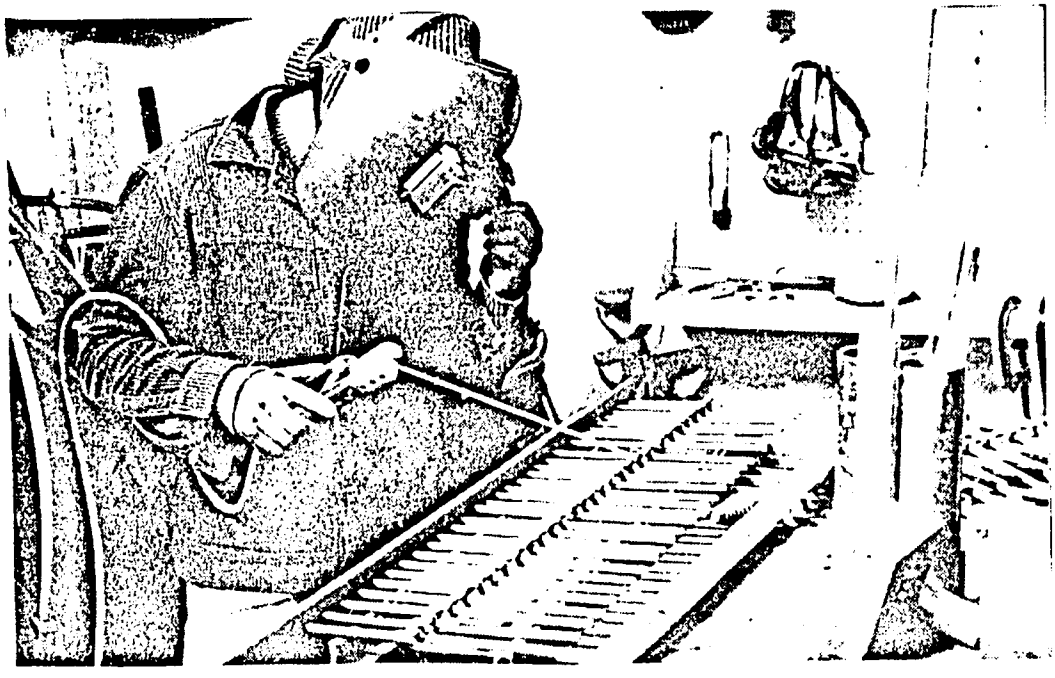
Originally, project staff felt that stone paolas would be most useful at primary schools which serve lunch because they cook large quantities of grains and legumes a long time. However, when village women near Malefiloane saw the stone paola, they wanted it for use at home and insisted that RET staff members teach them how to make the device.

Since December, 1982, many groups of women have received training in how to build a stone paola. Courses have been held through Food-for-Work training programs at several schools in the lowlands, "multiplier" groups such as village health workers, nutrition extension agents and self-help clubs sponsored by the Women's Bureau. Due to limitations on staff time, much of the project's stone paola training effort during the third year will be directed toward such multiplier groups. Another major focus for this effort in the coming year will be to identify, train and certify teachers and builders so that the private sector can begin to meet the rapidly growing demand for stone paolas and training in how to make them.

Building a stone paola during an RET training course in the mountains.

In addition, the project is training local metalworkers to produce the pot supports and grate needed to build a stone paola. The distribution of these items has to be improved, but it is already clear that the stone paolas is an accepted technology and its use will continue to expand.

Important features of the stone paola extension program include the development of a slide show, set of instructional posters and simple "how-to-build-it" fact sheet. In addition, technical follow-up, quality control through certification of trained builders, and maintenance advice are also included in the extension effort planned for this technology. This kind of support will be continued until the stone paola becomes such an accepted part of Basotho cooking culture that project involvement is no longer necessary.



A skilled Basotho welder in Malefiloane learns to make and use a jig for mass production of the iron grates used in the stone paola. Inexpensive kits that include a grate and three rods for pot supports are being made by local artisans for sale to those who attend training courses and wish to build their own stone paola.

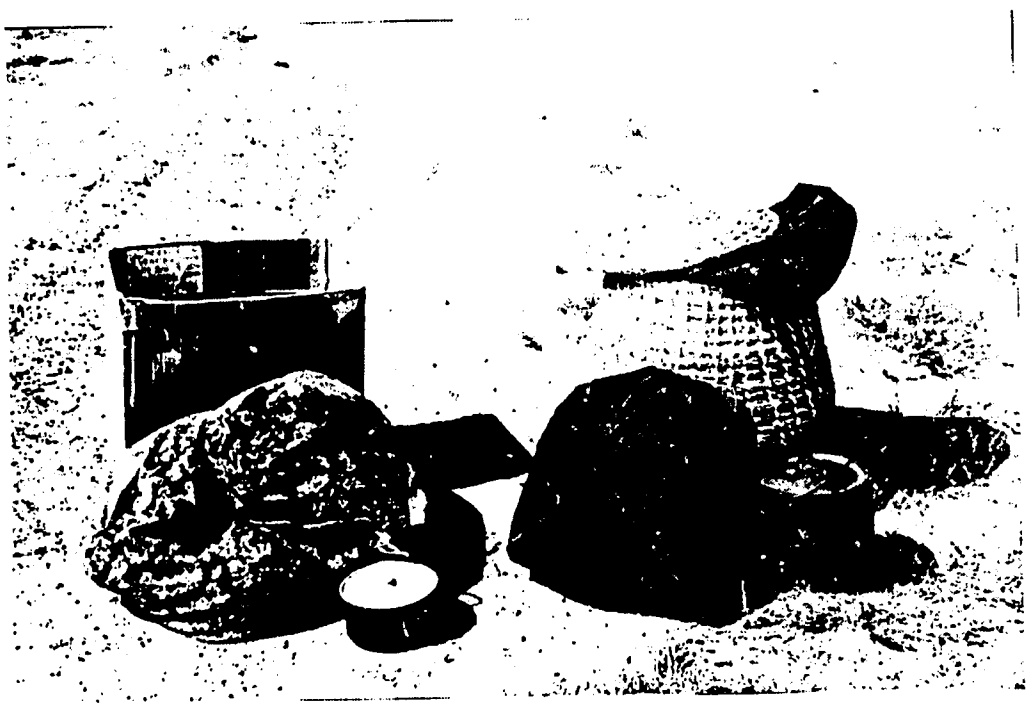
B. Retained Heat Cookers

The retained heat cooker--also known as a hay-box or fireless cooker--is a proven technology that is used in many countries. There are a variety of ways to make retained heat cookers, as well as many recipes that are well suited to this cooking method. In Lesotho, however, the main meal is traditionally cooked rapidly in an iron pot over an open fire and eaten immediately. Thus, the Basotho have few suitable recipes and little experience with slow cooking, although many of their dishes, such as beans and meat, require long cooking times and hence, are ideal for retained heat cooking.

Several foods commonly eaten in Lesotho, such as maize meal, steamed bread, porridge, rice and vegetables, can be cooked in the usual way for a short period to raise the temperature of the dish before putting it in a retained heat cooker for the remainder of the cooking time. This saves up to 80 percent of the fuel that would ordinarily be consumed--the exact savings depends on the food being cooked. With solid fuels, like dung, wood or coal, the use of a retained heat cooker means that another dish can be cooked and water heated for washing up after the meal without adding extra fuel to the fire after it is

initially stoked. A paraffin, gas or electric stove can be turned off after the dish is placed in the retained heat cooker. In either case, fuel is saved, as are time and/or money, thereby improving the quality of life for users, in both villages and urban areas.

Retained heat cookers vary in design from simple mud-walled enclosures filled with straw or grass to wooden boxes with insulating cloth bags stuffed with styrofoam beads (a common packing material in urban Lesotho). The RET project has tested various insulating materials--including hay, chaff, sawdust and paper--and containers, such as wicker baskets, cardboard and metal boxes, and stone- or mud-walled enclosures.



Retained heat cookers made from a cardboard box and a straw basket woven locally--two of the types that have been tested and demonstrated by the RET project.

Because the Basotho have no history with this type of cooking, the RET project developed a variety of recipes for preparing traditional foods using a retained heat cooker, and incorporated them into recipe booklets and guides for using and making retained heat cookers. Thus far, the dissemination effort for this device has focused primarily on such multiplier groups as nutrition extension agents, village health workers and women's groups. While the newness of this technology hampered its acceptance at first, the dissemination program is slowly gaining momentum and project staff feel that this RET has great potential.

An ATS staff member places a pot in a retained heat cooker during a recipe development test.

Since the retained heat cooker is relatively simple to construct and use, it lends itself to a different sort of dissemination strategy than the stone paola or metal stove. Courses in making and using retained heat cookers will continue to be offered, but in addition, large numbers of people can be reached through radio programs and written fact sheets. The retained heat cooker will be a major component in the media campaign planned for the project's third year.

C. The RET Metal Stove

During the project's second year, the RET metal stove was developed in close cooperation with Basotho women and extensively tested. Two features distinguish it from other commercially available metal stoves. First, it is expressly designed for

multi-fuel use--it easily burns dung, coal, shrubs and/or agricultural residues with marked fuel savings. Dung is the fuel most commonly used in Lesotho and closely resembles peat in its burning characteristics--a very smoky fire with high ash content. The RET metal stove introduces adequate "secondary air" to reduce the amount of smoke produced, thus increasing fuel efficiency. The stove also has a generous ash collection drawer to prevent choking of the fire. Second, the interior baffle design and removable lids permit the stove to accommodate the traditional, three-legged, cast-iron pots with round bottoms. Newer, flat-bottomed pans can be used as well by replacing the lids in the stove's top.

An ATS staff member examines a metal stove in the Malefiloane testing shed--some improvements were made in this design, which was first developed at Thaba Tseka, before additional testing and modifications led to the development of the RET metal stove.

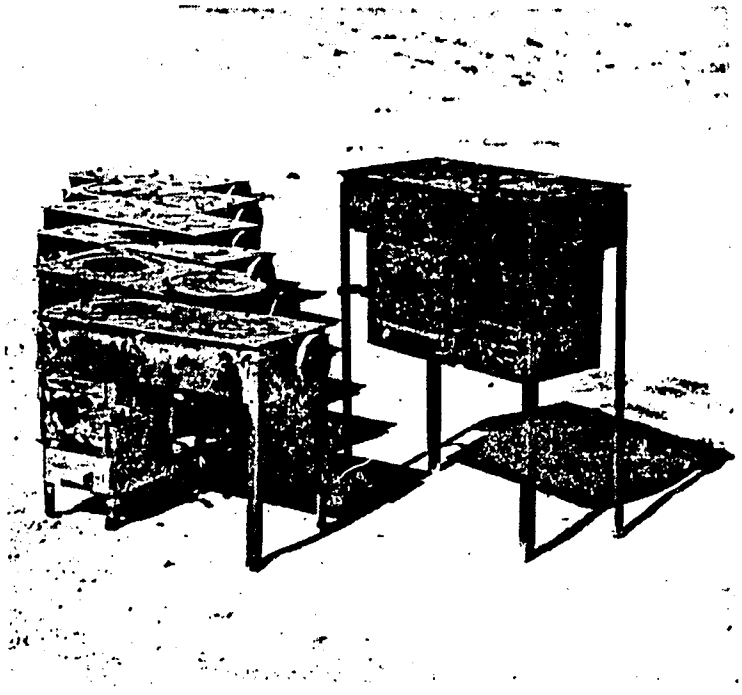
A staff member takes measurements prior to conducting a durability test on this RET metal stove--numerous tests are performed to determine the adequacy of any design.

The RET metal stove can also provide the radiant space heating needed in Lesotho's cold mountain climate. The stove is undergoing tests to quantitatively evaluate user acceptance and fuel efficiency, but so far, it has enjoyed an enthusiastic response in the mountains. The results of these technical and social evaluations will be compiled at the end of the 1983 winter.

As part of the RET project's commitment to increasing local industry, this device was intended for manufacture in Lesotho from the very start. Quality control procedures were established to help assure that producers adhere to desired standards. In addition, patent proceedings were initiated through the ministry with the hope that small licensing royalties will provide a cash return to the GOL.

The MINRUDEV's Deputy Permanent Secretary Selae, Mr. Kanetsi and the Honorable Minister of Finance Ralekhetla examine an RET metal stove production jig held by Mr. Stryker during an open house tour of the Khubetsoana workshop.

Several potential producers were approached about handling an initial production run, and training by ATS/RET staff members was offered to ensure that only quality units would be made. One manufacturer took advantage of this opportunity for training and increased production capability. Thus, a small number of stoves were produced in anticipation of a market test to be conducted during the winter of 1983. The results of the market test will be evaluated in conjunction with the technical and social data being collected, so that final production prototypes can be built during the project's third year. Then, local producers will again be sought and trained, and the stove will be marketed more widely before the coming winter.

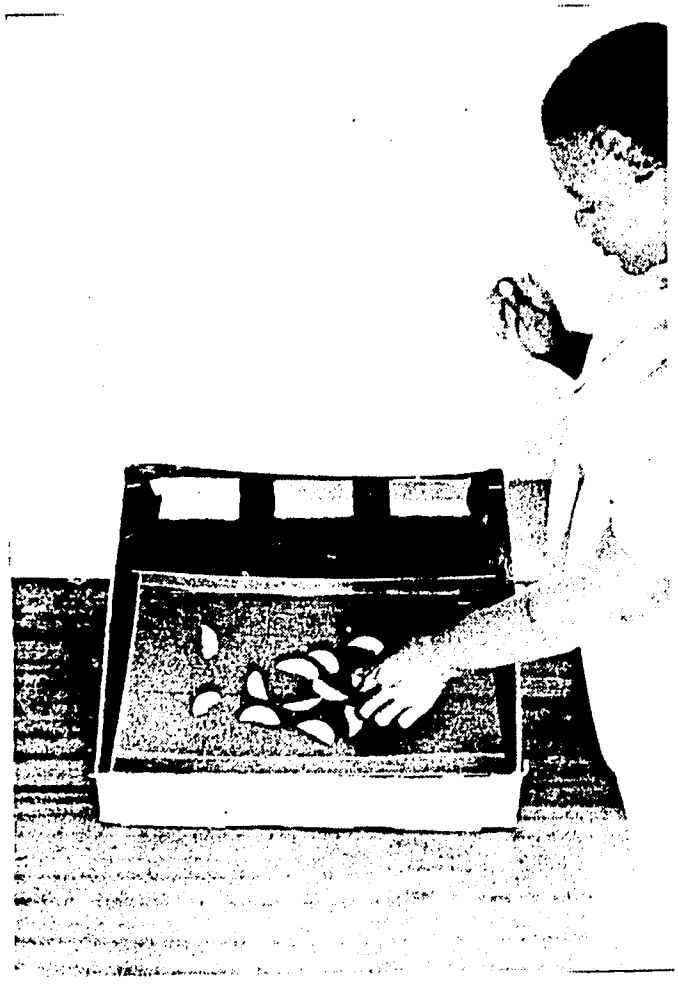


One of the first batches of RET metal stoves produced by a local manufacturer, alongside a taller stove that the Khubetsoana workshop made as a prototype--it includes an oven and is still being tested.

D. Food Dryers

Social surveys and needs assessments indicated that drying is a recognized procedure for preserving and maintaining adequate stocks of perishable foods in rural Lesotho. Typically, the food (e.g., sliced peaches or chopped cabbage greens) is air- or sun-dried by placing it on metal roofing sheets, or cloth or plastic sacks spread on the ground. Meat is often dried by simply slicing and then hanging it in the sun and wind for a few days. Villagers realize that these techniques often allow birds, dust and flies to degrade the quality of the final product, in addition to the fact that someone must be present throughout the process to bring the food inside if it rains.

The ATS/RET staff has come up with several devices that solve these problems with the traditional method of drying food. They range from inexpensive, homemade, cardboard-box dryers to locally manufactured, sheet-metal and fiberglass units. The project decided to concentrate its efforts on developing food dryer kits, which include the materials required to construct the plastic covers and screen trays for a cement block or stone-walled dryer that can easily be constructed by the user.



An ATS staff member tests peach slices in a cardboard-box food dryer, which is made of readily available materials requiring no cash outlay--thus, users can learn about improved food drying techniques before investing in a more durable dryer.

An ATS staff member holds a four-tray, portable food dryer, constructed from discarded wire and vegetable bags.

The project's dissemination strategy for food dryers is similar to that for the stone paola--some parts for a dryer must be purchased from a local kit-maker, but actual construction takes place at the user's home. Trainer/builders will be essential in this dissemination effort, and multiplier groups will be used to increase public awareness of improved food drying methods and generate training opportunities. Concurrent media and training programs are scheduled for the summer of 1983/1984, when surplus fruits and vegetables will be available.

A visitor examines vegetables drying in metal and wooden, cabinet-type, food dryers.

E. Grow-Holes

Frost is possible any night of the year in Lesotho. This fact, in combination with the arid climate (especially as in this year of severe drought), dessicating winds and severe hail storms, cause high loss rates among young seedlings. It is not uncommon for a village farmer to plant the same field two or three times and still experience severe crop losses. Because seedlings are so highly vulnerable in this harsh environment, any device that can aid germination, early growth and starting reserve stock for replanting is a welcome technology.

A grow-hole (also known as a cold frame) consists of a low stone wall that is bermed or built into a hillside and surrounds a seedbed which is protected by a removable translucent cover. When properly used, a grow-hole yields high germination rates and rapid growth during the critical early stages of seedling life. Cabbages, carrots, beets, lettuce, chard, tomatoes, green peppers and similar plants have flourished in the project's grow-holes. In addition to seedling production, grow-holes can also be used to produce winter greens, even in high mountain areas, thus helping improve villagers' nutrition throughout the year.

Visiting women inspect vegetables in a grow-hole--use of this technology can supplement the family garden and even produce a small cash crop of out-of-season vegetables or early seedlings.

An ATS staff member teaches a villager how to build a grow-hole.

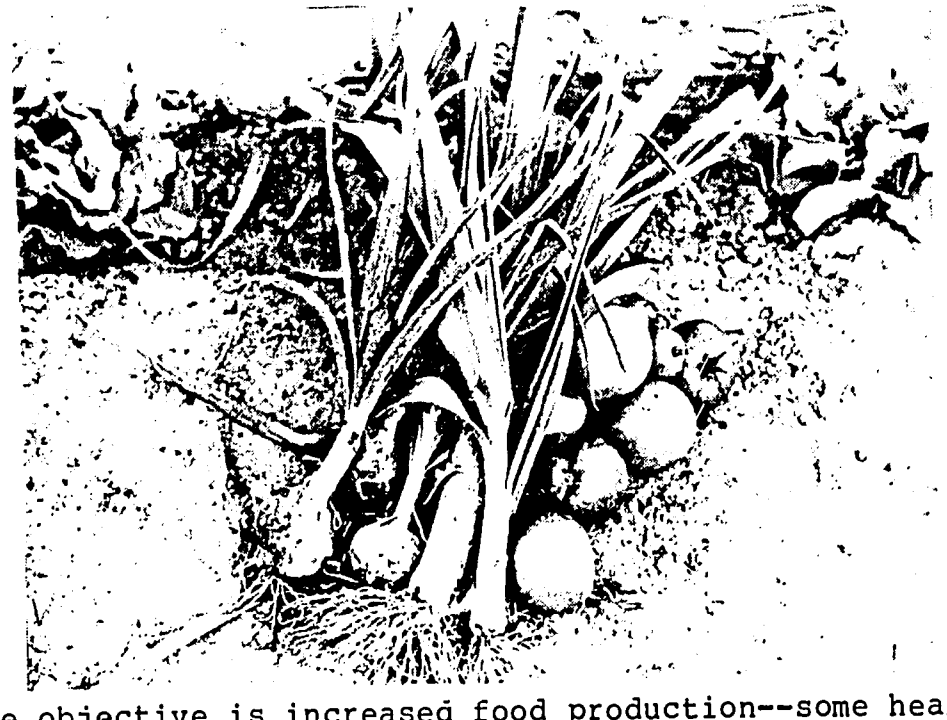
A small number of grow-holes were constructed in the Mokhotlong District before the 1982 winter. The results were encouraging, but staff members felt that additional demonstrations were needed to show people the benefits of using this technology. The primary vehicle for such demonstrations was the Food-for-Work program conducted in the lowlands. Units were built at several schools as part of a training program, which included the stone paola, with the dual purpose of training local builders and helping area schools work toward food and energy self-sufficiency. In addition, a grow-hole user's guide was drafted that addresses Lesotho's particular climatic and horticultural conditions.

Three Food-for-Work training instructors discuss a two-lidded grow-hole cover, which is being extensively tested for durability and thermal performance.

During its third year, the RET project plans to assist the schools in using their grow-holes to produce seedlings for their own gardens and sale to surrounding communities. Experimental plots have been started at Khubetsoana and Malefiloane which will be used to test and demonstrate the advantages and disadvantages of different types of grow-holes and cultivation practices. Both winter crop and spring seedling production will be investigated. The training and extension program for grow-holes should begin in time to produce winter crops during 1984.

Training in carpentry and the accurate fitting of a fiberglass grow-hole cover adds to a Basotho craftsman's skills.

Seedlings are watered by an ATS staff member--soil temperatures and moisture are monitored, while germination and growth rates are carefully recorded.



The objective is increased food production--some healthy vegetables harvested from a project-monitored grow-hole.

F. Energy-Efficient Buildings

Energy-efficient building designs and practices have obvious potential for Lesotho. Many of the designs currently in use include little or no insulation, and buildings are rarely sited to take advantage of solar gain. In addition, poorly fitted windows and doors and, in some cases, ventilation blocks in walls allow significant air infiltration. Often, these architectural ideas were brought into Lesotho by builders with experience in hot climates. However, Lesotho has a temperate climate with winter temperatures around or below freezing, and hence, its buildings should incorporate architectural features from cool to cold climates, as well as providing protection from overheating under clear summer skies.

After the seminars held for architects and builders during the first year, the RET project decided to develop energy-efficient house plans. Mr. Norris, the ARD consultant who prepared these plans, worked closely with staff members and the local building community to develop designs that utilize proven energy-saving techniques and address Basotho housing priorities. Outputs of his consultancy included information on improving the traditional rondavel's energy efficiency as well as modern house designs for three different income levels. Depending on the level of investment and user sensitivity, a thermal performance analysis program predicted energy savings of up to 90 percent for these designs. Although none of the three houses has actually been constructed, many of their energy-efficient features are being incorporated in other designs by local architects. The RET project has urged AID and/or the government of Lesotho to construct a demonstration solar house and/or project office building, but this has not yet been approved.

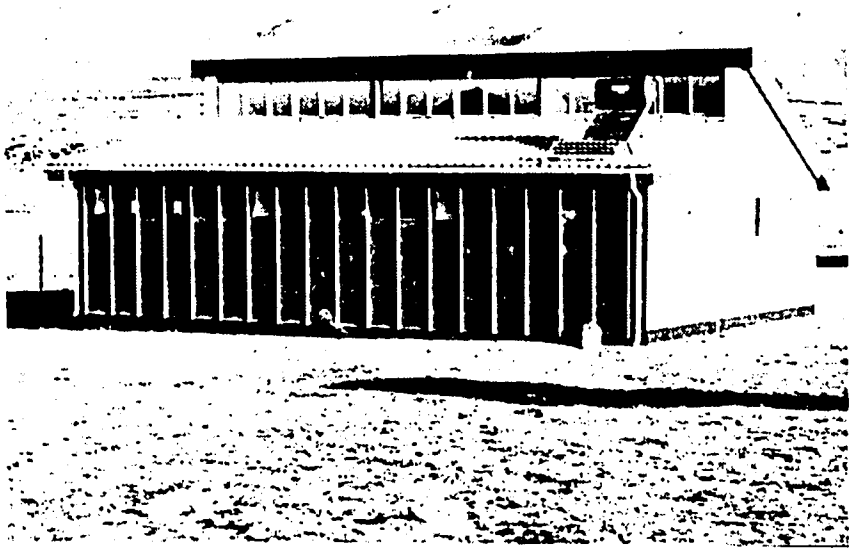
A traditional rondavel has an insulating thatch roof and an entryway that is protected from the wind.

A solar rondavel in Mohlakeng has glass on the northeast, north and northwest sides as well as a protected entryway on the left.

While demonstrations are generally the most effective means for disseminating this kind of information, this particular case posed certain financial constraints. Still, the RET project has built several solar and/or energy-conserving buildings for its own use. In addition, staff members have provided advice on the design of about 20 homes, clinics and hospitals, most of which have already been built or are currently under construction.

In the third year, the project will concentrate on monitoring the thermal performance of many of these buildings. Additional work will be done to gather baseline data so that these results can be evaluated in terms of costs and energy savings. With this information, the RET staff can develop educational materials and undertake more active dissemination of the ideas behind energy conservation and utilizing solar energy in building.

A staff member installs fiberglass insulation in the ceiling of the watchman's house at Khubetsoana--the RET project is trying to encourage greater use of this energy-conserving technique as homeowners switch from thatch to modern roofing materials.



The project assisted in the design of this passive solar clinic at Hilltop in the Qacha's Nek District--clerestory windows and a trombe wall provide heat, while the solar water heater and photovoltaic panel make the clinic virtually independent of imported fuel supplies.

G. Improved Metal Paolas

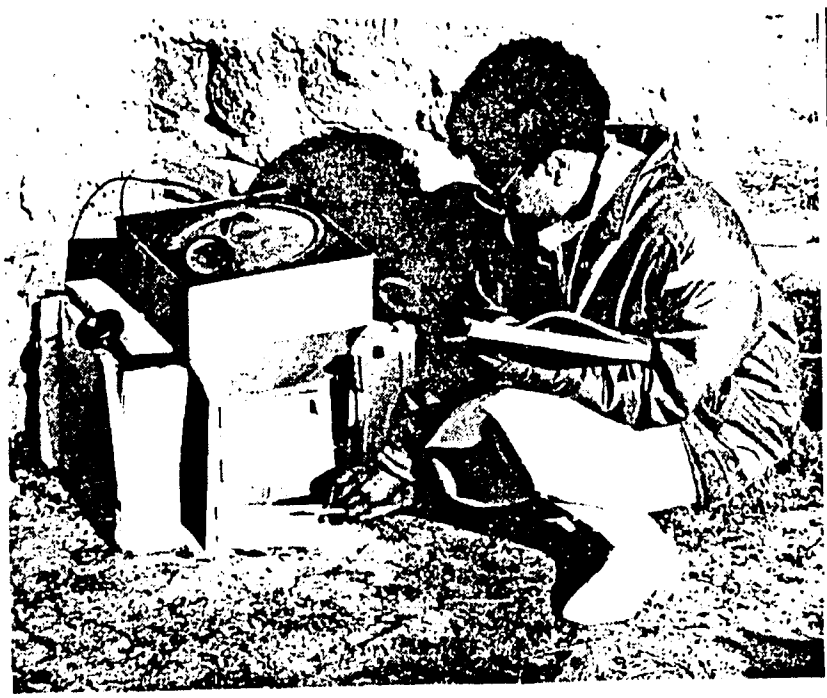
The metal paola is one of the most common cooking devices in Lesotho. A traditional paola is made by punching many holes in the sides of an old bucket or paraffin tin. The paola's chief advantage is its portability--during cold or inclement weather, a fire can be started outside and then brought indoors once the initial smoke has dissipated for cooking or heating. The cooking pot simply rests on top of the paola.

Observations and survey work by project staff members suggested that the metal paola's basic design could be improved. Thus, an extensive testing program was initiated to determine what changes would increase fuel efficiency. Two primary concerns were enclosing the fire so that the heat could be controlled and focused on the pot, and protecting the pot with a windbreak to prevent disruption of this heat transfer. The new paolas designed by the RET project include a protected resting place for the cooking pot, a considerably smaller firebox, and a grate which was introduced to improve combustion, an important consideration when burning dung and coal at Lesotho's high altitudes.

Some of the many different improved metal paolas tested during the project's second year.

Initially, the testing program examined four variations on three traditional types of paolas and found that the best were, in fact, the most common--the ones made from a paraffin tin or bucket. Then, three new shapes were tested, using the same simulated cooking task. The results showed that a paola with a small cylindrical base in combination with a grate and wind shield was almost 50 percent more efficient than the best traditional paola. Radiant heating tests were also conducted, and the traditional and improved paolas produced identical results.

Looking into a pot brought to a "rolling boil" in a metal paola--note how the pot sits down inside the paola, and the narrow space between the pot and the paola's walls.



A staff member conducts a test of this paola's radiant heating capabilities.

While one might be tempted to conclude that the laboratory tests had revealed the "best" paola design, the project discussed the construction of the various models with the skilled, local metalworker who built the test models. He indicated that the units with a cylindrical base were difficult to make because of the conical collar which supports the pot. He preferred the square-based model, which was a close second in the laboratory performance tests. Thus, the final design for an improved metal paola will take into account both performance and production criteria.

During the project's third year, the design prototype for an improved metal paola will be finalized. Then, the design will

undergo field and user testing, and more sheet-metalworkers will be trained to make the device. Finally, the RET project will be able to determine if the improved metal paola has a place among the various cooking devices used in Basotho homes.

H. Earthen Stoves

As one of its first activities, the RET project examined the potential of earthen stoves, known as "lorena" stoves in central America. Other projects had attempted to disseminate this technology in Lesotho with only limited success, but an evaluation of the fuel-saving potential of different types of stoves suggested that the project should include earthen stoves in its more extensive development efforts.

The primary advantage of an earthen stove is its low cost, as it can be built from locally available stones, sand and clay. In addition, if a chimney is used, it vents the acrid smoke of a dung fire out of the house. Finally, the stove's large thermal mass provides space heating by retaining heat for many hours after the fire has gone out and prevents injuries that can occur when children touch a hot metal stove or fall into an open fire.

The ATS/RET staff were assisted in the development of earthen stoves by two ARD consultants, Ms. Thomas and Mr. Burket. The dimensions and configuration of the firebox, smoke baffles and pot holes were studied intenstively to optimize performance with a typical mix of indigenous fuels. In conjunction with work on the RET metal stove, an insulated chimney system was developed that permits the chimney to be installed directly through a metal or thatch roof. Following this period of technical development, several earthen stoves were built in homes in the mountains to assess fuel savings and user acceptability.

A staff member tests an earthen stove in the Malefiloane testing shed to see whether the metal plate inserted at the left end will increase the stove's radiant heating capability.

Informal testing of a lorena-type earthen stove in the Khubetsoana cooking test shed for durability, performance and acceptability.

Field trials will be completed after the 1983 winter. Of particular concern are durability and maintenance problems, and whether users feel earthen stoves are capable of heating their homes during the cold mountain winters. If the results prove favorable, training courses will be offered so that many more villagers will be able to enjoy the benefits of these relatively inexpensive fuel-saving devices during the winter of 1984.

A nutrition extension agent from the Ministry of Agriculture learns how to make and use an earthen stove during a training course at Khubetsoana.

I. Water Heaters

Families throughout Lesotho use hot water daily, most commonly in the early morning, although the village energy survey found that almost half the hot water is used at other times of the day. This led project staff members to conclude that both conservation and solar heating techniques can play a role in meeting this need.

The traditional method for heating water involves using a tin filled with water (often a discarded, 3.5-liter, cooking oil tin) to capture "waste" heat from a fire. The tin may be placed next to the fire while other dishes are cooked or in the dying embers after the cooking is done. Occasionally, a fire is built solely for the purpose of heating water in a pot or kettle, particularly in the early morning.

The metal and stone paolas developed by the RET project heat water more quickly and efficiently than the traditional method, although a water-filled tin can also be used to capture residual

heat from a dying fire with these devices. The RET metal stove has a simple metal bracket which holds a tin against the firebox so that water can be heated while cooking. Some of the earthen stove designs have built-in water heaters; with others, water must heated in a pot. User tests will help determine the utility of the built-in heater.

As part of its overall program to reduce fuel consumption, the project is encouraging the widespread use of solar water heaters. An advisory service is available for government architects and other institutions to help them select the solar water heating system that is best suited to their particular needs. Homeowners can also request information on commercially available units. In addition, the project has tested designs for several simple, low-cost, solar water heaters. Most are made of materials that can easily be found or purchased. These devices are designed to heat the amount of water typically used by a rural household during an almost perfect solar day, which is most often the case in Lesotho.

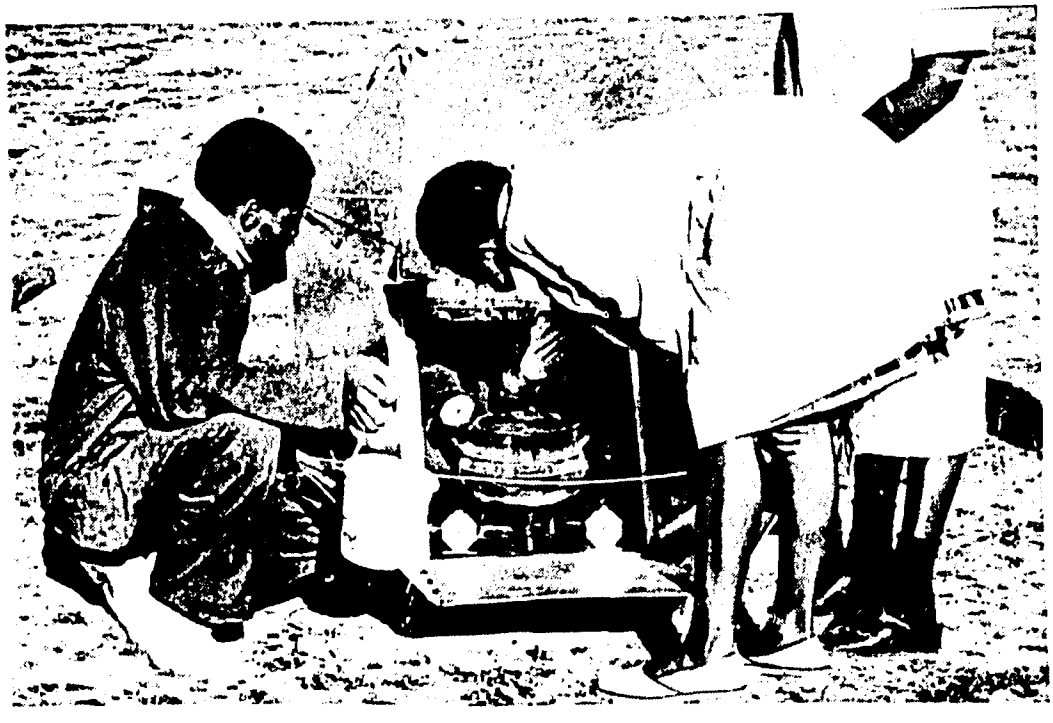
A demonstration of several types of solar water heaters during an open house at Khubetsoana for visitors from the MINRUDEV.

This close-up of a glass-covered solar water heater shows the cooking oil tins filled with water--these are painted black and rest on dry grass, which serves as insulation.

J. Solar Ovens

The last technology being investigated by the RET project is the solar oven. Technically, solar ovens would seem to make sense in Lesotho since fuel is relatively scarce and expensive, and there are over 300 clear, sunny days each year. After evaluating a number of solar cooking techniques, two ovens were chosen for testing--one developed by the Rural Technology Unit (RTU) in Thaba Tseka and the second by a similar organization in Lucknow, India. Both units can be used to cook a variety of foods, heat water, and preserve fruits and vegetables in bottles.

During the second year, the project put both units through performance tests, and the Lucknow oven produced consistently better results than the RTU unit. In addition, people at demonstrations preferred the Lucknow oven's appearance and ease of operation. Given these initial findings, the project plans to redesign the Lucknow unit to accommodate local cooking pots. Then, performance tests will again be conducted and public opinion sought. If those results prove favorable, more ovens will be built and distributed for user testing.



Staff members test one type of solar cooker being evaluated by the RET project--this unit was awkward to operate and did not perform as well as a model from India. However, the Indian device must be redesigned to accommodate the cooking utensils commonly used in Lesotho.

Although this technology is low on the RET project's priority list, solar ovens seem to fascinate many Basotho. Because of this public interest and their energy-saving potential, the project will continue its research on solar ovens, despite the potential difficulties of introducing such a radically new cooking technology.

VI. FUTURE DIRECTIONS

During the third year of the project, increasing emphasis will be placed on training, production and dissemination. Training for producers of technologies that can be built in the field or a workshop will be pursued. In addition, dissemination will continue in the form of village workshops, courses, and publications for special audiences, with more effort put into distributing information about the project, first in the Mokhotlong District and then throughout the rest of the country.

Also during the project's third year, administrative control will be transferred to the ATS staff, who have been with the RET project since its inception. This transfer may subtly change the program's focus in that the ATS' mandate is broader than that of the RET project, which is confined to energy-related matters. The ATS may explore a wider range of simple devices for production and sale, and can directly propose solutions to address not only the energy needs, but many of the other pressing problems faced by Lesotho's rural poor.

Appendix A

PCI 72-6

LOGICAL FRAMEWORK FOR SUMMARIZING PROJECT DESIGN

Est. Project Completion Date February, 1984

Date of this Summary May, 1981

Project Title: Lesotho Renewable Energy Technology Project

	NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
DEVELOPMENT HYPOTHESES — If Purpose, Then Goal	**Program Goal:** The broader objective to which this project contributes: To meet growing energy demand and to conserve fuels, especially for rural and lower income groups, and improve the quality of their lives through increased availability and efficiency of energy.	**Measures of Goal Achievement:** For the target populations: 1) decreased per capita use of biomass fuels, 2) increased per capita use of other renewable energy sources, and 3) decreased growth of imported energy.	Surveys. Government statistics.	**Concerning long term value of program/project:** 1. Traditional and conventional energy sources will become increasingly scarce and costly. 2. People are actively interested in increasing their standard of living. 3. Money saved in the process of adopting renewable energy sources and conservation strategies will not be used to purchase more imported energy supplies.
DEVELOPMENT HYPOTHESES — If Outputs, Then Purpose	**Project Purpose:** On a pilot basis, to develop, demonstrate, and disseminate feasible renewable energy technologies and strategies, and conservation technologies and strategies, and to develop an institutional basis for implementing the above.	**Conditions that will indicate purpose has been achieved: End of project status.** 1. A set of proven renewable energy and conservation technologies and strategies. 2. Operating MORD renewable technology unit. 3. Operating cadre of VETs.	Project evaluation process. External evaluation. Project records: surveys, orders for RETs, test results of RETs. Demonstration of RETs.	**Affecting purpose-to-goal link:** 1. Cooperation of GOL. 2. Target population acceptance of relevant innovations. 3. VETs will implement their skills in target areas.
MANAGEABLE INTEREST — If Inputs, Then Outputs	**Outputs:** 1. Research and development laboratory installed. 2. Regional training centers established. 3. Training materials produced. 4. Personnel trained. 5. Demonstration buildings designed and constructed. 6. RET & conservation strategies introduced. 7. Energy-related data collected & analyzed. 8. Experimental technologies evaluated. 9. Library & ref. materials established. 10. Village-level implementation process.	**Magnitude of Outputs necessary and sufficient to achieve purpose.** One (1) R. and D. laboratory. Two (2) or more regional training centers. Pamphlets, brochures, films, slides. Eight (8) MORD staff, at least 100 VETs. Three (3) or more buildings. At least four (4) different types. One (1) data base. Two (2) or more. Books, files, reports, pamphlets.	Project reports and files. External evaluation. Inspection.	**Affecting output-to-purpose link:** 1. Space and materials are made available on a timely basis. 2. Qualified candidates are available for training.
MANAGEABLE INTEREST — If Inputs, Then Outputs	**Inputs: Activities and Types of Resources** AID-technical assistance commodities local training construction support PEACE CORPS GOL-regional training center facilities; office & lab. space; warehouse land & space; housing for PCVs; furniture; staff; secretarial and translation service regional MORD staff support	**Level of Effort/Expenditure for each activity** 3 long-term (physical sci., sociologist, lab sup.) 2 long-term local hire; 20 person-mos. short-term. Vehicles, horses, mules, tack & stables, media equip. & supplies, lab & sci. equip., R&D equip., energy-saving construction material, shop equip. Travel, per diem, lodging, supplies, equipment. Design expertise and materials -- $64,000. Vehicle operations and maintenance -- $65,000. 4 volunteers for life of project; 4 motorcycles. At least two locations. Eight MORD staff. As needed from existing MORD staff.	Project records.	**Affecting input-to-output link:** Continuity of GOL, USAID, and U. S. Peace Corps support.

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Washington, D.C.

APPENDIX B

Extension Activities During 1982/1983

Maseru/Khubetsoana

Seminar on energy-efficient housing for architects--July 21, 1982; Maseru.
Earthen stove construction course for nutrition workers, Women in Development Project--August, 1982; Khubetsoana.
Demonstration at nutrition course--September, 10, 1982; Mafeteng.
Six-month pilot program with Food-for-Work project, training village workers to construct stone paolas and grow-holes at local schools; actual construction at 11 schools with subsequent follow-up visits--October, 1982-March, 1983; Maseru and Mazenod area villages.
World Food Day demonstration--October 16, 1982; Maseru.
Agricultural College home economics classes and practical sessions on cooking RETs--October 20, 22, November 10 and 12, 1982; Maseru.
Stone paola training for senior prisons staff--November 4-6, 1982; Maseru.
Seminar on micro hydro potential in Lesotho--November 25, 1982; Maseru.
Seminars on school feeding programs, sponsored by Food and Nutrition Coordinating Office; RET introduction of stone paolas, grow-holes--November 28-December 3, December 13-17, 1982 and January 3-7, 1983; Maseru, Quthing, Leribe and Thaba Tseka.
Lorena stove construction course for villagers--January 11-13, 1983; Cenez.
RET metal stove training for Thaba Khupa staff--January 11-14, 1983; Khubetsoana.
Open house for ministry staff--February 10, 1983; Khubetsoana.
Agricultural College home economics classes and practical work on food dryers--March 16 and 17, 1983; Khubetsoana.
Stone paola and retained heat cooker training, the first two of 10 courses organized by the Women's Bureau for leaders of rural women's groups throughout the country--May 16-17 and 30-31, 1983; Leribe and Matelas FTCs.
Demonstration at district agricultural show--May 28, 1983; Teyateyaneng.

Mokhotlong/Malefiloane

Pitso to introduce local communities to RET--July 10, 1982; Malefiloane.
Regular demonstrations and consultations on cooking technology development with women at Malefiloane preschool clinic every Tuesday as well as village visits--July-November, 1982.

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Stone paola training course for villagers--October 27-28, 1982; Malefiloane.
Stone paola and retained heat cooker demonstration for nutrition workers--November 24, 1982; Mokhotlong.
Stone paola training course for villagers--November 25-26, 1982; Moeling.
Grow-hole and food drying presentations to agricultural extension workers--November 28-29, 1982; Mokhotlong FTC.
Stone paola training course for villagers--January, 1983; Manganeng.
Stone paola training course for villagers--January 6 and 12, 1983; Bafali.
Stone paola training course for villagers--January 20-21, 1983; Thaba Khubelu.
Stone paola training course for nutrition workers--January 27-28, 1983; Salang.
Training courses for village health workers--February 2-4 and 23-25, 1983; Mokhotlong FTC and Malefiloane.
Follow-up visits to assist nutrition and village health workers in conducting course and give technical follow-up for stone paolas built--March-April, 1983; various villages.
Training course for village health workers--May 26-27, 1983; Libibing.

Butha-Buthe

Three demonstrations of solar ovens and retained heat cooker at local high schools--September-October, 1982; Butha-Buthe.
Food dryer demonstrations at Agricultural Development project and several schools--January 24-28, 1983; Hololo Valley.
Food dryer demonstrations and construction courses for schools and church groups--February-March, 1983; Qalo, St. Paul's High School and Serutle.

APPENDIX C

Project Personnel and Senior Officials for 1982/1983

Associates in Rural Development, Inc.

J. Stryker, Project Coordinator
J. Gay, Field Supervisor
G. Klein, Laboratory Supervisor
M. Maqanda, Administrative Assistant
M. Mathe, Stock and Supply Manager

Ministry of Cooperatives and Rural Development

Senior Officials

V. M. Makhele, Honorable Minister
S. T. 'Mota, Permanent Secretary
M. Salae, Deputy Permanent Secretary
M. Mosae, Projects Coordinator
M. Williams, Planning Officer
T. Mofokeng, Desk Officer for ATS/RET Project
M. Lesoana, Senior Engineer, Technical Division

Appropriate Technology Section

B. Kanetsi, Solar Engineer
M. Mahooana, Assistant Solar Engineer
N. Thelejane, Assistant Solar Engineer
E. Khabisi, Senior Technical Officer
M. Khoboko, Senior Technical Officer
Z. Lenono, Technical Assistant
K. Matete, Technical Assistant
M. Mots'oene, Secretary
M. Kao, Office Assistant
T. Letsaba, Watchman
P. Sekoati, Watchman
M. Moima, Workshop Helper

Volunteers

U. S. Peace Corps

B. Kligerman, Regional Center Coordinator
G. Krapp, Regional Center Coordinator*
D. McLean, Regional Center Coordinator
D. Palasits, Regional Center Coordinator
M. Savino, Regional Center Coordinator**

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*Transferred--February, 1983.
**Completed service--September, 1982.

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U. S. Peace Corps (continued)
D. Wolfe, Laboratory Coordinator*

Danish Volunteer Service
J. Hoffman, Regional Center Coordinator**

Other
J. Nicholson, Regional Center Coordinator

Support Staff

A. Adontsi, Technical Assistant
B. Koloti, Field Trainer
V. Matanda, Technical Assistant (photography)
P. Nthontho, Technical Assistant
K. Pitso, Field Trainer
A. Ramoholi, Technical Assistant
E. Sehai, Field Trainer
L. Sello, Field Trainer

U. S. AID Mission to Lesotho

E. Borady, Director
T. Friedkin, Assistant Director
D. Bernius, General Development Officer

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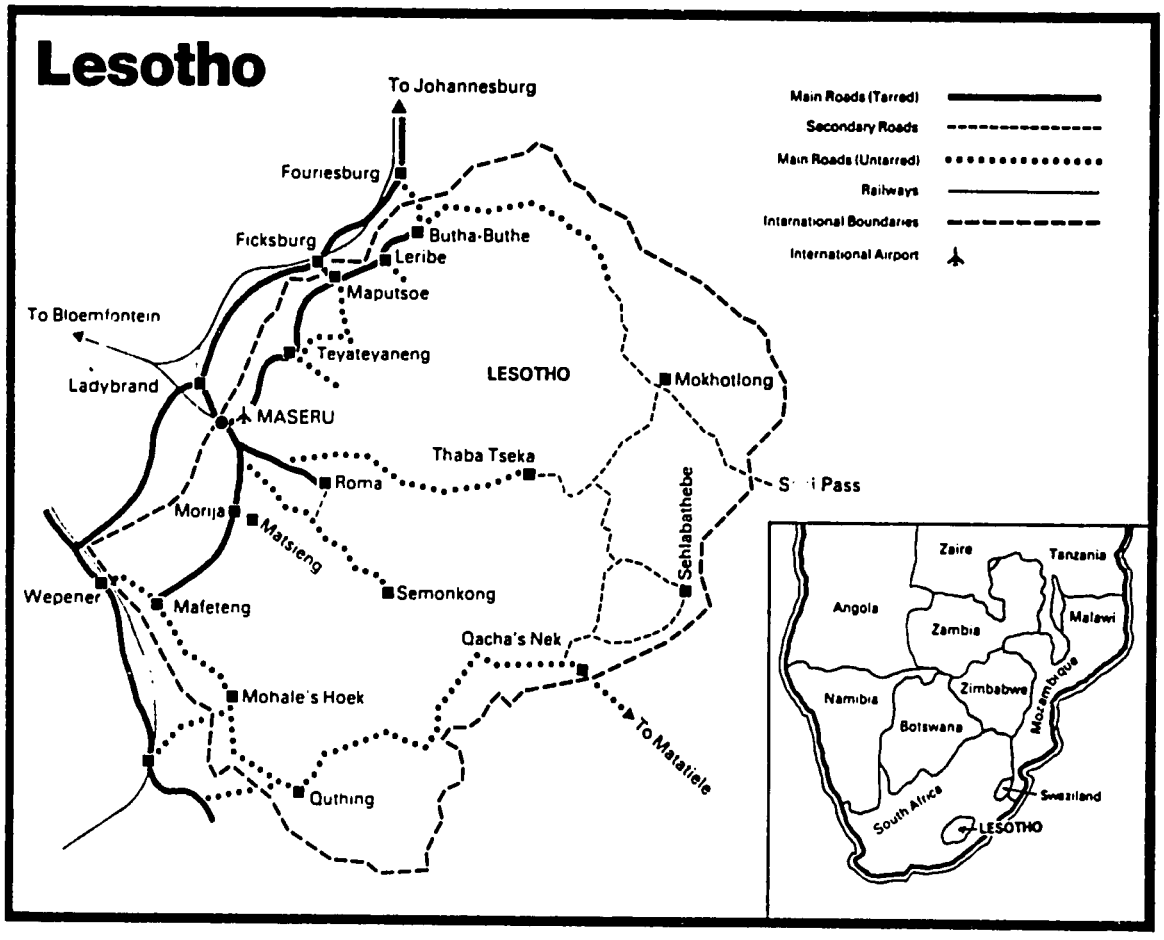
*Resigned--December, 1982.
**Completed service--October, 1982.

APPENDIX D

Map of Lesotho



APPENDIX E

Publications and Reports to Date

General and Administrative

Project Paper (632-0206), August, 1979
Monthly Status Reports
Quarterly Reports
First Evaluation, 1982
Annual Plan, January, 1983
Second Evaluation, 1983 (in progress)
Bimonthly Reports to Ministry
First Year Annual Report, May 31, 1982

Fieldwork and Social Aspects of the Project

Preliminary Cooking and Fuel Use Study
Village Energy Data List
Village Energy Survey
Village Energy Needs Assessment in Mokhotlong District of Lesotho
The Social Feasibility of Renewable Energy Technologies, 1982
Lesotho Village Energy Survey Report, November, 1982

Technology Selection, Testing and Adaptation

The Technology Selection and Development Process
Preliminary RET Selection/Needs Assessment
Technology Development Status Reports -- Cooking, Water Heating and Keeping People Warm; Increasing the Year-Round Availability of Food; Research and Development Technologies; Clinic Communication, Lighting, Refrigeration; October, 1982
Status Report on Stove Work, March, 1982
Passive Solar Heating in Lesotho Housing, July 21, 1982
Passive Solar Design in Lesotho: A Consultancy Report, July, 1982
Toward a Warmer Rondavel, July, 1982
Architect's Plans -- C4-EC, lower-income house; A3-EC, middle-income dwelling; Pitso-EC, higher-income home, July, 1982
The Economics of Improved Energy Technology in Lesotho -- Notes for a Seminar in Economic Evaluation, August, 1982
Stove Consultancy for Lesotho RET Project, January, 1983
Cook Stove Testing and Development at the Lesotho RET Project, May, 1983
Microhydroelectricity in Lesotho, an NRECA report

Dissemination

Food-for-Work Pilot Project Information and Reports
Disseminating Renewable Energy Devices in Lesotho: A Consultancy Report, March, 1983
Dissemination Plan for the Lesotho Renewable Energy Technology Project, March, 1983
Fact Sheets -- Stone Paola, Retained Heat Cooker