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42d/

AGENCY FOR INTERNATIONAL DEVELOPMENT

# PROJECT PAPER FACESHEET

1. TRANSACTION CODE: A (A = ADD, C = CHANGE, D = DELETE)

PP

2. DOCUMENT CODE: 3

3. COUNTRY/ENTITY: LESOTHO

4. DOCUMENT REVISION NUMBER:

5. PROJECT NUMBER (7 digits): 632-0206

6. BUREAU/OFFICE: A. SYMBOL: AFR; B. CODE: 06

7. PROJECT TITLE (Maximum 40 characters): Renewable Energy Technology

8. ESTIMATED FY OF PROJECT COMPLETION: FY 83

9. ESTIMATED DATE OF OBLIGATION: A. INITIAL FY 79; B. QUARTER 4; C. FINAL FY 79 (Enter 1, 2, 3, or 4)

10. ESTIMATED COSTS ($000 OR EQUIVALENT $1 – )

| A. FUNDING SOURCE | FIRST FY B. FX | FIRST FY C. L/C | FIRST FY D. TOTAL | LIFE OF PROJECT E. FX | LIFE OF PROJECT F. L/C | LIFE OF PROJECT G. TOTAL |
|---|---|---|---|---|---|---|
| AID APPROPRIATED TOTAL | 882 | 718 | 1600 | 882 | 718 | 1600 |
| (GRANT) | ( 882 ) | ( 718 ) | ( 1600 ) | ( 882 ) | ( 718 ) | ( 1600 ) |
| (LOAN) | ( ) | ( ) | ( ) | ( ) | ( ) | ( ) |
| OTHER U.S. 1. | | | | | | |
| OTHER U.S. 2. | | | | | | |
| HOST COUNTRY | | | | | 77 | 77 |
| OTHER DONOR(S) | | | | | 168 | 168 |
| TOTALS | 882 | 718 | 1600 | 882 | 963 | 1845 |

11. PROPOSED BUDGET APPROPRIATED FUNDS ($000)

| A. APPROPRIATION | B. PRIMARY PURPOSE CODE | PRIMARY TECH. CODE C. GRANT | PRIMARY TECH. CODE D. LOAN | E. 1ST FY 79 F. GRANT | E. 1ST FY 79 G. LOAN | H. 2ND FY ___ I. GRANT | H. 2ND FY ___ J. LOAN | K. 3RD FY ___ L. GRANT | K. 3RD FY ___ M. LOAN |
|---|---|---|---|---|---|---|---|---|---|
| (1) SDA | 752 | 870 | | 1600 | | | | | |
| (2) | | | | | | | | | |
| (3) | | | | | | | | | |
| (4) | | | | | | | | | |
| TOTALS | | | | 1600 | | | | | |

| A. APPROPRIATION | N. 4TH FY ___ O. GRANT | N. 4TH FY ___ P. LOAN | Q. 5TH FY ___ R. GRANT | Q. 5TH FY ___ S. LOAN | LIFE OF PROJECT T. GRANT | LIFE OF PROJECT U. LOAN |
|---|---|---|---|---|---|---|
| (1) | | | | | 1600 | |
| (2) | | | | | | |
| (3) | | | | | | |
| (4) | | | | | | |
| TOTALS | | | | | 1600 | |

12. IN-DEPTH EVALUATION SCHEDULED: MM 08 YY 83

13. DATA CHANGE INDICATOR. WERE CHANGES MADE IN THE PID FACESHEET DATA, BLOCKS 12, 13, 14, OR 15 OR IN PRP FACESHEET DATA, BLOCK 12? IF YES, ATTACH CHANGED PID FACESHEET.

1 (1 = NO, 2 = YES)

14. ORIGINATING OFFICE CLEARANCE

SIGNATURE: Frank W. Campbell

TITLE: Acting Mission Director

DATE SIGNED: MM 07 DD 13 YY 79

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RENEWABLE ENERGY TECHN(

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## SUMMARY AND RECOMMENDATIONS

### A. Recommendations

Authorization of a grant of $1,600,000 for a pilot project subject to the following waivers and approvals:

1. Waiver of the 25 percent cost sharing requirement contained in Section 110(a) of the Foreign Assistance Act of 1961, as amended.

2. A procurement waiver to permit the purchase of shelf items imported from other free sources in excess of the total allowed by AID Handbook 1, Supplement B, 18A, 4b.

### B. Project Summary and Description

The project proposes to meet expanding energy demand, primarily among lower income groups, in ways that minimize national requirements for scarce, expensive or non-renewable energy. This will be done by disseminating a set of renewable energy technologies in rural pilot areas, while simultaneously developing the institutional basis for more general distribution of systems found to be technically, economically and socially feasible.

More specifically, the project will, on the one hand, minimize demand for combustible fuels through village level conservation measures such as (a) fuel efficient wood and dung burning mud stoves, (b) pedal power grain grinding, (c) thatch insulation and weatherization, and (d) passive solar greenhouses. On the other hand, research into increasing technologically appropriate energy production will be undertaken through introduction of (a) a feedlot anaerobic digester system for production of methane gas and sludge fertilizer (b) a mini hydroelectric production scheme. Success with these measures will mean achievement of the project purpose of disseminating renewable energy technologies, establishing their feasibility, and providing the basis for their dissemination nationwide.

This purpose can be achieved through the use of existing GOL personnel and facilities. Consequently, the project will not represent significant additional strain on GOL absorptive capacities and, especially, it will not involve increased recurrent costs.

The technologies will be introduced through an "in place" village implementation process using traditional village meetings and GOL community development staff and procedures. The introduction process involves the villagers in sociological, technological, and economic decision-making concerning possible technologies. Given the complexity of this process and the need for feedback as it proceeds, particular attention will be given to the project's implementation and evaluation procedures.

Project outputs will center on (1) trained field and headquarters staff, (2) establishment of a village-centered implementation and evaluation process, (3) village technologies introduced and evaluated, (4) research and development technologies introduced and evaluated, (5) an operational research and development laboratory, and (6) construction of an energy efficient demonstration house. Inputs center on a three-person long term technical assistance team, commodities, in-country training, and construction of the house.

## C. Summary Findings

The analyses undertaken in final project design indicate the project is technically, economically, socially, and financially feasible.

Introduction of alternative technologies will represent the only way for many of the rural poor to meet their energy needs as supplies of coal, oil, and wood diminish and prices increase.

The environmental impact is benign. The negative determination given with the PID remains in order.

The GOL is firmly committed to the project and has already budgeted increased staff for full support.

## II. Project Background and Detailed Description

### A. Background

#### 1. General

The Kingdom of Lesotho is one of the world's least developed countries. The country is small, arid, mountainous, entirely surrounded by the Republic of South Africa, lacking in mineral resources and overpopulated. Lack of an initial obvious development potential, compounded by the fact that Lesotho has for a century been a migrant labor reserve for the Republic of South Africa mining industry, has lead to the situation that Lesotho is one of the world's most dependent states.

The 1976 census indicated that Lesotho had a de jure population of approximately 1.2 million persons, 94% of which live in the rural areas. The de facto population is considerably less than this as a result of oscillating migratory labor between Lesotho and the Republic of South Africa. While recent estimates indicate a fall in the numbers of migrants, in the mid 1970s it has been estimated that over 150,000 Basotho worked in the Republic. Approximately two-thirds of the population live in the lowlands, an undulating belt between 1,500 and 1,700 meters running from north to south on the western side of the country. The lowlands, foothills and Senqu River valley to the south occupy approximately one-third of the land area. The remaining two-thirds of the country, containing approximately one-third of the population, is all mountainous and stretches up to 3,500 meters in the most easterly regions. The country is divided into 10 districts. The capital is Maseru, a lowland town with a population of 60,000. Only 13% of the land area is arable, and the population density on the arable land is 300 people per sq. km. (3 per hectare), one of the highest in Africa.

Migrant employment remains the dominant fact of economic life in Lesotho and migrant labor remittances account for 70% of the rural household income. Despite increases in miners' wages in the mid 1970s, migrant remittances have not kept up with inflation, since 1976. The main domestic economic activity is agriculture though government efforts to increase total output have largely been unsuccessful. Lesotho Government capital expenditure was approximately R30 million in 1978-1979. Government has expressed concern that the recurrent costs implicit in these development programs are becoming excessive. This concern stems from projections that the revenue derived from the South African Customs Union, of which Lesotho is a member, is expected to decline in real terms after 1980-1981.

Lesotho's economy is extremely dependent upon external

sources. Approximately 70% of development capital is supplied by donors, though the rate of underspending of donor funds is substantial. In the course of the Second Year Plan over 70 donor agencies aided Lesotho, and in 1977, 560 expatriates worked in development programs in the country. The extent of Lesotho's dependence upon South Africa is indicated by the fact that GDP is of the order of 60% of the GNP. In 1977 the average rural income was put at $140 per capita, compared to the GNP per capita of $230. Furthermore migrant labor remittances finance the rapidly increasing level of imports. The trade deficit is currently around $180 million. Approximately 40% of food consumed in Lesotho comes from an external source (10% in food aid) and almost all manufactured goods and high quality energy supplies come from South Africa.

2. National Energy Needs

Lesotho has negligible fossil energy reserves. Narrow seams of bituminous coal extend into Lesotho but the cost of extraction is prohibitive. Small peat deposits exist but are of a low quality, have a low caloric value and their extraction would aggravate soil erosion. The results of investigations into possible oil deposits in Lesotho have so far been negative, although the government is continuing explorations. Consequently, Lesotho is almost totally reliant on external supplies of high quality energy sources. Fuel and lubricants form an increasingly large amount of Lesotho's import payment. In 1977 mineral fuels and lubricants totalled R17.6 million ($20.6 million) or 8.8% of total imports, whereas the cost of fuel in Lesotho is dependent upon South Africa. The greatest increase occurred in mid-June 1979 when the price of petroleum-based products was increased by 36% such that in late June a litre of petrol cost 53 cents (U.S. 62 cents or $2.43/US gallon). There remains great uncertainty over the availability and price of future supplies.

The chief imported fuels in 1977 were petrol, (R4.7 million) paraffin (R4.5 million) and diesel (R2.3 million). The amount spent in 1976 on paraffin is nine times that spent in 1972. Limited data suggests that this dramatic increase is largely due to the price increase rather than to an increase in use, although greater amounts of paraffin continue (until 1977) to be imported. Twenty-seven million litres of paraffin were imported in 1977. Chart I indicates the rate in price increase of paraffin in Lesotho.

The majority of electrical power in the country is derived from the South African grid. Electrical power only serves the capital and district centers. Dependence on South Africa for electrical power will continue into the foreseeable future. The GOL is considering the creation

of hydro-power sites, and intends to encourage the use of alternative sources of electricity -- diesel generators, solar energy systems and windmills -- in the Third Five Year Plan.

Lesotho's wood resources are minimal and the country imports timber and firewood. The indigenous lowland forests were virtually destroyed by the turn of the century, and all attempts at large scale reforestration since then have proved unsuccessful. A woodlot project was established in 1973 under the Ministry of Agriculture and annually plants approximately 450 ha (1,100 acres) of eucalyptus and wattle forest in areas adjacent to lowland villages to serve as a source of domestic fuel. Even at full production the 104 woodlots already established will cater to only a small percentage of their neighboring villages' needs. The prospects of extending the project to the mountains appear slim.

3. Village Energy Needs

a) The Definition of Needs. It is essential that village development projects -- particularly broadly-based self-help activities such as the RET project -- respond to "real" local needs, as ultimately defined by villagers themselves. In the RET project, needs of specific villages will, therefore, be determined through regular consultations among village representatives, GOL/MORD staff, and contract personnel.

b) Are Energy Needs a Priority? No comprehensive assessment of village development needs has yet been carried out in Lesotho. Nonetheless, available evidence suggests that energy-related needs are viewed by villagers as significant. For example, a study of energy consumption in Southern African villages found that a large majority of Basotho respondents considered collection of firewood to be a serious and increasing burden.

Although final judgements will depend on the formal survey process mentioned above, interviews with villagers and officials concerned with village development support the tentative conclusion that the following are priority energy-related needs:

(i) improved fuel saving facilities for cooking
(ii) improved fuel saving facilities for heating
(iii) a means of extending the vegetable growing season
(iv) improved grain grinding facilities

Other energy-related village needs which at this stage are more tentatively identified are the need for water heating, improved food drying facilities, water pumps for irrigation, and lighting. No simple improved lighting facility has yet been proposed and the problem will not be addressed by the project. On a national level, the need for small-scale, decentralized electrical power supplies (e.g., for radio facilities and rural clinics) and renewable heating fuels (e.g., for grain-drying at regional feedlots) were identified as falling within the scope of this project.

## B. Project Description

### 1. Project Goal and Purpose

The project proposes to meet expanding energy demand, primarily among lower income groups, in ways that minimize national requirements for scarce, expensive, or non-renewable energy. This will be done by disseminating a set of renewable energy technologies in rural pilot areas, while simultaneously developing the institutional basis for more general distribution of systems found to be technically, economically and socially feasible.

More specifically, the project will, on the one hand, minimize demand for combustible fuels through village level conservation measures such as (a) fuel efficient wood and dung burning mud stoves, (b) pedal power grain grinding (c) thatch insulation and weatherization, and (d) passive solar greenhouses. On the other hand, research into increasing technologically appropriate energy production will be undertaken through introduction of (a) a feedlot anerobic digester system for production of methane gas and sludge fertilizer; (b) a mini hydroelectric production scheme. Success with these measures will mean achievement of the project purpose of disseminating renewable energy technologies, establishing their feasibility, and providing the basis for their dissemination nationwide.

The purpose of this pilot project can be achieved through the use of existing GOL personnel and facilities. Consequently, the project will not represent significant additional strain on GOL absorptive capacities and, especially, it will not involve increased recurrent costs. A follow-on nationwide program would involve increased recurrent costs, but the pilot program will have provided a clear picture of costs and benefits.

### 2. Outputs

Outputs can be grouped into six basic categories:

(1) A renewable energy technology staff trained and in place both at headquarters and in the villages and more importantly an institutional connection between village and headquarters activities.

(2) A village renewable energy technology implementation process established which is based on village definition of needs.

(3) Introduction and evaluation of the village renewable energy technologies and the associated social and economic factors.

(4) Establishment and evaluation of the research and development renewable energy technologies.

(5) A research and development laboratory made operational in

existing facilities at headquarters and at rural RET training centers.

(6) Construction and evaluation of an energy efficient house for habitation by the Chief of Party, but also for project demonstration purposes.

It is estimated that 75% of the activity performed in achievement of these outputs will occur in the villages. Over 70% of the headquarters activity will be in direct operational support of the village level activity. Only the feedlot activity and headquarters operations in support of the feedlot activity do not directly support and benefit villagers. However, spinoff benefits of this experiment (such as employment, inexpensive fertilizer, and better veterinary services and marketing channels) may be realized by villagers. This activity is included for its significant long range potential.

3. Inputs

To achieve project outputs, the following inputs of technical assistance, commodities and vehicles, construction, in-country training, support costs, and GOL inputs will be required.

| AID INPUTS | COST |
|---|---|
| A. Technical Assistance | |
| 1. Program Coordinator (PHYSICAL SCIENTIST) 3 yrs | 250 |
| 2. Field Supervisor (SOCIAL SCIENTIST) - 3 yrs | 75 |
| 3. Laboratory Supervisor - 3 yrs | 75 |
| 4. Administrative Assistant - 3 yrs | 15 |
| 5. Stock and Supply Manager - 3 yrs | 15 |
| 6. Short Term Consultants (20 person months) | 120 |
| 7. External Evaluation | 4 |
| Sub-Total | 554 |

The Program Coordinator will be recruited from the Unites States by the contractor - probably a small business or minority firm. The field supervisor and laboratory supervisor will also be recruited by the contractor specifically by the program coordinator upon his arrival in country. The laboratory supervisor will most likely be a Peace Corps volunteer just ending his service as five qualified volunteers are known to be interested. The field supervisor may have to be recruited under a Code 935 waiver, although initial attempts will focus on an American or Code 941 person.

The short term consultants will be a combination of American and Code 941 persons. The remaining long term persons will be Basotho local hire. See Annex K for position descriptions.

B. Commodities

| | | |
|---|---|---|
| 1. | Vehicle Purchase (5) | 50 |
| 2. | Media Equipment and Supplies | 40 |
| 3. | Curriculum Materials | 46 |
| 4. | Laboratory and Scientific Equipment | 125 |
| 5. | Research and Development Project's Equipment | 155 |
| 6. | Energy Saving Devices Construction Materials | 140 |
| 7. | Shop Equipment | 27 |
| | | 583 |

Media and Curriculum -

Due to the heavy emphasis on training in the RET project and due to the documentation activities associated with project evaluation, extensive use of media equipment will be employed. This equipment will be used to prepare training curriculum materials, promotional films, slide shows and pamphlets and brochures. The basis for much of the future training conducted by MORD will be a semi-automated or packaged training program in Sesotho and English. The media equipment and curriculum budget will provide for this packaging.

Laboratory and Scientific -

The laboratory and scientific equipment are necessary in the RET project to establish technical credibility of the RET units and to establish a quantitative, scientific basis for evaluating their technical performance.

Research and Development Equipment -

The research and development RET technologies represent attempts to experimentally determine the feasibility of using relatively sophisticated technologies in rural areas to replace diesel fuels with an equivalent quality of energy. These technologies can only be evaluated under these conditions experimentally and are therefore included in the RET project.

Energy Saving Devices -

The materials purchased for energy saving devices will be used for training demonstrations and by VETs for building their demonstration RET

units in the villages. None of this material will be given to the villagers for construction of privately owned RET units.

Shop Equipment -

The shop equipment purchased by the project will be placed at each of the RET training centers and the R & D Laboratory. These facilities will be used to make prototype RET units and will be used by the VETs thereafter to repair installed units.

C. Training Costs

| | | |
|---|---|---|
| 1. | Local Training Expenses | 59 |
| 2. | Peace Corps Training | 2 |
| 3. | Tool Kits and Training Equipment | 40 |
| | Sub-Total | 101 |

Training

All training costs, with the exception of the Peace Corps training costs, will be expended in direct support of the VET trainees. Each VET will receive an appropriate tool set box, coverall, hat and related safety equipment during the training project. In addition, the project will provide transportation and/or lodging cost for women trainees who could not otherwise attend training sessions.

D. Construction

| | | |
|---|---|---|
| 1. | Design ($15) and Construction ($49) of Program Coordinator's House | 64 |

Construction

The energy conserving house built for the Project Coordinator will exemplify what urban Basotho and the GOL could do in the future with local skills and materials to conserve household energy use. This house will be a showpiece and will help urban Basotho understand the potential of RET. Most importantly, this house will save $600 to $800 per year in heating costs at present electric rates in Maseru.

E. Support Costs

| | | |
|---|---|---|
| 1. | Vehicle Operation and Maintenance | 65 |

| | |
|---|---|
| F. Inflation | 127 |
| G. Contingencies | 106 |
| TOTAL AID INPUTS | $1,600 |

GOL INPUTS

| | |
|---|---|
| A. Support Costs | |
| 1. GOL Staff (Eight Positions) | 66 |
| 2. Office Space/Laboratory Space | 3 |
| 3. Warehouse Space/Land for Program Coordinator's House, site preparation and utilities hock-up | 8 |
| | $77 |

OTHER INPUTS

| | |
|---|---|
| A. Technical Assistance | |
| 1. Four Peace Corps volunteers, each for 3 years to act as regional testing center coordinators | 168 |
| TOTAL OTHER INPUTS | $168 |
| TOTAL PROJECT INPUTS | $1,845 |

## 4. Organizational and Operational Approach

### a. General

Upon award of the prime contract to a U.S. firm the Program Coordinator (Chief of Party) will be assigned to Lesotho and will begin hiring the other project personnel in cooperation with MORD. The Program Coordinator will also begin procurement and curriculum development procedures. When the Field Supervisor (Social Scientist) is hired he/she will begin developing the field survey procedure and working with local community development officers and the MORD staff toward beginning the Village-Level RET Implementation Process (see Chart No. 5). The Field Supervisor will work predominantly in villages and the Program Coordinator will organize the overall project in Maseru and begin the MORD staff and Peace Corps training program. After the staff training is complete, (approximately 3 months) the MORD A.T. Unit staff, three Peace Corps volunteers and the Program Coordinator will set up the Regional RET Training Centers (ref. Farmers' Training Centers) located at Mokhotlong, Mohale's Hoek, and Quthing. The Laboratory Supervisor immediately after being hired will begin setting up the Research and Development (R & D) Laboratory in Maseru. The R & D Laboratory jointly with members of the A.T. Unit staff and one of the Peace Corps volunteers will begin building and testing the priority technology RET units at the laboratory and at each of the training centers. This four person team will continue throughout the project lifetime to focus on improving technical performance of the RET units and on getting this technical information into the training activities and into the villages.

### b. Organizational Strategy

The project proposes to establish a village-level process to identify and verify felt needs and technologies and to meet these needs through the existing structure of the Ministry of Rural Development (MORD). This village-level survey and evaluation process has the flexibility to foster village decisions and arrangements on which technologies would be most economic and acceptable and on which village residents should be trained in renewable energy technology. The primary focus of the RET project is to create and support this process at the village level and to develop the social, economic and technical skills through the MORD staff to carry on the process within the existing administrative and institutional structure. The largest single effort of the RET project is that of training and building confidence in the MORD staff and village selected trainees. The village residents will be selected by the villagers for training and will be called Village Energy Technicians (VET). The VETs will return to their villages after training is complete to establish demonstrations and begin offering their new skill to other villagers for a fee. Major emphasis will be placed on support of the VET corps by the project and MORD staff because the success of this project depends upon the village acceptance of this relationship. The RET project is structured to provide continual "on site" improvement or retraining when and where necessary. Technical performance of RET units and the quality are assured through a process documentation evaluation scheme and field testing of RET units by the project Research and Development Laboratory.

c. RET Implementation Process. The RET project implementation is based on a process which involves village people in an ongoing discussion concerning the nature of their needs within the context of energy usage and an educational process concerning renewable energy technology. This dialogue will proceed using the traditional Pitso, or village meeting, with members of the MORD and RET teams initiating the meeting jointly with the Regional Community Development Officer (MORD). Through this process, villages will make several decisions, e.g.: 1) would the village like to participate in the RET project, 2) if so, who in the village will become the Village Energy Technician (VET trainee), 3) what needs should be met, 4) what technologies should be employed to meet their needs and 5) what constitutes an economically and culturally acceptable RET design. The objective of this process is to produce a sensitive integration of village-level requests with technologies and system designs that can eventually be implemented and maintained by village people without continual outside help. This RET implementation process also strives to minimize frustration and disappointment by villagers when difficulties are experienced with the RET units.

Chart No. 5, entitled "Village-Level RET Implementation Process", outlines the ten step process and evaluation - feedback loop which will insure that the RET project meets its objectives. Steps 4 (Village Energy Technician Training), 9 (RET Unit Construction) and 10 (Evaluation) are critical. More than fifty percent of the total project effort is directed towards training of the VET corps identified in Step No. 4. The success of the project concept depends on how effective these trained village residents are when they return home after training. Furthermore, the MORD and project staff must provide timely support to the VET corps once they are practicing in the villages. Construction of household and community RET units and operational training for these units (Steps No. 8 and 9) must also be closely supported by the MORD and RET teams until such time as a VET is well-established, experienced and confident in his or her new skills. Step No. 10, Evaluation, is the vehicle used to maintain technical quality of village training and of the RET units. The Evaluation procedure will help understand and transfer the RET implementation process and necessary technical and management skills to the Ministry of Rural Development.

From the outset of the project, the Program Coordinator will share responsibility for project management with the MORD's AT section chief. After initial training, the MORD staff will gradually assume full VET training responsibility and, eventually, complete project management. The rate at which the transfer process from the RET Team to the MORD staff can proceed will be determined by utilizing the Evaluation and Feedback procedure. This procedure will also be used to support and upgrade MORD

staff and VET trainees capabilities by identifying strengths and weaknesses as the project progresses. Chart No. 6, entitled "RET Implementation Schedule" and Chart No. 7 entitled "RET Project Implementation Chronology" show the projected timeline for this transfer of responsibility and for monitoring the performance during the transition.

The selection of villages for initiation of this process will be done on the basis of socio-economic research initiated in the first few months of the project. Precise sites will be identified by the Field Supervisor in conjunction with local community development officers. It is envisaged that the project will initially work in one mountain district. The justification for selecting a mountain district is that the project work initially in Mokhotlong and that training take place at the Farmers' Training Center. During the life of the project it is envisaged that the project will work additionally in two rural districts, provisionally, Qacha's Nek and Mohale's Hoek. Villages will be selected in the proximity of the training facilities in each of these areas.

d. Management Components. The proposed RET project has five management components: 1) Administration, 2) Evaluation, 3) Training, 4) Research and Development and 5) Village Demonstrations. The activities within each of these functional administrative groupings are designed to initiate the desired village-level process through MORD and to provide continual support until such time as MORD is capable of carrying out these activities independently. The relationship of the RET project structure to MORD is shown in Chart No. 8, entitled "Proposed RET Project Organization".

(1) Administration. The Project will be administered jointly by a technical person experienced in renewable energy technology (the Project Coordinator) and by the MORD's AT Section Chief. These individuals will be responsible for all administrative and fiscal activities as well as coordinating the Project Advisory Committee and training activities. The Advisory Committee will be comprised of representatives of all collaborating ministries and projects as well as selected Community Development Officers and VETS. This body will provide an interministerial viewpoint and help avoid duplication of efforts. The Project Coordinator and AT Section Chief will report to the MORD Rural Development Coordinator. The Project Coordinator will also be a primary instructor in the training program.

(2) Evaluation. Evaluation is the most important management function in this Project. Evaluation will be coordinated by the Field Supervisor. This evaluation is internal to the project and couples the

continuing village survey procedure, the technical performance analysis and input from staff VET corps, and village participants into an on-going documentation process. These inputs are formally reviewed each week by the Process Evaluation Group for strengths, weaknesses, problems, successes, etc. The Process Evaluation Group will be comprised of members of all involved sectors of the project, including the MORD ATU, VET's, village residents, regional outreach workers and others as the group feels the need for their input. Standardized procedures and formats will be used by all persons involved in the project for collecting quantitative data and other qualitative information and for presenting this data to the Process Evaluation Group. Topics of concern may include attitudes towards trying RET units, real costs of systems, difficulties in construction and operation, impact on other villagers, technical performance, etc. These procedures and forms will be developed early in the project along with the village survey process.

Compiling and analyzing this information is truly an interdisciplinary process history of the project activities. A schematic representation of this process is shown in Chart No. 5, entitled, "Village-Level RET Implementation Process". The findings of the Process Evaluation Group will be fed back to appropriate activities of the project for use in: improving project management, upgrading training, repairing existing malfunctioning RET systems, improving RET designs, evaluating the capabilities of MORD and the VET corps and to graduate VET trainees. The LDTC Service Agency, presently performing surveys in Lesotho, will be used periodically as a facilitator to check the findings of this group.

The Process Evaluation Group will initially be responsible for identifying and verifying village needs, corresponding technologies and selecting villages and working out arrangements with each village for communal and individual RET units. This group will also be responsible for the formal project evaluation and the annual and final reports.

The Process Evaluation Group will make use of the existing computerized village survey data base developed by Basic Agricultural Services Project (BASP) within the Ministry of Agriculture. This tool is called Diagnostic Socio-Economic survey and can help formulate survey questions early in the project.

(3) Training. The RET training program will be administered by the Project Coordinator and AT Section Chief and will use expatriate short-term consultants,

local interministerial skills, MORD staff and the VET corps to accomplish this task. Training is the primary effort of this project. The training program is divided into four levels of activity: 1)orientation and training of RET project staff and Peace Corps volunteers in the Sesotho language, process documentation and construction of RET units, 2) training the MORD staff, specifically the Appropriate Technology Unit, 3) comprehensive process and technology training of the VET corps and 4) supporting the VET corps in the training of the village participants. The schedule and phasing of these training activities is shown in Chart No. 6, entitled "RET Project Implementation Schedule".

Each trainee will be issued an appropriate set of tools provided by the project and a tool box upon entry to the training program. Some trainees will require different tools than others, depending upon the type of technologies her/his village selects (e.g. communal greenhouses, mud stoves, hydroelectric generators, etc.). The check-out and tool assignment program will be managed by the Appropriate Technology Unit and the Project Supplies Manager and handled through the regional training centers.

In addition to the training activities there will be an ongoing curriculum and training materials development program in English and Sesotho. This activity will be conducted jointly in the Ministry of Education with the Lesotho Distance Teaching Center and will attempt to produce high quality training materials and "how-to-build-it" brochures for various RET systems which will be distributed during village training sessions. This activity will depend heavily on the media and documentation activities of the project which will be coordinated through the Process Evaluation Group. The photographs, motion picture film and data collected throughout this project evaluation will also be used to formulate training booklets, construction documents, a training film and promotional slide shows as well as village demonstration brochures.

These activities will be conducted by the members of the Project Staff, MORD Project Staff and Peace Corps but not the LDTC to do field work for the RET project, but will help with other curriculum tasks.

(4) Research and Development Laboratory. The Research and Development Laboratory (RDL) will be established in Maseru and supervised by a local-hire engineer. The RDL will: test prototype RET units and provide optimum designs; evaluate the quality of construction and technical performance of demonstration and village RET units; upgrade training programs based on findings; construct and operate the two R & D technologies

identified, i.e., anerobic digester and mini-hydroelectric system; act as a technical liaison base for other GOL activities in Maseru and transfer all technological development to the MORD Appropriate Technology Unit staff. The overall responsibility of the RDL is to assure technical competence throughout the project and to serve a monitoring and quality assurance function.

(5) Village Demonstration. The village demonstration activity is carried out by the VET trainee with the timely support of the appropriate MORD and RET staff. The VET trainees will build RET units on their own (or their parent's) house as a demonstration to the village. In order for a VET trainee to graduate from the RET training program and be certified he/she must successfuly build and operate a specific number of RET units within a one year period. As the appropriateness of these demonstration units are perceived by the village people, they will, in turn, request the VET trainee to help in the design, construction and operation of the unit. For this service, the VET will be paid a set fee (see Economic Analysis Section III. C.). From this point forward the VET will be selling his/her skill and the materials used for construction of the RET units to villagers who chose to purchase this technology.

It is important to note that all materials used for construction of the RET units, which will be owned individually or communally, must be purchased by the owner(s) through the VET or other local supply mechanisms. No materials will be provided without charge for RET units except the original demonstration units at the training centers and training units on the home of the VET. At present, the most appropriate materials supply mechanism has not been specified. Distribution, marketing and accountability could be established, however, at state stores, the training centers or other existing institutions. This will be worked out during the initial stages of project implementation.

e. Selection of Technologies

The renewable energy technologies have been selected based upon the preliminary need assessment, and economic analysis (see Economic Analysis Section III. C.) and upon the degree to which these technologies could be implemented by village people using local materials and skills. The assumptions leading to these conclusions must be verified and the technologies must be tested early in the RET project. The selected technologies are placed into three groups: priority technologies, candidate technologies and research and development technologies. This grouping of technologies can be seen in Chart No. 9, entitled "Matching

Basic Needs and Renewable Energy Technologies".

(a) Priority Technologies.were selected as economically viable technologies that correspond directly to "felt needs". These technologies include wood and dung burning mud stoves, pedal power grain grinding, thatch insulation and weatherization of rural housing, grow hole greenhouses and community passive solar greenhouses. The RET project will focus on implementing these technologies as a priority. A detailed discussion of the priority technologies is given in Section III. A.

(b) Candidate Technologies. This group of technologies corresponds to a more tentatively identified set of needs referred to as "abstract needs" (see Section II. A. 3. "Village Energy Needs"). In addition to the substantive uncertainty of these "abstract needs", the RETs identified to meet these needs are somewhat more technically sophisticated and expensive. The successful implementation of these technologies would probably result in communally owned and maintained systems. However, the exact process for implementation is difficult to identify at this stage of development. The technologies included in this group are: solar food dehydrators, passive solar space heating systems including mass walls and attached greenhouses, solar cell trickle battery charges, solar cell irrigation water pumping and passive solar water heating. If a suitable situation is identified by the village survey process, the technologies can be utilized by the project.

(c) Research and Development Technologies. This group of RETs was identified based on regional and national needs that would have a direct impact on the rural village dwellers. The two proposed RET systems include: installation of a demonstration anerobic digester at the Masianokeng village feedlot for methane gas production and installation of a mini-hydroelectric system at a rural health clinic in the remote Ha Lejone Mountain area. The purpose of these experimental projects is to demonstrate that there are RETs that can replace diesel-powered electricity generating systems.

f. Project Housed in Ministry of Rural Development. The nature of the RET requires the use of an "in-place" rural/community development structure. It is recommended that the Lesotho RET project be housed in the Ministry of Rural Development (MORD) for exactly this reason. The Ministry is concerned with rural problems, has technical construction facilities, attempts to work within a framework of experience, works under a self-help philosophy, and has already carried out research into alternative technologies.

The MORD was created in 1976 out of the former Department of Community and Rural Development. The Ministry contains a number of

specialized units which promote the construction of village water supplies, communal gardens, mountain access tracks, feeder roads, footbridges and soil conservation and can be used to deploy renewable energy technology. These diverse activities have in common a concern with community-based development, and each technical speciality draws on the services of a cadre of community development workers which ranges from a chief community development officer in Maseru, to newly established posts for Community Development Assistants who shall be resident in villages.

The MORD has also recently (since PID preparation) upgraded the research unit investigating alternative technologies and created an eight member staff Appropriate Technology Unit (ATU). All personnel in this unit will be available to work with the RET project. That eight positions have been created in this unit at a time when the GOL is finding it increasingly difficult to establish new permanent positions must be seen as proof positive of the Ministry's enthusiasm for the RET project. The Ministry is now actively recruiting to fill the positions.

The MORD has in the past had severe organizational problems. The recommendations of the UN ACC Task Force Mission on Rural Development in Lesotho and the creation of the Ministry from the previously existing Department of Community and Rural Development has given the Ministry new impetus. The Task Force Mission led to the UNDP Integrated Rural Development Institutional Support Program, which will upgrade the Ministry's district and central planning capabilities and the implementation of the Wilmot report's recommendations on strengthening community development activities. (In addition, three Area-based Integrated Rural Development Projects are in the process of being established. These are: The Thabana Morena Integrated Rural Development Program, the Siloe Rural Development Program, and the Mafotholeng Rural Development Project). The largest single institutional development project in the Ministry will be the USAID assisted Lesotho Rural Water Supply project which should substantially increase the capability of the Ministry's Technical Section.

g. Collaboration with Other GOL Ministries. The interdisciplinary nature and village-level focus of the RET project necessitate close cooperation with other ministries that have either specialized capabilities needed by the project or in-place institutions in rural RET project impact areas (see Chart No. 2 entitled "RET Project Demonstration Impact Area". This inter-ministerial cooperation (e.g., dormitories, classrooms, etc.) and allow the program staff to begin working immediately on village-level survey process and skill development. The use of other ministerial facilities and staff capabilities permits the majority of the project funds

and staff time to be directed towards training village people.

The collaborating ministries are 1) Ministry of Agriculture, (MOA) 2) Ministry of Education (MOE), 3) Ministry of Commerce and Industry (MCI), and 4) Ministry of Works (MOW). Through the Ministry of Agriculture, arrangements will be made to utilize the Farmer Training Centers in Mokhotlong, Qacha's Nek, and Mohale's Hoek to house the RET Regional Training Centers. The Permanent Secretary of MORD has committed himself to make all arrangements with the Ministry of Agriculture for use of these centers. A close working relationship will also be developed with the MOA Horticultural and Food and Nutrition Units to mutually support village food production and preservation. The Ministry of Education's Lesotho Distance Teaching Center Service Agency will be utilized to help prepare curriculum, training and media materials in Sesotho and English. The Bsotho Enterprises Development Corporation (BEDCO), located in the Ministry of Commerce and Industry, will be used to develop commercially viable RET units and to manufacture promising or proven RET units and parts or kits which will be sold to villagers. BEDCO will also publish articles on the findings of the RET project in their monthly Appropriate Technology Newsletter. Cooperation with the Ministry of Works will center around the RET Project Research and Development activities directed at replacing diesel-powered electrical generators at remote clinics and schools. Other ministries such as the new Ministry of Energy, Water and Mines may be interested in the RET project as it progresses, however, this relationship can only be determined as such organizations see the value of this critical technology.

h. Relationship with Other Donors

While the AID project will be the major thrust in renewable energy in Lesotho, there are other donors carrying on closely-related activities which are complementary. The PID described the Swiss-financed project which provided one solar engineer to the Ministry of Rural Development for the past year and a half. During PID preparation and subsequently, USAID/Lesotho held discussions with Swiss and GOL officials in an effort to interest them in developing a jointly financed project. However, by mutual agreement, the Swiss and GOL decided to terminate their project as of June 30, 1979. Their decision was based upon a judgment of where to place limited funds within an expanded priority list. While the Swiss-financed project did not result in a very widespread introduction of the technology in the rural areas, it did generate sufficient interest within the GOL, as evidenced by the Government requesting this expanded demonstration project from AID.

The Canadians are financing a rural development project in the Thaba Tseka District, a remote mountainous district in central Lesotho.

The project has a solar energy research activity planned; however, as yet, has not been able to solicit funds. There has been close coordination between the Canadian technical assistance group and the PP team. During project implementation there will be an exchange of information and the AID project administration will utilize Thaba Tseka as a testing site. In addition, the method of disseminating the technology to the rural areas, as developed by the AID-financed project, will be shared with the Canadians.

The Swedish Government, British High Commission and the Anglo/American Company are all working on woodlot projects. As elsewhere, there will be coordination between these activities and the AID-financed project. The success of the project improved mud stoves will greatly effect the requirement of woodlots.

## III. Project Analysis

### A. Technical Analysis

Selecting the RET designs which meet the identified needs in this project cannot be separated from village-level social and economic realities. Therefore the selection of the priority technologies are firstly tentative and secondly difficult to describe in purely scientific terms. The technologies selected will not be the solution in themselves; however, the interdisciplinary implementation process utilizing the proposed technologies could help solve village energy problems. It is not the technologies that are most important, but the process by which they are implemented.

1. Basis for Selecting Technologies. The technologies selected by the PP team have been discussed in Section II. B. 4. The Technical Analysis will discuss the Priority Technology Group only. However, a detailed explanation of systems design and expected efficiencies is covered in the appendix. The following criteria were used to identify the technologies and tentative designs proposed by the PP team. The RET team designs: 1) must use only renewable energy sources; 2) must meet a felt need; 3) must be well understood by the technological community (proven); 4) must improve thermodynamic efficiencies or time expended by at least a factor of two (2); 5) must be very low in cost; 6) must be easy to construct and maintain; 7) must use indigenous or locally available materials and skills; 8) must result in a positive net energy analysis within the unit lifetime; 9) must be environmentally benign or result in environmental enhancement; 10) must show the potential of being accepted such that a natural demand for the RET will occur; 11) must be presented and designed to permit innovation on behalf of the user; 12) must have the potential for marketing VET skills and RET units within the village.

The technologies employed in this project will supply new or improved thermal sources of energy for cooking, space heating and growing of food to village people. This is accomplished by utilization of what may be Lesotho's most used energy source at present, the sun, and by improved combustion of fire fuels. Wood and dung combustion efficiencies are improved by using mud stoves, and passive solar heating is used directly. The Basotho know well the daily benefits of direct solar radiation as evidenced by the northeast orientation of most rural rondavels for early morning warmth and by the national pastime of conducting daily business and social events outside in the sun. It is estimated that in Lesotho an average of 320 days each year in the highlands and 340 days each year in the foothills and lowlands contain at least 6 hours of sunlight. The daily cummulative value of solar radiation that falls on

a vertical wall during Lesotho's winter is approximately 1500 BTU/ft.$^2$ . Based on a finding by Best in 1978, the average Basotho family utilizes 90,000 BTU/day for cooking and heating averaged on a yearly basis. Given relative low efficiencies (approximately 20%) of glazed mud solar collectors on mud wall greenhouses, installation of 60 ft$^2$ of glazed mud wall solar collector on a rondavel would cut heating demands by 50%. Coupling direct passive solar space heating with a thatch insulated home which utilized a mud stove for cooking could reduce the total household fuel consumed by 75% This packaging or integrating of RET designs appears to have long term potential in helping overcome some of the limitations of the RET designs. For example, the mud stove in the previously described solar houses reduces the net heat gain to the house because they are more efficient and therefore use less fuel. However, the thatch insulation compensates for this reduced heat input by reducing the total house heat loss. The result is that the house is still warmer, uses less fuel and has less smoke.

2. Description of Technologies

(a) Wood and Dung Burning Mud Stoves. Presently, stoves are not used in Lesotho; however, interest and need is high among villagers. The stoves to be used in Lesotho must be designed to burn all available fuels in the mountain areas, e.g. brushwood, dung and aloes or small wood logs where they are available. The stoves must also be made entirely of mud, dung and stone with designs for indoor and outdoor systems that will hold two or four standard size pots or one very large pot for cooking outside. The primary fuel is dried dung which has a caloric (heat) value of 967 K cal/lb (3837 BTU/lb) and dried shrubs and aloes which have a caloric value of about 3 times that. Dung burns slowly and without a flame. Wood burns more rapidly and with a flame; that is, the rate of combustion is different for each. Mud stove designs must also accommodate these different fuels. The PP team has suggested three stove designs that meet these criteria and should improve cooking efficiency from the approximate 3% of an open fire to 8-12%. The designs are 1) the Domestic Technology Institute Plenum/Damper stove and 2) the modified chula stove developed by Rural Industries Innovation Center in Kanye, Botswana and 3) the portable pipe stove developed by Willi Suremann for MRD. These designs are shown in the appendix. The materials cost for the mud stove designs is zero and the construction skills are available in the village.

The mud stove program should look at individual fuel efficiencies, as it pertains to dry vegetative matter such as crop residue, weed, leaves, etc. At present these fuels are gathered and burned as very small pieces, one to two inches (2.5 to 5 cm) in length,

directly in open fires. These fuels burn rapidly and as much as 97 to 98% of the heat is lost to the wind in a rapid combustion process. A much more efficient use of fuel could be experienced if pellets or cakes are made by mixing, compacting, and drying cow dung, water and dry, chopped or ground vegetative matter.

Combustion time of the briquet of fuel could be tripled and fuel efficiency doubled. If such a process of fuel compaction could be implemented at village level, it would accomplish several objectives: (1) Weeds, grasses and certain other crop residue could be used to a degree, to replace dung as a fuel, therefore allowing most of the dung for restoring organic matter and plant nutrients to the badly depleted soils of Lesotho, (2) The smoke and ash residue in the village houses would be reduced even further, and (3) Coupled with mud stove efficiencies, the relative energy efficiency of cooking could be improved by 12 to 15% compared to an open fire. Some preliminary work on compressing cakes into rectangular and round shapes, using tin cans, string and nails together with other hand made devices from plastic pipe and square metal tubing, give positive indications that hand compaction can be done at the village level. This fuel compaction technology will link well with the AID sponsored Farming Systems Research Project 0065, particularly for the provision of some of the vegetative matter. This will be investigated by the Process Documentation Group and the RDL.

(b) Pedal Power Grain Grinding. The pedal power grain grinder was selected over hand methods of grinding because it can process a quantity of grain in one third to one fifth the time required by hand systems for roughly the same investment. Draft animal methods are too large and expensive and require a herdboy to work the oxen. The pedal power design shown in the appendix can grind about 50 lbs per hour or 30,000 lbs per year, costs about $80 and can be manaufactured by BEDCO and assembled in the village. This technology appears to be a feasible one to recommend for the project.

In addition to grain grinding, and as a necessary complement, the project will provide various designs for storing grains and flour or mealie (crushed maize) to the VET trainees. Some of these techniques will be integrated with solar food dehydrators and some will be purely mechanical. This storage technology is necessary because without adequate storage, there is less incentive to operate a grain grinder.

(c) Thatch Insulation and Weatherization. At present about 20% of lowland and 5% of mountain dwellings are rectangular and incorporate corrugated metal roofs. These metal roofs are a status symbol and very easy to install. The heat loss associated with this type of house design

with an uninsulated metal roof, coupled with the fact that the only fuel that can be burned in such a structure is paraffin, makes these houses thermally inefficient, expensive to heat and either too cold in the winter or too hot in the summer. The use of 2 inches of thatch insulation made by the village women and placed in the ceiling of the metal roofs, windows and cracks could cut the heat loss of this structure by 75%. This would reduce the fuel required for space heating and improving the comfort of the house.

A picture of the proposed thatch insulation is shown in the appendix. This insulating material uses short grass which women weave into a grass mats which are laminated with aluminium foil to achieve a thickness of one or two inches. One inch of this insulation material has an R factor of about 4, making it approximately equal to American fiberglass insulation. This technology is recommended because the materials and skills are presently available and potential for adoption is good.

(d) Passive Solar Greenhouses. The growhole greenhouses used for seedling production and winter gardening and the large communal passive solar greenhouse for off-season and winter food production are well known and proven technologies in the United States. Because the technologies were developed primarily by the American poor, in the mountainous regions of the southwestern U.S. (e.g. New Mexico and Colorado), the low-cost adobe (mud) designs are particularly suitable for the rural mountains of Lesotho. By using fiberglass instead of glass and a wire hail guard, no damage will be caused by Lesotho hail storms. These RET designs appear to have a good probability of succeeding as an extension of the MORD communal garden program. Designs and photographs of these Solar Greenhouse RET units are shown in the appendix and a detailed economic analysis is given in Section III. C.

3. "Hands-on" Technology.

The technologies proposed in this program are based on sound scientific models. The methods of training used for introducing these technologies to the rural Basotho will enable them to assimilate the technologies by directly involving village people in the construction of RET units. The "science process" is therefore assimilated experientially by the VET trainees and village participants, helping them to discover for themselves how the system functions. This community based technology development process involves Basotho participants from its beginning by defining their needs and conceptually developing RET unit designs through a workshop in the village. This method of turning technology design and development over to villagers allows the participants to thoroughly understand the technology and the design process within their cultural, economic and social framework and it therefore becomes "their" solution. This

process also provides a thorough understanding of how the system works because the participants build, install and operate the systems. They will therefore be able to carry out the service and repair responsibilities after technical assistance is no longer available. This is the "do it yourself" or "self-help" process upon which the project is based.

4. Technological Feasibility.

The priority technologies and specific designs recommended are deemed feasible by the PP team. However, to insure long term acceptability, design modification must be made by the villagers and program staff as the program progresses, and the successful modifications must be incorporated into the training process. To insure this occurs the RET Research and Development Laboratory will monitor and document these village innovations so they can be channeled through the Process Documentation Group and incorporated in future training efforts.

5. Research and Development Technologies.

The Research and Development technologies have been identified as technologically feasible but relatively expensive for the villages and as technologies which require continual maintenance. In spite of these limitations, there appear to be situations where the use of this type of technology would be warranted and would have significant benefits for rural Basotho. Therefore, the following technologies were selected for experimental determination of their socio-economic feasibility.

(a) Feedlot Anerobic Digester System. The Ministry of Agriculture and the Ministry of Rural Development have made efforts to improve soil conservation and implement a range management program through establishment of grazing associations in the mountain areas and through establishing feedlots in the foothills and lowlands. Relating to these activities is an effort to improve the marketability of cattle by feedlot fattening and by providing veterinary and marketing services. The feedlot studied by the PP team at Masianokeng village presently has an average head count of 150 to 200 oxen and cows with plans to expand to 5,000 head. The feedlot presently is powered by diesel for feed grinding and some other energy uses.

The proposed installation of medium-sized 100 cow anerobic digester for methane gas production and sludge fertilizer production at this village feedlot would experimentally determine the feasibility of replacing diesel fuel with bio-gas (methane gas) generated by the anerobic digestion of the feedlot manure. This digester would be about 13,000 gallons in volume requireing 440 pounds of dry organic volatile matter per day or about 1800 pounds of fresh manure. The collection of manure could

be done manually or with a front end loader. Based on Lesotho's feedlot conditions and assuming a 75% manure capture efficiency at 40 lbs of manure per cow with 18% of the manure being organic volatile solids, this size system will yield about 3000 ft $^3$ of bio-gas per day or about 2.3 million BTUs per day. The sludge fertilizer yield would be about 450 gallons per day(5 to 6% nitrogen). If this technology is viable under these conditions it would provide Lesotho with a high quality fuel product, i.e., methane gas, comparatively priced with diesel fuel. The benefits to the rural areas are uncertain at present but if reduced feedlot operational costs were realized and a much needed fertilizer (digester sludge by-product) was made available to the villagers and the desired soil conservation was achieved, the technology would be a significant one where feedlots are located in the future.

(b) Mini-Hydroelectric Production. The use of a three to five kilowatt hydroelectric scheme is proposed to provide electricity for the Rampai clinic located near Lejone. The clinic presently uses diesel fuel hauled over a rough road which requires five to six hours transportation time. The proposed system will incorporate a fall of water through a two inch (5 cm) pipe with a 100 foot (33 meters) drop, which will drive a Pelton wheel turbine generator. The generator would provide twenty-four hours of lighting at 24v and water and space heating (sequentially not simultaneously) at 220 v throughout the year. The experiment will be designed to determine reliability of the system, as well as the cost at the clinic of hydro vs diesel-generated electricity.

5. Environmental Concerns. An Initial Environmental Examination recommending a Negative Determination was prepared and submitted with the PID. This was approved. No information contrary to that recommendation emerged in preparing the PP.

## B. Social Analysis

### 1. Basic Social Characteristics of the Rural Population

(a) The People. In comparison with other African countries, Lesotho's population is remarkably homegenous. Historically, the Basotho nation comprises a number of Sotho clans and San and Nguni groups which were united well over a centry ago. Other national minority groups - mainly Asians and Europeans - form under 2% of the population.

(b) The Population. Ninety-four percent of the de jure population of 1.2 million (in 1976) live in the rural areas. The high level of male migrant labor and the earlier male death rate effectively means that rural villages are largely inhabited by women and children. Roughly two-thirds of the population between 16 and 60 are women. The rural population is concentrated in the lowland third of the country, and lives in approximately 3,000 villages with populations varying from 40 to over 1,000. Villages consist of compact clusters of homesteads and have a distinctive social and geographic identity.

(c) Sotho Culture. Sotho culture dominates the region in a uniform manner. Sesotho is the language spoken throughout the country. The Basotho are traditionally cattle-owning agriculturists, who, prior to the twentieth century were renowned for their smelting of iron, copper and tin, Over a century and a half of European influence and a century of wage labor has totally altered the basis of their economy and fundamentally altered many aspects of Sotho culture. Family relations and marriage practices have been subject to the effects of migrant labor and inflation Christianity has long gained a firm foothold; the position of the chieftaincy and the nature of chiefly power has altered; and the position of women has become increasingly difficult and complex. The effect of varied influences on Basotho culture is made all the more complex as the majority of Basotho have both experienced the working class life in South Africa's mines and have been made to remain within the skeleton of a more 'traditional' way of life in the impoverished rural areas of Lesotho.

(d) Village Social Organization. The basic social and geographic unit in a village is the household. The mean household size in the mountains is over three, while that in the lowlands is just over four. The absence of migrant laborers and the higher male death rates mean that women effectively head 60% of households. Migratory labor seriously jeopardizes the survival of the nuclear family and promotes a high level of conjugal instability.

In addition, migratory labor has a deleterious effect upon corporate village organization. It results in a loss of enthusiasm for communal labor, breaks up the group of male household heads, and undermines communal organization in villages by introducing

alternative values and sources of power and wealth.

There are three forms of corporate village organizations in Lesotho:

(i) Interhousehold Co-operation - whereby households arrange to cooperate on various agricultural tasks such as ploughing, harvesting grinding, or other activities, e.g. beer brewing, burial insurance societies.

(ii) The Chieftainship - Villages traditionally fall under the political and administrative jurisdiction of a local chief. The chieftainship is determined by descent, although the chief is traditionally responsible to the villagers under his authority. The status and powers of the chieftaincy have declined in the twentieth century, principally because of the establishment of a central national government.

(iii) Village Committees - have become formalized institutions in the last decade and several committees exist in most villages. The highly political character of the all-purpose village development committees has caused, and continues to cause, disruptions. Despite this, village committees have become the accepted institutional form of village control to complement a weakened chieftaincy.

(e) The Village Economy. Villagers have four souces of income:
(i) Migrant Labor Remittances account for the largest proportion (59% in 1973/74) of household income. The irregularity of remittances, and budgetary control by the migrants themselves often prevents efficient investment in primary household needs.

(ii) Local Salaried Employment is restricted to a very small number of villagers, Government being the largest local employer.

(iii) Farming. The importance of Agriculture in the village economy has declined dramatically since the 1920's to the extent that effective agriculture is in practice reliant upon migrant labor earnings. Serious farming is prohibited by lack of investment in modern inputs and difficult environmental conditions.

(iv) Other Income-Generating Activities include beer-brewing, and activity sociologically well-suited to the demands of the migrant labor economy, and the occasional sale of fresh produce, milk and handicrafts.

(f) The Position of Women. Customarily, and in ideal conception, in Sotho culture, women are treated as jural minors. Their area of jurisdiction is limited to domestic control from birth. Girls are

traditionally weaned before boys and are quickly socialized into their future roles as mother and wife by learning to bear the burden of household's domestic chores. In ideal terms a woman may exercise a great deal of autonomy over her areas of responsibility and her position is secure and clearly defined.

In practice, adaption to a society dominated by migrant labor has meant that the position of women is more contradictory and more ardous than the ideal. Firstly, women are generally better educated than men. This is largely explained by the fact that herding responsibilities conflict with boys' schooling and by young men's early conscription to the mines. Nevertheless fewer women have salaried jobs in the country, and women remain formally subservient to men in matters of household management.

Second, the absence of men has meant that women have had to adopt new responsibilities with little formal recognition of their altered position. Women are now in practice very often the resident heads of households and resident farm managers and, while often better able to manage household affairs, are not able to control the resources necessary to carry out the responsibilities of these positions. Resources here refer not only to income and labor, but also to power over the mystical plain.

The stress resulting from the contradictions in the present position of women in rural Lesotho must be added to their other burdens. The insecurity of their position resulting from conjugal instability, lack of control over the mystical realm, intermittant income and yet increased household responsibilities may well be as important a factor as poverty in explaining village inertia.

2. Beneficiaries

A. Direct and Indirect

a) Rural Women. The initial and chief beneficiaries of the Lesotho RET Program are the rural women in the villages to be served by this project. In many ways their daily activities will be made much easier. In Lesotho, women have virtually sole responsibility for domestic activities such as heating, cooking and food supply.

b) Entire Villages. The entire villages in the area to be served by the project may also be considered as potential beneficiaries. Firstly, program activities may enhance the health and wealth of all householders affected by the project; secondaly, some of the technologies envisaged by the project are communal and hold out benefits for an entire community; and thirdly, implementation by means of a self-help strategy potentially provides a number of other social benefits described below.

c) Users of Institutions. Demonstration units will be installed in institutional buildings in strategic locations, i.e., schools, clinics, hospitals, community centers and Farmer Training Centers. Perhaps up to one hundred such locations will be served during the life of the project. This will benefit immediately those using the institutions in addition to the spread effect.

d) Regional and/or National Beneficiaries. Some of the technologies proposed int he Program, particularly those that require research as to their feasibility (e.g. solar cell water pumping and battery charging, solar food dehydrators) and those identified to be established as national research projects (e.g. mini-hydroelectric systems and feedlot anerobic digesters) have regional and/or national benefits. The Program could potentially contribute to national development by developing alternative souces of high-grade energy at national feedlots, small-scale hydropower schemes and improved energy sources for communication facilities.

B. Social Benefits.

1) Time-Hardship Saving. The most immediate social benefit accruing from the proposed technologies is a saving in time and energy expended on fuel collection. The collection of fuel is the most time-consuming of all domestic duties, and the haulage of paraffin and grain to mills is also a considerable effort. The significance of the saving in women's time and effort must be set against the arduous position of women in Lesotho for whom a reduction in workload is a real benefit. The importance of this benefit should be seen in the context of the constraints of the migrant labor economy, and not valued simply in terms of the minimal opportunity of the time saved.

2) Improved Health and Hygiene. The proposed technologies will improve villagers' health in a number of ways: warmer houses will generally promote better health and specifically lower the incidence of pneumonia; the removal of smoke from the inside of houses will lower the incidence of eye and respiratory diseases and make for a cleaner and more hygenic home environment; and greater vegetable production and extension of the growing season should improve nutrition.

3) The Benefits of Self-Help. If villagers are properly mobilized and trained and projects successfully implemented and managed, the experience of a successful project may promote self-reliance, and possibly a spirit of communal responsibility towards future development intiatives.

4) The Distribution of Benefits and Spread Effect. It is envisaged that the distribution of benefits will be reasonably uniform both within and among villages. The proposed technologies have been chosen precisely because they respond to a generally felt need, because of their extreme simplicity, and because of the potential they have of achieving widespread popularity among the poorer households. The only technologies which necessitate considerable capital will be communally organized.

Lesotho's small size and cultural homogenity allow easy communication throughout the population. Furthermore, a consequence of the high level of migrancy is that Basotho travel extensively in Lesotho and southern Africa. The main channels of communication occur along roads and briddle paths, and along the course of river valleys in the mountains. As a result, knowledge of the development initiatives spread easily across the country. The tremendous growth in the demand for village water supplies is evidence of this.

3. Number of Beneficiaries.

This being a demonstration project, it is impossible to predict with any accuracy the number of beneficiaries that will result from the activity. Except for the direct beneficiaries (the trainees) consisting of 140 VETS, 26 MORD staff plus 4 Peace Corps volunteers, who will most conservatively help construct 10 devices per year thus benefiting 2,500 village families over a three year period, allowing for a 30 percent drop out rate. In addition to these directly benefiting, there are all those who utilize the public institutions on which a device has been installed, the inhabitants of low-cost public housing project that receive technical assistance from the project and those employed by and those who purchase devices from small businesses that may well be established from the introduction of the technology.

4. Social Preconditions for Effective Project Implementation.

The Lesotho RET project is characterized by the wide scope of needs it is attempting to meet, and by the variety of technologies considered; by the fact that many of the technologies proposed are innovative in comparison with existing technologies; by the fact of it being a "self-help" project; and by the danger that technological innovations might be developed without a detailed understanding of village needs. In order to accomodate these characteristics and to ensure effective project implementation it is proposed that the following conditions are met:

(a) "Bottom-up" Planning. Rural villagers must be involved in the design, planning and implementation of all village-level RET activities. This condition will ensure that the technologies proposed are responsive to specific needs in particular villages, and that the project can be adapted to take account of problems and new insights as they arise. The concept of "bottom-up" planning is not new to the Ministry of Rural Development. It is the guiding principle of the Area-Based Integrated Rural Development Programs and is one of the rural development strategies adopted in the Third Five Year Plan. Fulfillment of this condition requires that the Project staff be chosen and the structure and activities of the project be designed so that they be responsive to village needs.

(b) Village Level Support. Experience in Lesotho has shown that self-help programs are not effective in the long term without substantial support for village development institutions and village activities. This and the previous condition necessitates decentralization of the district community development offices. The need for support of village level institutions has been discussed in several recent reports to the Ministry of Rural Development (Feachem et al (1977), Wilmot (1978), and UNDP (1978) and USAID (1979) and the Ministry is taking steps towards strengthening the District Offices.

(c) Ongoing Evaluation/Process History. Furthermore, the Project proposes an appropriate process documentation or process history management structure which will enable the project integrate engineering design and socio-economic data, cope with the broad scope of the project and be responsive to villagers'needs. It is proposed that this process of ongoing, internal evaluation of both survey and implementation processes and RET design performance (efficiency) is adopted to meet this need. This evaluation is discussed in section VI Program Evaluation.

5. Social Soundness of Proposed Technologies.

(a) Cooking. A study of energy consumption in Malefiloane a mountain village, concluded that cooking consumed 68% of domestic fuels. Villagers either cook on open fires inside or outside their houses, or on paraffin (kerosene) stoves. Fuels burnt in fires are dried dung, brushwood, crop residues (especially maize cobs) dried aloes and where possible, firewood. Coal is rarely available. Firewood is the preferred fuel, but it is in very short supply. The supply of dung fluctuates seasonally with the movement of cattle to winter grazing grounds. Almost every household has at least one or two paraffin stoves. Fuel collection, whether to gather brushwood, dung from the kraal, or paraffin from a trading store is ardous, time-consuming work. In Malefiloane the village women walked 3.5 kms

over a climb of 300 meters to the village's major fuel source. Another study in Mokhotlong estimated that an average of between 3 to 4 hours is spent daily on fuel collection, with four times that spent on water collection in the mountains.

Roughly speaking, fuel is required for three types of cooking: heating water for tea, and other uses; short term cooking for foods such as papa, most vegetables, and lesheleshele; and longer term preparations such as beer, motoho and bread. Paraffin stoves or fires might be used for the first two uses, while only fires are used in the last category. Paraffin stoves are preferred for quick cooking or heating operations, or when a women's time is at a premium. All households have a selection of flat-bottomed and three legged pots.

The provision of simple mud stoves inside a house would only affect the first two categories of cooking. The stoves would have to be designed such that they can be lit quickly to cater for short-term cooking and water heating if they are to replace paraffin stoves entirely. An additional outside structure capable of heating large three-legged pots would have to be constructed to cut down fuel use for all cooking purposes. The stoves would have to be designed to fit the standard sizes of householders' pots and pans.

The proposed technology does not entail a major change in cooking practices and so it is not a high risk innovation. Their cost should be kept considerably lower than paraffin stoves to encourage their use. A cut in the amount of fuel that is needed may, to a very small extent, disadvantage a handful of poor households who gather and sell fuel. This aspect should be monitored in implementation but it is expected that this will not seriously affect the village economy since the stoves will not eliminate the need for fuel-gathering. Further comments on the social soundness of mud-stoves are presented in the discussion on heating.

(b) Heating. The need for heating is felt throughout the country, though particularly in the mountains where temperatures remain close to freezing for many months in the year. The national dress, a blanket, indicates the importance and need for warmth. Cloudless winter skies enable villagers to keep warm during most days - houses are traditionally sited to catch the early morning sun - but other fuels are necessary for heating at night and at dawn and dusk. Summers are warm, and overheating is not a great problem.

Heating rondavels is most commonly accomplished by making a fire in the middle of the hut and simply allowing the smoke to filter through the thatch. The fire is also used for cooking.

The thatch and dung linings of Basotho huts provide adequate insulation, though windows and doors are major sources of heat-loss. Open fires cannot be lit in the tin-roofed houses (which consist of approximately 5% of mountain and 20% of lowland dwellings) and the only form of heating is often a paraffin cooking stove. Paraffin heaters are very rare in villages. Tin-roofed houses rarely have ceilings and consequently become very cold in winter and hot in summer. Heating has been estimated to account for 30% of domestic fuel used.

The provision of simple mud stoves to thatched huts must be accompanied by improved insulation if the full function of open fires is to be replaced. Mud stoves and improved insulation should also be implemented simultaneously in tin-roofed houses if mudstoves are to replace additional paraffin use for heating. A potential danger of using mudstoves to replace open fires is that the lighting function of fires is removed. The extent to which this will affect the acceptability of the innovation, or will entail further cost in additional candle and paraffin use, is not known for certain, but we judge that the amount of light given out by most dung or brushwood fires is minimal. The use of grass for insulation, the concept of insulation and the skill of weaving are not new to Lesotho.

(c) Food Supply: Extending the Vegetable Growing Season. The short growing season, particularly in the mountains, is one reason for the shortage of fresh produce in villages, and so contributes to nutritional deficiency in Lesotho. Lack of vegetables in winter and an absolute shortage of food in the "hungry period", preceding harvest-time, is an often expressed need. Only one vegetable crop is grown in the mountains per year and it is more possible to sow twice a year in the lowlands.

Intensive horticulture is not a traditional form of food supply in Lesotho, although most households do have small private gardens, and a communal garden program has been in existence for many years. A great percentage of communal gardens established in the past are now in disuse. The primary cause of the failure of communal projects has been inadequate, poorly designed and unsupported village-level management. Nevertheless, successful communal garden projects do exist, particularly in the mountains where fresh vegetables are in the least supply.

The most favored vegetables in Lesotho have green leaves - cabbage, spinach, onion tops and a variety of Sesotho vegetables - but potatoes, beetroot, carrots, pumpkins and tomatoes are also eaten. All of these vegetables besides potatoes, Sesotho vegetables and pumpkins are grown in gardens. Most vegetable production is for subsistence although surplus produce may be sold within the village or at a district center.

Grow hole greenhouses and communal greenhouses are both new technologies in Lesotho and will require considerable extension work, training of village cadre in their use, and local level support if they are to be implemented effectively. The use of grow hole greenhouse, which require less specialized expertise, should be encouraged as an addition to existing individual gardens. Individual greenhouses attached to homes are prohibitively expensive. Communal greenhouses are less expensive per capita - although still a high cost activity - but require horticultural expertise and, most importantly, efficient village management.

It is recommended that communal greenhouses are only proposed to villages which have existing successful communal gardens; a nearby water source; access to a local market; and which have adequate support from both agricultural extension agents and local community development staff. The precedent of communal gardens means that the style of village management required is not new. The implementation of communal greenhouses should draw on the experience gained from the communal garden program, and follow the organizational pattern whereby the construction of the garden, and the water supply and the provision of seeds are the only communal activities. Plots within the greenhouse should be individually owned.

(d) Food Production: Grain Grinding. The crops which require milling are maize and wheat. Grinding by hand, the traditional method, has become increasingly hard since the most widely used varieties of seed have been selected for their nutritional and storage capability and not for ease of milling. The traditional method entails grinding the grain between two smooth stones. The majority of households choose to have their grain milled at local diesel mills despite the growing expense and often considerable haulage involved. A very few households have purchased hand grain grinders from the Republic.

The argument for the provision of pedal-powered grain grinders is that they sould replace the need for haulage and the growing experience of milling at diesel-driven mills. The proposed technology is relatively novel, particularly the use of pedal-power. Hand grinding is women's work and there is a small chance that women will consider pedalling unbecoming. There is sufficient precedent for women taking on traditionally male tasks for us to judge that this will not prove an insurmountable barrier. Grain grinders should be proposed to villagers as communal projects in which the grinder would be owned by a women's grinding association. The initial cost and maintenance costs would be provided by the cooperative members, and training, support and maintenance expertise would be provided jointly by MORD's AT Unit, an agricultural

extension agent and local community development officers. Grinders should only be proposed in villages where the necessary support staff is available.

(e) Needs and Technologies Requiring Feasibility Study.

The following needs and proposed technologies have been identified as worth of further examination and discussion between the project and ATU staff, and villagers in the course of the project.

(i) Water Heating. Water, for use in cooking and for washing, is heated on stoves and open fires in villages. Solar water heaters have been developed appropriate to conditions in Lesotho, and a number have been implemented in urban areas. Their provision in villages is not likely to cause problems of acceptability, but the cost of suitable water heaters on an individual basis is prohibitive, and the maintenance requirements too demanding. The project should, however, undertake feasibility studies of communal washing facilities which might be attached to the communal washing facilities (initially clothes washing but possibly also body washing facilities) envisaged in the USAID Lesotho Rural Water Supply Program and the proposed Rural Sanitation Program.

(ii) Food Dehydration and Preservation. A substantial amount of agricultural produce is lost every year through poor food preservation practices. Furthermore lack of facilities forces farmers to sell the bulk of their produce when market prices are at their lowest, and to buy the same produce back at exhorbitant prices later in the year. This unsatisfactory situation could be improved by better food preservation technologies. The drying of food is currently practiced in a number of village households, although the range of foods is limited. The most common are corn-on-the-cob, cabbage and peaches. The food is not protected and is simply laid out on sacks or on tin-roofs until ready for storage.

The reason this technology has been placed as a second order priority is, firstly, that UNICEF currently funds a project in the Ministry of Agriculture with the specific purpose of developing and implementing village-level food preservation technology. Any developments made by this project would have to support, but not duplicate the existing project. Secondly, the cost of individually owned solar dryers, one of the technologies being considered, is prohibitive, and the social consequences of communal solar dryers would have to be worked at in greater detail.

(iii) Irrigation: Solar Cell Pumps. Irrigation is not commonly practiced in villages, but lack of timely watering is a significant constraint to crop yields. The untimeliness of the rains is an expressed problem faced by farmers. Village irrigation appears sociologically feasible, but more research into farmers' attitudes, the costs of irrigation, and appropriate forms of village-level management are necessary.

(iv) Passive Solar Heating. This heating technology has not been considered a priority since it entails greater individual expense, greater risk, and a greater innovation in comparison with other ways of preserving heat. The technology would, however, appear to be well-suited to mountain conditions and might be introduced at a later stage to supplement other thermal technologies.

6. Village-Level Management Issues. Two types of technology are proposed: (i) technologies that are managed individually; (ii) and technologies that are managed communally.

(a) Individual Technologies. The proposed technologies with individual benefits are simple mud stoves, improved home insulation and growhole greenhouses. Implementation of these activities will be carried out by a Village Energy Technician (VET) who will have been freely elected at a village meeting at which it was indicated that villagers would participate in the project. One VET should be trained per village. No strict selection criteria should be laid down other than popular support, but it should be pointed out to villagers that the job primarily concerns itself with domestic technologies and that the elected villager would be expected to remain within the village and not to migrate to the Republic. The factors favor the selection of women for the posts.

Part of the VET's training will be the supervised construction of demonstration projects at her/his own home. Thereafter, the VET will be responsible for promoting, supervising and maintaining the construction of similar facilities at other village homes, for a standard fee paid by each household for each facility. The District Community Development Officer and the RET Project Field Supervisor will be responsible for supporting the VETs in the settlement of village disputes. The RET Project Manager, the Ministry of Rural Development AT Unit and the district/regional technical officers are the support for the VETs in engineering matters. VETs should not, at this stage, be paid by the Project or by GOL. Incentives include the training, the status of the position, the use of a tool kit, a certificate indicating the VET's skills and the small income derived from each completed individual domestic facility.

(b) Communally-Managed Technologies. The technologies proposed that require communal management are communal greenhouses and grain-grinders. Village-level management of communal activities have a poor record in Lesotho. The chief problems in the past have been inappropriately designed village level institutions, and a chronic lack of support from government for village institutions. The implementation of the recommendations contained in the Wilmot report will, to a certain extent, alleviate the latter problem. In general, the all-purpose Village Development Committee, many of which are unelected, and were appointed by the Ruling Party's political structure, remain an inappropriate form of village-level management of development programs.

It is recommended that communal greenhouses and grain grinders be managed by associations of fee-paying villagers formed to manage and gain benefits from the technologies. These associations will be similar to the Communal Garden Committees. In the case of the communal greenhouses, suitable Communal Garden Committees will simply take on an additional project. The Field Supervisor should draw up a suitable association constitution for use in establishing appropriate village management bodies.

VETs will be trained in the use of these technologies, and their function will be to act as foreman during construction of the greenhouse, to give technical advice on the use of the technologies, and to carry out maintenance. The associations should decide for themselves how they should reward the VET for her/his services, but it is recommended that, to ensure long term success, the VET should receive a small annual payment in a fashion similar to that recommended for Village Water Minders in the USAID Lesotho Water Supply Project. Some training in the use of their technologies should be given to all greenhouse and grain grinding association members.

Outside support on both physical and social issues is crucial to the success of the communal activities. These activities should be visited regularly by district community development staff and the Field Supervisor.

7. Women in Development. All of the technologies to be disseminated in the first stage of the project will be of primary benefit to women: improved stoves, greenhouses, home insulation, grain-grinders. The same is true of such additional "candidate" technologies as food driers and solar water or space heating systems. Moreover, many women are likely to be provided a continuing source of income through training as Village Energy Technicians. In sum, women will have access to the greater part of project benefits.

## C. Economic Analysis

### 1. Introduction

As is true throughout Africa, most energy consumed in rural Lesotho is non-commercial: wood, dung, crop residues, human and animal labor. Unlike Africans elsewhere, however, even relatively poor Basotho tend also to use small amounts of kerosene for boiling tea water and (to a much lesser extent) for cooking and space heating. In recent years, both sorts of energy have become less accessible. The supply of wood and dung is increasingly inadequate to meet demand. At the same time, dramatic increases in petroleum prices have begun to cut deeply into the cash resources of the poor.

This project will address both problems. Most of the systems proposed would make more efficient use of non-commercial energy: improved wood and dung combustion efficiency stoves, better insulation, greenhouses, and possibly such additional systems as solar space and water heaters. A second group of systems would directly reduce demand for petroleum products: hand-operated grain grinders, along with such experimental devices as biogas generators and small-scale hydroelectric systems.

At least in the initial stages of the project, economic benefits will not lie primarily in foreign exchange savings or significant changes in national consumption of petroleum products. Instead, the project's value will be the sum of a large number of small improvements in the ways rural Basotho are able to carry out basic tasks. The job of economic analysis is therefore to be as certain as possible that the systems being disseminated will actually have benefits greater than their costs. These relationships are examined from the standpoint both of a system's buyers and of the society as a whole.

Techniques for carrying out this work are outlined in Annex I, "The Economics of Renewable Energy Systems for Lesotho." As noted in that discussion, forms of analysis will differ depending on whether a technology's benefits are largely quantifiable (Section A, below) or non-quantifiable (Section B).

### 2. Technologies With Quantifiable Benefits

Of the technologies proposed for initial support through this project, three have benefits which are largely quantifiable: pedal-powered grain grinders, community greenhouses, and grow holes greenhouses.

(a) Pedal-Powered Grain Grinders. In analyzing this system, we make the following assumptions:

- A locally-fabricated kit, including grinding stones and hardware, will cost R70 for a pedal-powered system able to produce 50 pounds an hour of medium ground grain.

- The system will last five years.

- The system will be used two hours per day, 150 days a year grinding 15,000 pounds of grain annually.

- Operating labor costs R0.05 per hour, or R15 per year.

- Maintenance costs will average R20 per year in years 2-5.

- The renewable energy technician will be paid R10 for assistance in the first year, and R2 in subsequent years.

- Commercial milling in rural areas now costs R,005 per pound.

These assumptions may well be too cautious. In practice, the grinder is likely to be used more than 300 hours per year, thereby enhancing its profitability. In addition, commercial milling charges are rising rapidly as a result of sharp price increases for diesel fuel. Since these charges determine the value of the pedal-powered grinder, benefits of the systems are likely to increase over time. Finally, we have made no allowance for the savings in labor which in the grinder's absence would be required to carry grain to stores for commercial milling. Adequately to value the reduction in this work would be to further increase the system's economic appeal.

Even given the conservative assumptions listed above, however, the economics of the grinder from the investors' point of view are extremely positive, as shown in Table 1.

Table 1: Benefits of Pedal-Powered Grain Grinder to Investors (in Rands)

| | YEAR 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Benefits** | | | | | |
| Commercial milling charges foregone | 75 | 75 | 75 | 75 | 75 |
| - Costs | | | | | |
| Construction Labor | 5 | -- | -- | -- | -- |
| Materials (kit) | 70 | -- | -- | -- | -- |
| Operating Labor | 15 | 15 | 15 | 15 | 15 |
| Maintenance | -- | 20 | 20 | 20 | 20 |
| Technician's Services | 10 | 2 | 2 | 2 | 2 |
| = Net Benefit to Investors | -25 | 38 | 38 | 38 | 38 |
| X Discount Factor (30%) | .769 | .592 | .455 | .350 | .269 |
| = Present Value to Investor | -19.23 | 22.50 | 17.29 | 13.30 | 10.22 |

According to this calculation, the grinder has a Net Present Value of R44.08 and an Internal Rate of Return in excess of 100%. Clearly, the investment is a very attractive one, although its high initial cost might make it difficult for individual families to afford. More likely, these grinders would be purchased by local entrepreneurs or by women's grain-grinding cooperatives, rather than by separate households.

From the national point of view, the system will look even more attractive. Lower shadow wages and discount rates will increase the rate of return significantly. Since marketing is likely to be carried out by a group such as the Basotho Enterprises Development Corporation (BEDCO), the Government itself should incur minimal extension costs in promoting the grinder. At least on the basis of preliminary analysis, use of the pedal-powered grain grinder seems well worth encouraging.

(b) Greenhouse. Greenhouses are likely to be installed in villages with already existing communal gardens, to be planted through existing Government programs. In analyzing the net contribution which a greenhouse would make to the economics of such a garden, we make the

following assumptions:

- The greenhouse has a lifetime of 10 years.

- Construction materials for a 30' by 50' greenhouse cost R2000.

- Four person-months of construction labor will be required, at R12.50 per month.

- Two crops (half tomatoes, half carrots) will be grown in years 2-10, as opposed to one garden crop in the absence of the greenhouse. In year 1, only one crop would be grown in either case.

- To deal with the extra crop in years 2-10, 70 person-days of operating labor will be required, at R.50 per day, including planting and harvesting. Additional operating labor in year 1 will cost R5.

- The cost of seed is R.01 per square foot for tomatoes, and R.04 per square foot for carrots.

- One square foot will yield 10 pounds of tomatoes, at R.20 per pound, versus 8 pounds of tomatoes per square foot in the greenhouse's absence. One square foot will yield 10 pounds of carrots, at R.30 per pound, versus 8 pounds in an open garden. The additional value of produce grown will therefore be R750 in Year 1 (one greenhouse crop) and R4500 in Years 2-10 (two greenhouse crops). Note the crop yield estimates are based on opinions of the PP team and of staff of the Ministry of Agriculture. These values could be extremely variable given horticultural practices and seed varieties. However the payback period and economic analysis will not be altered significantly within the yield variations that could occur.

- Scheduled maintenance requires painting the glazing every other year (at cost of R30), plus whitewashing each year (at a cost of R10). In addition, allowance is made for R100 per year in unscheduled maintenance costs.

- The community will pay R20 for services of a renewable energy technician in Year 1, and R5 in later years.

- Costs of transporting a portion of the additional produce to market will be R30 in Year 1 and R200 in subsequent years.

Given these assumptions, the economics of the greenhouse will be as shown in Table 2.

Table 2: Benefits of Greenhouse to Investors (in Rands)

| | YEAR | | |
|---|---|---|---|
| | 1 | 2 | 3-10 |
| **Benefits** | | | |
| Additional tomato production (market value) | 300 | 1800 | 1800 |
| Additional carrot production (market value) | 450 | 2700 | 2700 |
| - Costs | | | |
| Construction Labor | 50 | -- | -- |
| Greenhouse Materials | 2000 | -- | -- |
| Additional Seed | -- | 40 | 40 |
| Additional Operating Labor | 5 | 35 | 35 |
| Maintenance | 100 | 110 | 120 |
| Technician's Services | 20 | 5 | 5 |
| Transport Costs | 30 | 200 | 200 |
| = Net Benefit to Investors | -1455 | 4110 | 4100 |
| X Discount Factor (30%) | .769 | .592 | 1.730 |
| = Present Value to Investors | -1119 | 2433 | 7093 |

The greenhouse appears extremely profitable from the investors' point of view, paying for itself by the end of the project's second year. Even if we were to assume that only one crop of vegetables were to be grown annually over the system's ten-year lifetime, the greenhouse would still have a positive Net Present Value of R270 at a 30% discount rate. Although not all benefits will be in form of direct payments for vegetables, returns are sufficiently great that actual cash flows should be positive by quite early in the project.

The only real issue here would appear to be the system's high initial cost --about R133 per garden plot for materials alone, assuming 15 plots per

greenhouse. To deal with this following the project's pilot phase, the Ministry will need to create a revolving loan fund for greenhouse construction, according to patterns already established for financing of comparable Ministry projects.

From the national point of view, the greenhouse is equally attractive. Even assuming a requirement for an additional two months of agricultural extension assistance per year, at R100 per person-month, the greenhouse achieves a positive Net Present Value in social terms during the project's second year. As an added dividend, greenhouses would serve vital Government policy objectives by reducing food imports from neighboring countries.

(c) Grow Holes. To analyze grow holes, we make the following assumptions:

- A 6' x 6' grow hole will require R4,27 in materials (depending on the durability of the covering) and R1 in construction labor.

- One crop of 1000 cabbage seedlings (worth R.01 each) and one crop of tomatoes (405 pounds in Year 1 and 810 pounds in subsequent years, at R.20 per pound) will be grown annually..

- Seed costs R.006 per square foot to produce cabbage seedlings and R.01 per square foot to produce tomatoes.

- Operating labor costs R10 per year.

- The renewable energy technician is paid R2 for services at the beginnning of the project.

Under these circumstances, the grow hole would have a positive Present Value of R38.45-56.14 (depending on materials used) in the first year alone, at a discount rate of 30%. From the point of view of both the investor and the nation, this is a system of considerable economic promise. Even if extension assistance on the order of a month annually were required on the Government's part, Net Present Value in social terms would be positive by the end of the project's second year.

3. Technologies With Unquantifiable Benefits

Of the systems proposed for initial support through this project, improved stoves and home insulation provide benefits which are in major part unquantifiable.

(a) Dung-Burning Stove. We assume the following of our stoves:

- Raw materials (mud and stone) are free.
- About three days of construction labor will be required on the part of the stove's owner.
- Three days of assistance will be required from a renewable energy technician, at a cost of approximately R3.
- Although cooking will be done inside, smoke will be vented outside the home.
- If operated properly, the stove could increase by three times (from 4% to 12%) the efficiency with which dung is used for cooking.

This appears to be a very worthwhile investment. For R3 in cash and three days of work, the investor achieves a continuing reduction of two-thirds in the amount of labor involved in collecting, hauling, and drying dung for cooking, as well as a dramatically cleaner and healthier living environment. Interviews suggest that Basotho will value such benefits highly, assuming they can be clearly demonstrated under village conditions. From the national point of view, additional benefits include improvements in soil quality as dung is left on the ground instead of being burned.

(b) Home Insulation. We assume the following of locally-made insulation:

- To insulate a 10' x 15' square house with metal roof requires R2 worth of aluminium foil, plus about eight days of labor to weave grass matting and install the system.
- The insulation should last three years without need for significant repairs.
- About R2 would be paid the renewable energy technician for advice and assistance.
- In winter, the insulation could cut use of heating fuels by 75%. In summer, the insulation would avoid the overheating characteristics of houses with metal roofs, adding greatly to the comfort of the occupants.

As with improved stoves, considerable advantages appear to follow from home insulation at minimal cost to the user. For eight days work and a cash outlay of R4, great increases in comfort would be possible within the home during both winter and summer months. Again, interviews suggest that a high value would be placed by Basotho on such benefits. For people who use kerosene for space heating, a significant reduction in fuel expense would also result. From the national point of view, any such savings in commercial fuel used would strongly reinforce the appeal of what in any case seems an attractive investment.

4. Information-Gathering

Although the analysis above is based on the best available data, information is relatively "soft" for such key variables as these: vegetable yields in local greenhouses as opposed to open gardens, the extent of markets for seedlings and produce, the durability of dung-burning stoves or grain grinders, the effectiveness with which stoves and insulation systems would be used under actual operating conditions, the actual or imputed cost of labor for operating the systems under review, and so on. Only through local survey work and testing of pilot technologies can more reliable data be gathered on these and related points.

Part C of Annex I suggests the kinds of economic information which the project will need to collect, along with the uses which should be made of this. To help ensure that this work is adequately done, a consulting economist will be employed at the outset of the project to assist in design of the survey instrument and monitoring system. Additional economic review will be provided by short-term consultants throughout the project's lifetime.

## IV. Financial Plan

### A. Summary

The total AID cost of this project is $1,600,000 and the total measurable GOL contribution is $77,000 or 4.1 percent of the total project cost. Lesotho is on the UN's list of "Least Developed Countries" and as such has a very limited amount of financial resources. The entire GOL budget in fiscal year 1977/78 was only $58 million, among the lowest of any country in the world. Outside of foreign assistance, Lesotho is heavily dependent upon receipts from the Southern Africa Custom Union to finance Government expenditure. Under the Custom Union Agreement Lesotho's revenues amounted to R51.2 ($61.4) million in 1977/78. Through reformalization of Custom Union duties, the GOL recurrent revenues are anticipated to decrease after fiscal 1979/80. With the projected decrease in revenue and expenditures increasing sharply (from R33.7 million in fiscal 1976/77 to R53 million in fiscal 1978/79), a budgetary crises seems very possible by fiscal 1981/82. Unfortunately this negative trend will undoubtedly be exacerbated by the recent price increases in crude oil effected by OPEC. These circumstances make it virtually impossible for the GOL to finance 25 percent of total project costs. A waiver of FAA Section 110 (a) will be required in conjunction with project approval and is hereby requested.

While the energy saving technology and related devices introduced by the project will result in considerable cost savings to the GOL in the long run, the short term benefits will be the significant improvements in the living conditions of the rural Basotho. Since the rural poor consume very little petroleum products now, the project will not have a direct impact on Lesotho's oil consumption.

In addition to many indirect contributions that the GOL will make to the project, eight new permanent positions have been provided in the Ministry of Rural Development to form the core of personnel who will implement the project. Assuming a successful project and a decision to undertake a national program, the GOL is expected to increase the permanent staff to the extent required to replace the AID financed technical staff by the end of the project. In addition, the GOL will have the recurring cost of maintaining the workshops, the laboratory and the regional training facilities. However, the GOL will not have the recurring cost of the construction and demonstration materials as it is expected that the value of

the energy saving devices will have been sufficiently demonstrated so that people will be willing to purchase them.

B. AID Input

1. Technical Assistance - $554,000

The project will provide an expatriate Physical Scientist as the Project Coordinator for the life of the project (3 years). He will be assisted by a Social Scientist, Laboratory Supervisor, Administrative Assistant and a Stock/Supply Manager. These four positions will be filled locally by the most qualified candidates available. Recruitment and hiring will be the responsibility of the firm providing the Project Coordinator. It appears that it may be necessary to hire TCNs from a Code 941 source or Americans (ex PCVs) locally to fill the Social Scientist and the Laboratory Supervisor positions.

The Project Coordinator and his permanent staff will be augmented by consultants as required over the life of the project. Consultancies in training (10 m/m) stove modification (2 m/m) are anticipated.

2. Commodities - $583,000

Five vehicles will be purchased locally to insure adequate maintenance and spare parts availability and to conform to the Ministry's vehicle standardization policy. The budget includes $50,000 for this purpose. The project will also fund the specialized scientific equipment required by the technology. Media equipment and supplies ($40,000), curriculum materials ($46,000), laboratory and scientific equipment ($125,000) and reserach and development equipment ($125,000) will be funded through the technician services contract. Energy saving devices construction materials ($140,000) and shop equipment will be financed directly from the project and outside the technician services contract.

3. Training Costs - $101,000

Local training expenses ($59,000), Peace Corps Volunteer training ($2,000) and training equipment ($40,000) will be funded through the technical services contract.

4. Construction - $64,000

It is anticipated that the design for the energy efficient Project Coordinator's house ($15,000) will be provided through a direct AID contract and construction ($49,000) will be provided

through a host country contract awarded by the Ministry of Works. Construction will be closely supervised by the Project Coordinator.

5. Support Costs - $65,000

Support costs for vehicle operation, repair and maintenance will be financed directly from the project and outside of the technician services contract.

6. Inflation - $127,000, Contingency - $106,000

Reasonable amounts have been budgeted for inflation and contingency for the life of the project. The budget for total AID inputs is deemed to be accurate and firm.

C. GOL Input

1. Support Costs - $77,000

The GOL will provide eight permanent staff within the Ministry of Rural Development ($66,000) for the life of the project. The Ministry will also provide office space, laboratory space and warehouse space ($6,000) for project activities.

D. Other (Peace Corps) Input

1. Technical Assistance - $168,000

The Peace Corps will provide the services of four volunteers over the life of the project.

TABLE I

DETAILED COST ESTIMATES
(U.S. $ 000)

| AID INPUTS | COST |
|---|---|
| A. Technical Assistance | |
| 1. Program Coordinator (PHYSICAL SCIENTIST) - 3 yrs | 250 |
| 2. Field Supervisor (SOCIAL SCIENTIST) - 3 yrs | 75 |
| 3. Laboratory Supervisor - 3 yrs | 75 |
| 4. Administrative Assistant - 3 yrs | 15 |
| 5. Stock and Supply Manager - 3 yrs | 15 |
| 6. Short Term Consultants (20 person months) | 120 |
| 7. External Evaluation | 4 |
| Sub-Total | 554 |
| B. Commodities | |
| 1. Vehicle Purchase (5) | 50 |
| 2. Media Equipment and Supplies | 40 |
| 3. Curriculum Materials | 46 |
| 4. Laboratory and Scientific Equipment | 125 |
| 5. Research and Development Project's Equipment | 155 |
| 6. Energy Saving Devices Construction Materials | 140 |
| 7. Shop Equipment | 27 |
| Sub Total | 583 |
| C. Training Costs | |
| 1. Local Training Expenses | 59 |
| 2. Peace Corps Training | 2 |
| 3. Tool Kits and Training Equipment | 40 |
| Sub Total | 101 |

| | |
|---|---|
| D. Construction | |
| 1. Design ($15) and Construction ($49) of Program Coordinator's house. | 64 |
| E. Support Costs | |
| 1. Vehicle Operation and Maintenance | 65 |
| F.. Inflation | 127 |
| G. Contingencies | 106 |
| TOTAL AID INPUTS | $1,600 |

GOL INPUTS

| | |
|---|---|
| A. Support Costs | |
| 1. GOL Staff (Eight Positions) | 66 |
| 2. Office Space/Laboratory Space | 3 |
| 3. Warehouse Space/Land for Program Coordinator's house, site preparation and utilities hock-up | 8 |
| TOTAL GOL INPUTS | $77 |

OTHER INPUTS

| | |
|---|---|
| A. Technical Assistance | |
| 1. Four Peace Corps volunteers, each for 3 years. | 168 |
| TOTAL OTHER INPUTS | $168 |
| TOTAL PROJECT INPUTS | $ 1,845 |

TABLE 2

## SUMMARY COST ESTIMATE AND FINANCIAL PLAN

(US $ 000)

| | AID | | GOL | | OTHER 1/ | | TOTAL | |
|---|---|---|---|---|---|---|---|---|
| PROJECT INPUTS | FX | LC | FX | LC | FX | LC | FX | LC |
| TECHNICAL ASSISTANCE | 550 | 4 | | | 84 | 84 | 634 | 88 |
| COMMODITIES | 189 | 394 | | | | | 189 | 394 |
| TRAINING | | 101 | | | | | | 101 |
| CONSTRUCTION | 15 | 49 | | | | | 15 | 49 |
| SUPPORT COSTS | | 65 | | 77 | | | | 142 |
| INFLATION | 70 | 57 | | | | | 70 | 57 |
| CONTINGENCY | 58 | 48 | | | | | 58 | 48 |
| SUB-TOTALS | 882 | 718 | -- | 77 | 84 | 84 | 966 | 879 |
| TOTALS | 1,600 | | 77 | | 168 | | 1,845 | |
| PERCENTAGE | 87% | | 4% | | 9% | | 100% | |

1/ Four volunteers provided by Peace Corps

TABLE 3

COSTING OF INPUTS/OUTPUTS
(US $ 000)

| PROJECT INPUTS | No 1 | No.2 | No 3 | No 4 | No 5 | No 6 | TOTAL |
|---|---|---|---|---|---|---|---|
| AID | | | | | | | |
| TECHNICAL ASSISTANCE | 127 | 123 | 122 | 122 | 136 | 17 | 647 |
| COMMODITIES | 112 | 133 | 299 | 97 | 43 | -- | 684 |
| TRAINING | 118 | -- | -- | -- | -- | -- | 118 |
| CONSTRUCTION | -- | -- | -- | -- | -- | 75 | 75 |
| SUPPORT COSTS | 15 | 16 | 15 | 15 | 15 | -- | 76 |
| SUB-TOTAL | 372 | 272 | 436 | 234 | 194 | 92 | 1,600 |
| GOL | | | | | | | |
| SUPPORT COSTS | 17 | 19 | 17 | 18 | 1 | 5 | 77 |
| OTHER (PEACE CORPS) | | | | | | | |
| TECHNICAL ASSISTANCE | -- | 84 | 84 | -- | - | - | 168 |
| TOTAL PROJECT | 389 | 375 | 537 | 252 | 195 | 97 | 1,845 |

NOTE: OUTPUTS

No. 1 RET staff trained and in place
No. 2 Village RET implementation process established
No. 3 Village RET's introduced/evaluated
No. 4 Research RETS established/evaluated
No. 5 Research and development laboratory operational
No. 6 Energy efficient house constructed

TABLE 4

## PROJECTION OF EXPENDITURES

## BY FISCAL YEAR

(US$ 000)

| AID INPUTS | FISCAL YEARS 80 | 81 | 82 | 83 | TOTAL |
|---|---|---|---|---|---|
| A. Technical Assistance | | | | | |
| 1. Program Coordinator | 50 | 80 | 80 | 40 | 250 |
| 2. Field Supervisor | 12 | 25 | 25 | 13 | 75 |
| 3. Laboratory Supervisor | 12 | 25 | 25 | 13 | 75 |
| 4. Administrative Assistant | 2 | 5 | 5 | 3 | 15 |
| 5. Stock and Supply Manager | 2 | 5 | 5 | 3 | 15 |
| 6. Short Term Consultants | 60 | 30 | 10 | 20 | 120 |
| 7. External Evaluation | 1 | 1 | 1 | 1 | 4 |
| B. Commodities | | | | | |
| 1. Vehicle Purchase | 50 | | | | 50 |
| 2. Media Equipment/Supplies | 20 | 5 | 5 | 10 | 40 |
| 3. Curriculum Materials | 23 | 12 | 11 | | 46 |
| 4. Laboratory/Scientific Equipment | 100 | 25 | | | 125 |
| 5. Research/Development Equipment | | 75 | 80 | | 155 |
| 6. Energy Devices Construction Materials | | 45 | 45 | 50 | 140 |
| 7. Shop Equipment | 20 | 7 | | | 27 |

TABLE 4 (Cont)

| AID INPUTS | 80 | 81 | 82 | 83 | TOTAL |
|---|---|---|---|---|---|
| C. Training Costs | | | | | |
| 1. Local Training Expenses | 10 | 20 | 20 | 9 | 59 |
| 2. Peace Corps Training | 2 | | | | 2 |
| 3. Tool Kit/Training Equipment | 15 | 10 | 10 | 5 | 40 |
| D. Construction | | | | | |
| 1. Program Coordinator's House | 50 | 14 | | | 64 |
| E. Support Costs | 10 | 22 | 22 | 11 | 65 |
| F. Inflation | | 56 | 47 | 24 | 127 |
| G. Contingencies | 34 | 30 | 27 | 15 | 106 |
| TOTAL AID INPUTS | 473 | 492 | 418 | 217 | 1,600 |
| GOL INPUTS | | | | | |
| A. Support Costs | | | | | |
| 1. GOL Staff | 11 | 22 | 22 | 11 | 66 |
| 2. Office/Lab Space | | 1 | 1 | 1 | 3 |
| 3. Warehouse Space/Land | 5 | 1 | 1 | 1 | 8 |
| TOTAL GOL INPUTS | 16 | 24 | 24 | 13 | 77 |
| Other (Peace Corps) Inputs | | | | | |
| A. Technical Assistance | | | | | |
| 1. Four PCVs | 28 | 56 | 56 | 28 | 168 |
| TOTAL PROJECT INPUTS | 517 | 572 | 498 | 258 | 1,845 |

## V. Implementation Arrangements

Many of the arrangements for project implementation have already been described in the Technical Analysis and the Project Description as well as the annexes. They need not be repeated here. In this section, anticipated implementation issues will be examined and a tentative schedule of project events will be presented, as will a discussion of procurement of project inputs.

### Implementation Issues

A. Recruitment of technicians - program coordinator (physical scientist), field supervisor (social scientist), and laboratory supervisor. The program coordinator is the field representative of the contractor and is responsible for, among other things, scheduling short term assistance. This position should thus be filled by an American from the contractor home office staff or at least be extremely well known to the contractor home office.

The social scientist needs operational knowledge of the Lesotho village environment, including language capability. He thus should be recruited locally. While no qualified Basotho are known at the present, the project would consider employing one for this position. There are known, qualified and interested code 935 personnel in the area and, if necessary, a waiver will be issued for recruitment of one of these.

While it is not essential, local knowledge would be highly beneficial for the laboratory supervisor. Five qualified Peace Corps volunteers who will soon become available are interested in the position and the design team projects recruitment of one of these.

As the latter two positions will be recruited locally, a low person year cost is projected. Should costs be higher than projected, adjustments will be made in the contingency account and in other line items.

B. Construction of Energy Efficient House. The design team technician and the mission engineer calculate that a house reducing heating costs by 75% can be constructed with locally available materials for about one thousand dollars more than the standard Pitso IV model. The house will contain only two bedrooms and 1800 square feet as opposed to three bedrooms and 2300 square feet for the Pitso IV. The additional costs will involve primarily a second row of concrete blocks in the north side wall, locally made multilayer aluminum foil thatch insulation over the ceiling, and special floor insulation, movable insulation for double glazed windows, passive domestic hot water, and grey water treatment. The house will be designed under the AID/W architectural requirements contract but constructed locally under the close supervision of the program coordinator. The desire to have the program coordinator present for construction accounts for the $10,000 for housing rental during the project's first year.

Procurement

As a major feature of the project is the use of locally available materials, most commodities will be purchased locally off the shelf. The specialized scientific equipment, communication media equipment, and specialized shop equipment will be purchased in the United States by the Program Coordinator.

As explained in the waivers annex, 935 vehicles will be purchased in accordance with GOL standardization policies, maintenance requirements and possibilities, and host country driving conditions. All durable goods will be turned over to the GOL upon project completion unless AID finances a follow on project. The energy efficient demonstration house will be used by AID technicians as long as required. When no longer required for such use, it will be turned over to the GOL.

It is assumed that the U.S. contract for technical assistance will be reserved for small business or minority firms.

## C. PROJECT IMPLEMENTATION SCHEDULE

(See RET Program Implementation Chronology)

| Timeline Months | Activity | Responsibility |
|---|---|---|
| D | Sign RET Project Agreement | GOL/USAID |
| D+2 | AID/W Release R.F.P. | AID/W |
| D+6 | Support Services Contract Award; Project Begins | AID/W |
| D+8 | Contract Start-Up - Staffing | AID/W - Contractor |
| D+10 | Project Staff Orientation US/Lesotho | Contractor |
| D+10 | Program Coordinator's Passive Solar House Construction (4 months completion time) | Contractor/GOL USAID |
| D+10 | Process Evaluation Group Meeting (begin - held every two weeks) | Contractor/Field Supervisor |
| D+10 | Begin monthly Program Advisory Meeting Begin monthly Technical Reports to Staff MRD and BEDCO Newsletter | Contractor/ Program Manager |
| D+10 | GOL Appropriate Technology Unit Hired | GOL/MRD |
| D+10 | Program Organization and Procurement | Contractor/USAID |
| D+12 | Staff Training (Language) | Contractor/Consultant |
| D+13 | Staff Training (Evaluation Process) | Contractor/Consultant |
| D+13 | Staff Training (Technology) | Contractor/Consultant |
| D+13 | Village Meetings, Presentations and Survey Begin | Contractor/Field Supervisor |
| D+13 | Village Energy Technicians (VET) Trainees Selected | Contractor/Field Supervisor |
| D+14 | Train first group of VET Trainees at RET Rural District No. 1 (Mokhotlong Farmers Training Center) | Contractor |
| D+14 | Set up RET Research Laboratory in Maseru | Contractor/MRD/GOL |
| D+17 | Begin Construction of Village Demonstration Units (continue throughout program) | Contractor |
| D+18 | Annual Report | Contractor |
| D+18 | MRD AT Unit Assumes Responsibility for Training and Survey Activities 1/ | MRD AT Unit |

| Timeline Months | Activity | Responsibility |
|---|---|---|
| D+20 | Begin R&D Unit Pilot Project<br>Install Methane Digester Plant at Masianokeng Feedlot | Contractor |
| D+21 | Formal Program Evaluation Conference | Contractor |
| D+22 | First VET Group Begins Village Construction of Household and Community RET Units | VETs/Contractor |
| D+22 | Train 2nd VET Trainees Group (60 Trainees) at RET Rural Distrct No. 2 (Qachas Nek) | Contractor/AT Unit |
| D+24 | Evaluation of MRD AT Unit Training and Administrative Capabilities 1/ | Contractor |
| D+26 | Second R&D Pilot Project - Install Mini 3 to 5 kw Hydroelectric System to Replace Diesel Electric Generator Located at Clinic in the Ha Lejone-Rampais Areas | Contractor |
| D+26 | Second VET Group Begins Village Construction of Household and Community RET Units | VETs/Contractor |
| D+28 | Annual Report | Contractor |
| D+30 | Evaluation of MRD AT Unit Training and Design Capabilities 1/ | Contractor |
| D-32 | Train Third VET Trainees Group (60 Trainees) at Rural District No. 3 (Mohale's Hoek Farmers Training Center) | MRD AT Unit |
| D+36 | Evaluate MRD AT Unit Training Capabilities and Survey Effectiveness | Contractor |
| D+36 | Third VET Group Begins Village Construction of Household and Community RET Units | VETs/MRD AT Unit |
| D+38 | Formal Program Evaluation Conference | MRD |
| D+40 | Final RET Program Report | Contractor |
| D+40 | End RET Program | MRD/USAID |

1/ Important milestones in RET Program e.g., transfer of responsibilities

## VI. Evaluation

Evaluation has been treated as a program component and discussed in Section II. B. 3. This was felt to be necessary by the PP team because of the unique part the internal program evaluation process plays in the RET implementation and management functions. The proposed evaluation comprises an ongoing process documentation procedure with formal feedback mechanisms to all levels of the Program, e.g., Program Coordinator, MORD staff, VET corps and the village using RET units. This procedure will provide the basis for good program management and for the development of a viable and well understood village RET implementation process. The project is designed around the evaluation process using a formally structured body called the Process Documentation Group for collection and analysis of all data. This evaluation structure and feedback loop is shown in Chart No. 5, entitled "Village Level Implementation Process" and Chart No. 8, entitled "RET Program Organization".

All formal documents reporting program status or progress will be compiled by the Process Documentation Group, e.g, evaluation of MORD capabilities and annual and final reports. The primary objective of these reports is to discuss development of the village-level RET implementation process, progress towards meeting program objectives and technological developments. The schedule for these deliverables is given in Chart No. 7, entitled "RET Program Implementation Chronology". External program evaluation will be performed by the LDTC Service Agency under the Ministry of Education. In summary, the evaluation procedure proposed for the RET program is comprehensive from an internal process and overall program management point of view. It is estimated that about 20% of the program effort will be devoted to this activity.

AID will draw upon these program evaluation documents as well as program personnel in producing an annual PES. The PES's will be produced by mission staff, REDSO staff, outside consultants under PDS funding, or some combination of the three.

One of the tasks involved in the second annual PES preparation will be to determine whether there should be a major, outside evaluation toward the end of the project and, if so, define evaluation team qualifications and requirements plus their scope of work. The evaluation would be funded with PDS funds.

## VII. Conditions Precedent, Covenants and Negotiating Status

### A. Conditions Precedent

Prior to the execution of the technical services contract, the Grantee will furnish to AID satisfactory assurance that:

1. The AT Section Chief in the MORD has been hired.

2. A suitable plot of land has been identified and obtained for the Program Coordinator's house.

3. Office space, warehouse space and laboratory space has been identified and will be available at project start-up.

### B. Covenants

The Grantee will covenant that:

1. An Appropriate Technology Section with eight full time technical employees has been established (but not necessarily fully staffed) in the Ministry of Rural Development. The Section will be funded for the full three-year life of the project.

2. Project personnel in the AT Section will be qualified for training in the technologies being introduced.

3. Space will be made available as required by the project at the farmer training centers in Mokhotlong, Qacha's Nek, and Mohale's Hoek.

4. Periodic meetings will be arranged (as will be specified in Implementation Letters) between USAID, Program Coordinator, Ministry of Rural Development, Ministry of Planning and Development and Ministry of Finance for the purpose of reviewing project progress and action to be taken by the Ministry of Rural Development to take over the activities and functions of the AID-financed technical assistance team, who will be phased out within the project three year life.

### C. Negotiating Status

During the course of PP preparation the design team met several times with the Acting Permanent Secretary for Planning, the Permanent Secretary for Rural Development, their supporting staff, and appropriate staff from related ministries. The draft PP was reviewed at a final meeting of all related ministries, including Finance, which reviewed the project for recurrent cost and absorptive capacity implications. The GOL then stated its concurrence per Annex H in basic project approach.

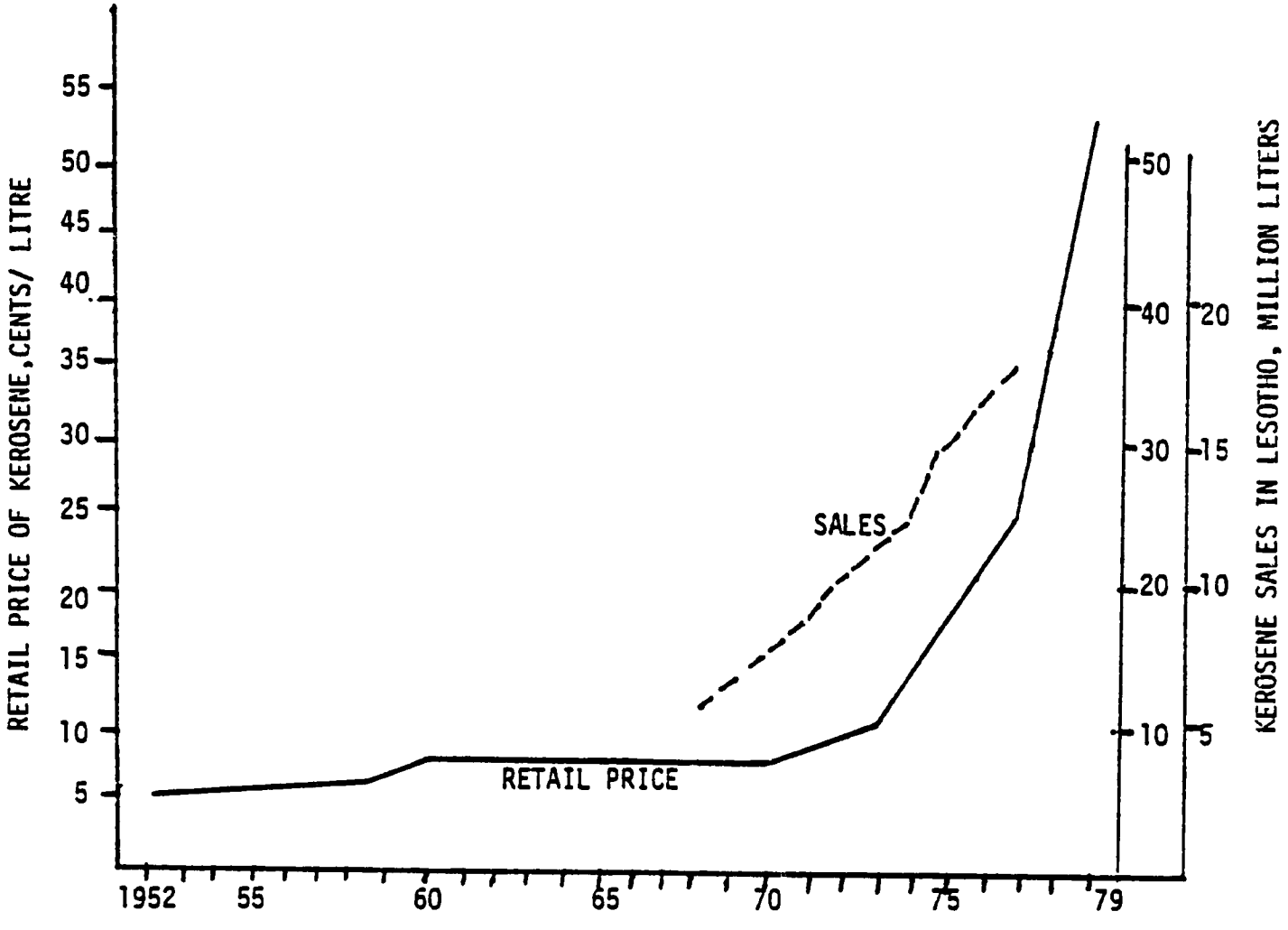
APPENDIX #A

Charts and Maps


| TITLE | CHART # |
|---|---|
| Kerosene Cost and Consumption in Lesotho from 1952 - 1979 | 1 |
| RET Program Trainee Selection Areas - Map | 2 |
| RET Program Demonstration Impact Areas - Map | 3 |
| RET Program Training Center Location - Map | 4 |
| Village-Level RET Implementation Process | 5 |
| RET Program Implementation Schedule | 6 |
| RET Program Implementation Chronology | 7 |
| Proposed RET Program Organization | 8 |
| Matching Basic Needs and Renewable Energy Technologies | 9 |
| Ministry of Rural Development Organizational Chart | 10 |
| Village Energy Use-Per Family of Four | 11 |

CHART #1

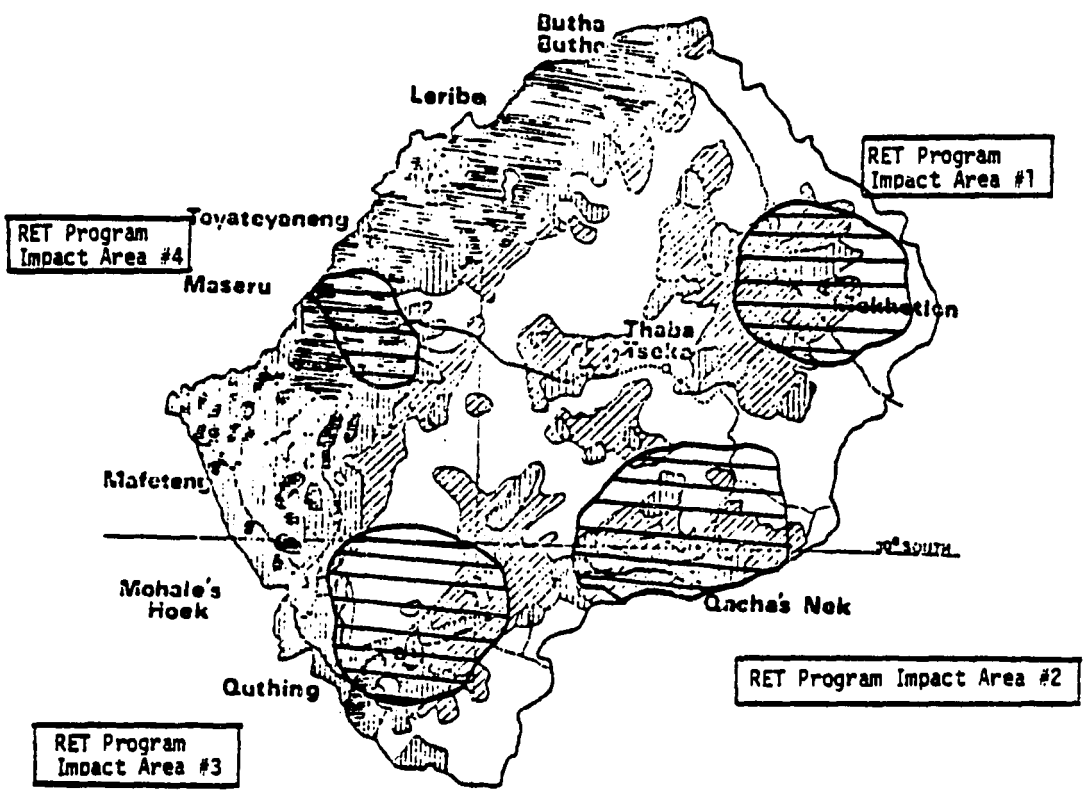
KEROSENE COST AND CONSUMPTION IN LESOTHO FROM 1952 to 1979




National expenditure on kerosene has increased 11 times in nine years, from R412,000 to R4,55 million.

CHART #2

## RET PROGRAM TRAINEE SELECTION AREAS




29° EAST

**POPULATION DISTRIBUTION**

key

- 0-45 per sq km
- 46-83 per sq km
- 84-175 per sq km
- 176-450 per sq km
- 451 and above

CHART #3

RET PROGRAM DEMONSTRATION IMPACT AREAS

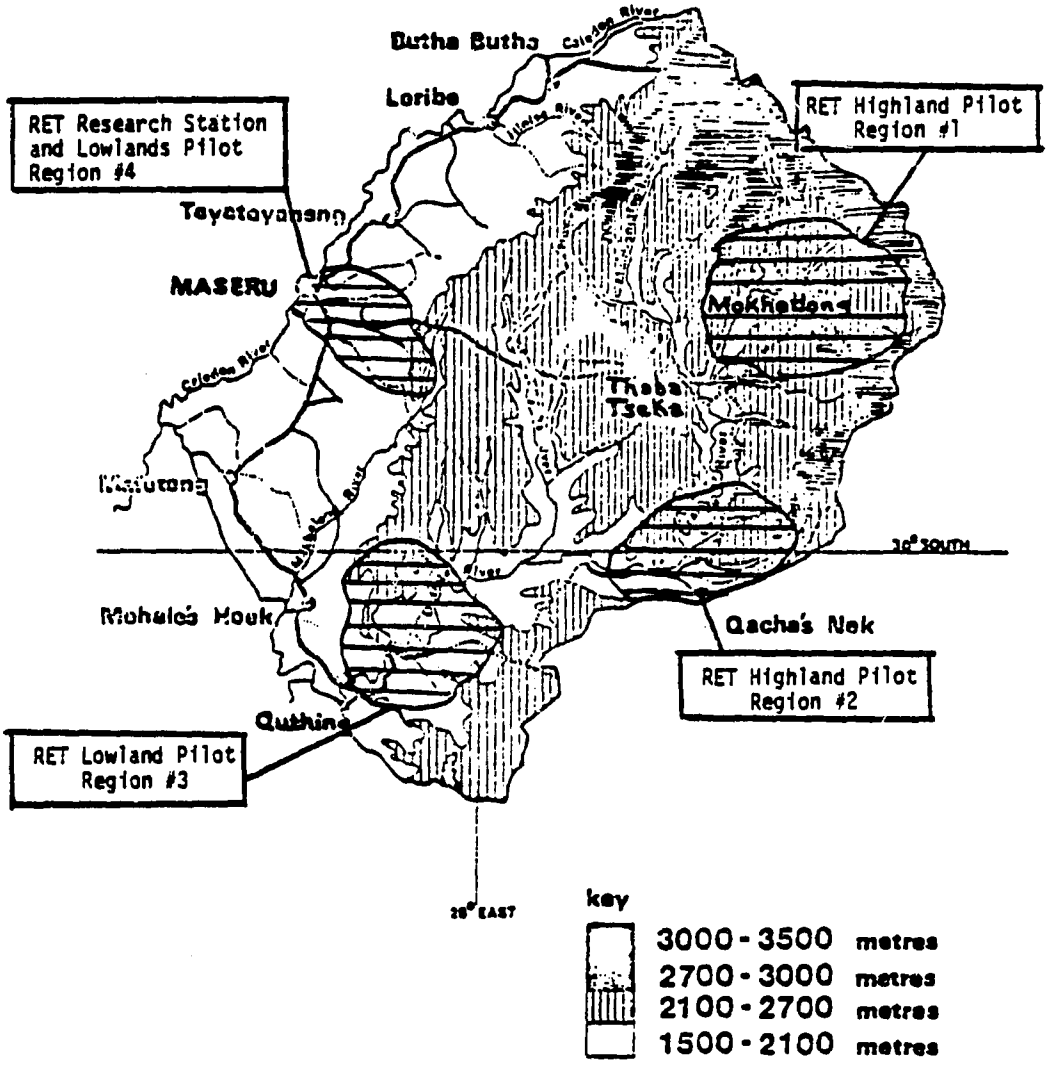
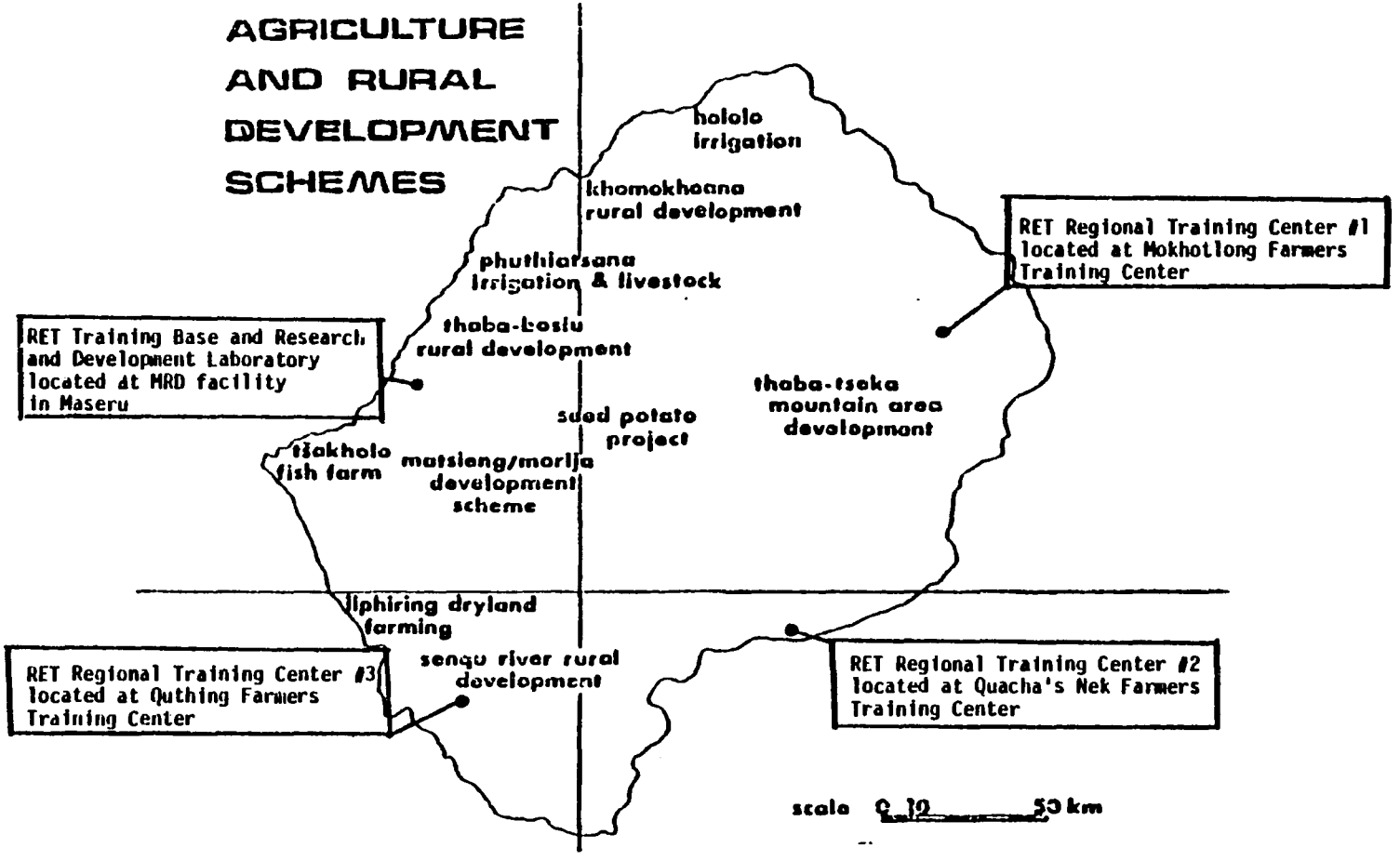


CHART #4

## RET PROGRAM TRAINING CENTER LOCATIONS



## VILLAGE-LEVEL RET IMPLEMENTATION PROCESS

A - 5

CHART #5

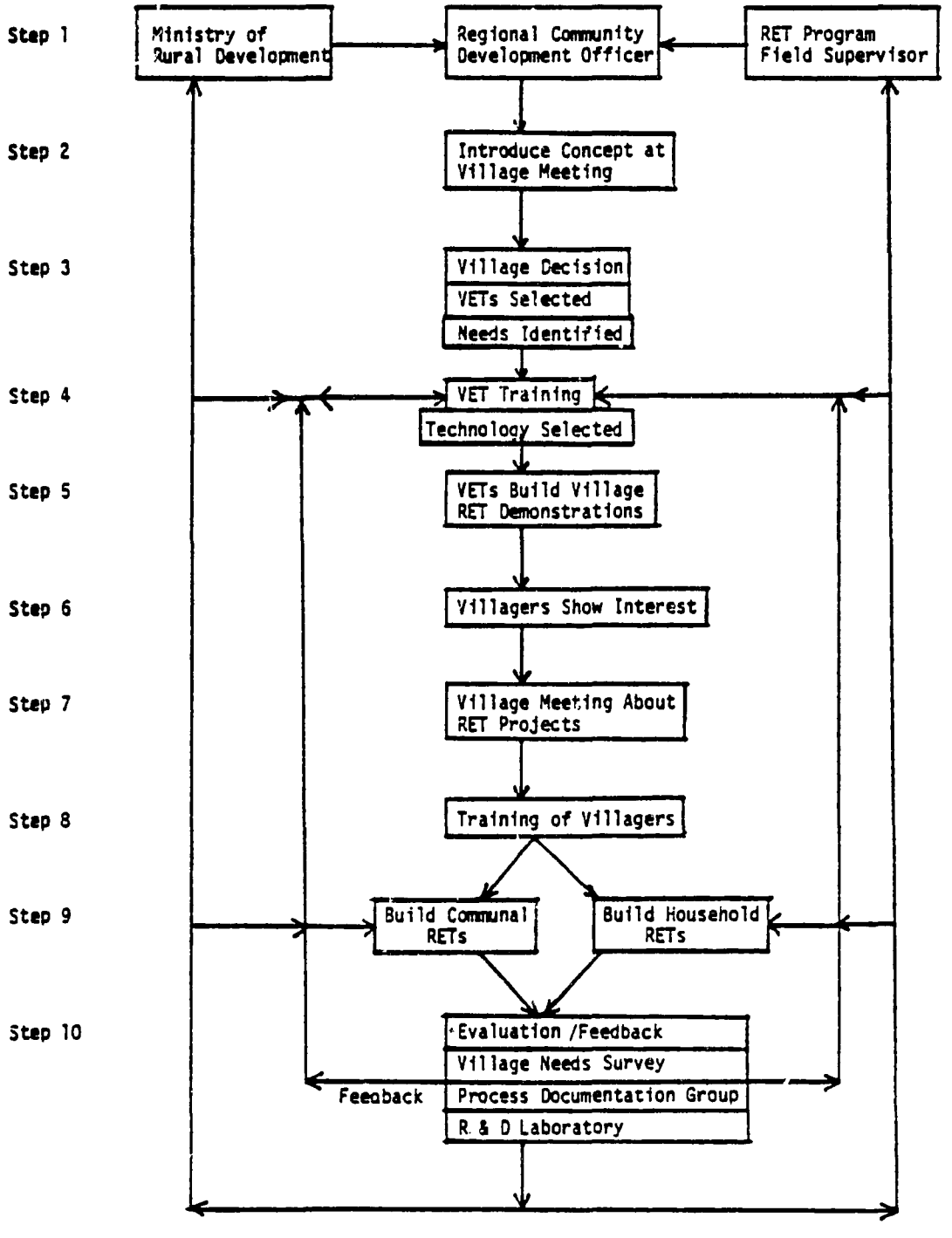


CHART # 6

C. RET PROGRAM IMPLEMENTATION SCHEDULE
(See RET Program Implementation Chronology)

| TIMELINE MONTHS | ACTIVITY | RESPONSIBILITY |
|---|---|---|
| D | Sign RET Project Agreement | GOL/USAID |
| D+2 | AID/W Releases R.F.P. | USAID/W |
| D+6 | Support Services Contract Award Project Begins | USAID/W |
| D+8 | Contract Start-Up - Staffing | USAID/W - Contractor |
| D+10 | Project Staff Orientation US/Lesotho | Contractor |
| D+10 | P.M. Passive Solar House Construction (4 months completion time) | Contractor/GOL USAID |
| D+10 | Process Evaluation Group Meeting (begin - held every two weeks) | Contractor/Field Supervisor |
| D+10 | Begin monthly Program Advisory Meeting Begin monthly Technical Reports to staff MRD and BEDCO Newsletter | Contractor/ Program Manager |
| D+10 | GOL Appropriate Technology Unit hired | GOL/MRD |
| D+10 | Program organization and procurement | Contractor/USAID |
| D+12 | Staff Training (Language) | Contractor/ Consultant |
| D+13 | Staff Training (Evaluation Process) | Contractor/ Consultant |
| D+13 | Staff Training (Technology) | Contractor/ Consultant |
| D+13 | Village meetings, presentations and survey begins | Contractor/Field Supervisor |
| D+13 | Village Energy Technicians (VET) trainees selected | Contractor/Field Supervisor |
| D+14 | Train 1st group of VET trainees at RET rural district #1 (Mokhotlong Farmers Training Center) | Contractor |
| D+14 | Set up RET Research Laboratory in Maseru | Contractor/MRD/GOL |
| D+17 | Begin construction of village demonstration units (continue throughout program) | Contractor |
| D+18 | Annual Report | Contractor |
| **D+18** | *** MRD AT Unit assumes responsibility for training and survey activities.** | **MRD AT Unit** |
| D+20 | Begin R&D unit pilot project Install methane digester plant at Masianokeng Feedlot | Contractor |
| D+21 | Formal progfram evaluation conference | Contractor |
| D+22 | First VET group begins village construction of household and community RET units | VETs/Contractor |
| D+22 | Train 2nd VET trainees group (60 trainees) at RET rural District #2 (Qachas Nek) | Contractor/ATUnit |

| TIMELINE MONTHS | ACTIVITY | RESPONSIBILITY |
|---|---|---|
| D+24 | *Evaluation of MRD AT Unit training and administrative capabilities | Contractor |
| D+26 | Second R&D Pilot Project - install mini 3 to 5 kw hydroelectric system to replace diesel electric generator located at clinic in the Ha Lejone-Rampais areas | Contractor |
| D+26 | Second VET group begins village construction of household and community RET units | VETs/ Contractor |
| D+28 | Annual Report | Contractor |
| D+30 | *Evaluation of MRD AT Unit training and design capabilities | Contractor |
| D+32 | Train 3rd VET trainees group (60 trainees) at rural district #3 (Mohale's Hoek Farmers Training Center) | MRD AT Unit |
| D+36 | Evaluate MRD AT Unit training capabilities and survey effectiveness | Contractor |
| D+36 | Third VET group begins village construction of household and community RET units | VETs/MRD AT Unit |
| D+38 | Formal program evaluation conference | MRD |
| D+40 | Final RET Program Report | Contractor |
| D+40 | End RET Program | MRD/USAID |

* important milestones in RET Program
e.g. transfer of responsibilities

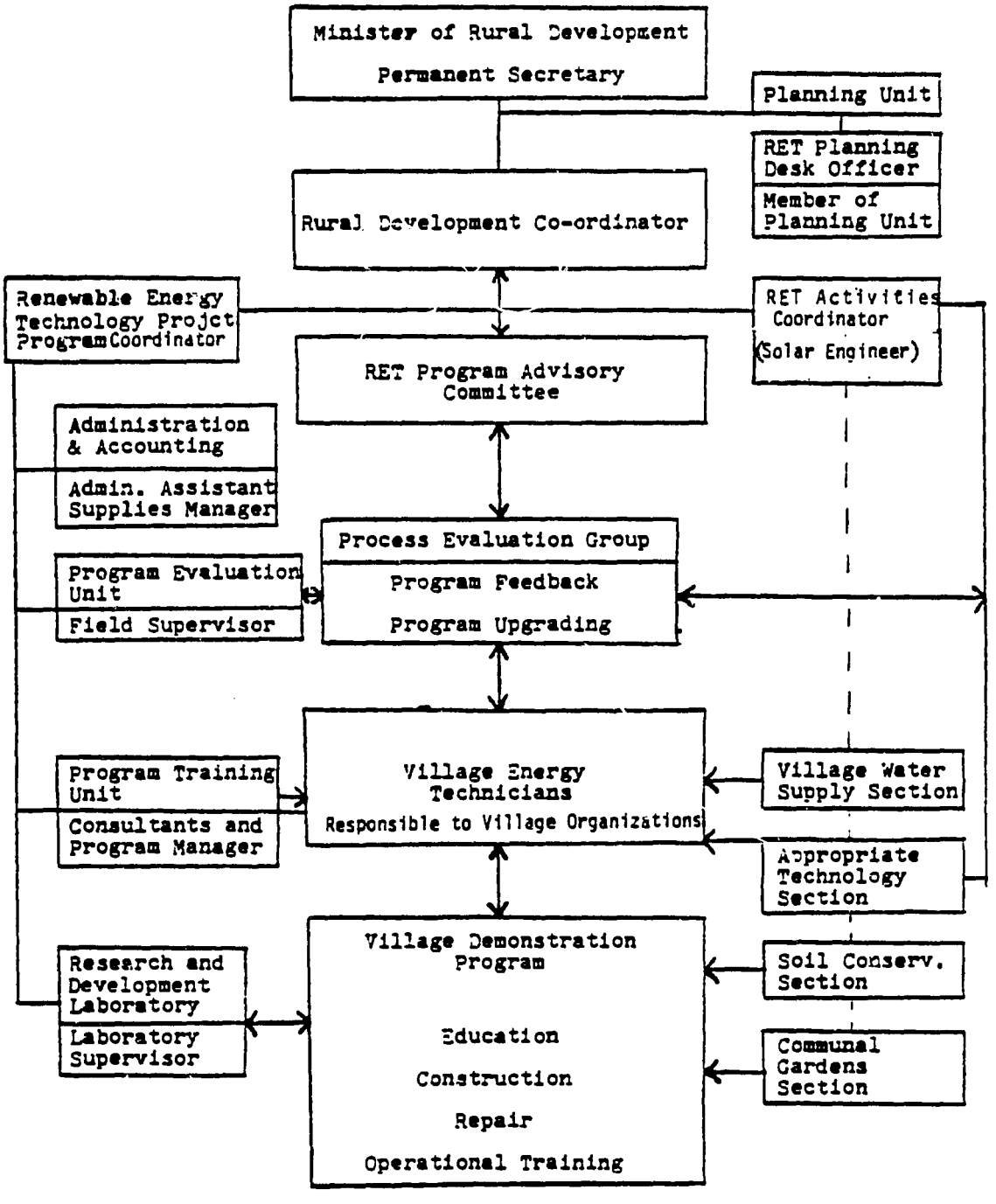
## RET PROGRAM IMPLMENTATION CHRONOLOGY

CHART # 7

| ACTIVITY | FIRST PROGRAM YEAR | SECOND PROGRAM YEAR | THIRD PROGRAM YEAR |
|---|---|---|---|
| A. Sign project agreement | | | |
| B. Request for Proposal (60 days) | | | |
| C. Prime contract award (90 days) | | | |
| D. Contractor start-up period | X----X | | |
| E. Staff orientation/planning | X----X | | |
| F. Program organization/procurement | X----X | | |
| G. Staff Training | | | |
| Language | X----X | | |
| Evaluation Process | X----X | | |
| Technology | X----X | | |
| H. Village Presentations/survey | X----X | continuous | |
| I. VET selection | X------X | continuous | |
| J. Train AT Unit | X----X | | |
| K. Train VET 1st group | X----X | X | |
| L. Set up RET laboratory | X----X | | |
| M. Village demonstration units | X----X | | |
| N. R&D activities | | X------X bio-gas; X mini-hydro. X | |
| O. Solar house construction | | | |
| P. Train VET 2nd group | | X----X X | |
| Q. Build household and community units | | X------X continuous | X |
| R. AT Unit assumes training responsibility | | X | |
| S. Train VET 3rd group | | | X----X X |
| T. Evaluation | | | |
| AT Unit capability | | X----------X----------X | X----------X----------X |
| Process evaluation group | X continuous | | |
| Advisory committee | X X X X X X X | X X X X X X X X X X X X | X X X X X X X X X X X X |
| Monthly Technical Report (BEDCO newsletter) | X X X X X X X | X X X X X X X X X X X X | X X X X X X X X X X X X |
| U. Annual Report | | X----------X | X----------X |
| V. Final Report | | | X |

CHART #8

PROPOSED RENEWABLE ENERGY TECHNOLOGY PROGRAM ORGANIZATION



## MATCHING BASIC NEEDS AND RENEWABLE ENERGY TECHNOLOGIES

(Based on preliminary P.P. survey)

CHART # 9

| FELT NEED | PRIORITY TECHNOLOGIES | BENEFICIARY | EFFECT |
|---|---|---|---|
| Cooking | Wood and Dung Burning Mud Stoves | Women | Saves Money and Fuel |
| Food Supply | Grain Grinding and Grain Storage | Women | Saves Money and Time |
| Space Heating | Thatch Insulation and Weatherization | Family | Conserves Fuel/Warmer Houses |
| Food Production | Grow Hole Greenhouses | Women/Family | Employment and Cash Generation |
| Food Production | Community Passive Solar Greenhouse | Village | Increase Food Supply<br>Better Nutrition |

| ABSTRACT NEEDS | CANDIDATE TECHNOLOGIES | BENEFICIARY | EFFECT |
|---|---|---|---|
| Food preservation | Solar Food Dehydrators | Family | Improves Diet |
| Space Heating | Passive Solar Mass Wall<br>Attached Passive Solar Greenhouse | Family | Reduced Respiratory Disease<br>Saves Fuel |
| Communications | Solar Cell Trickel Battery Chargers | Village | Improved Education<br>Improved Clinic Performance |
| Irrigation | Solar Cell Water Pumping | Village | Improved Crop Yield |
| Water Heating (Institutional Structures) | Passive Batch/Thermosyphon Water Heaters | Women | Saves Fuel and Money<br>Improves Village Health |

| REGIONAL NEEDS IMPACTING RURAL POOR | RESEARCH AND DEVELOPMENT TECHNOLOGIES | BENEFICIARY | EFFECT |
|---|---|---|---|
| Utility (Electricity) Energy Replacement | Feedlot Anerobic Digestion System<br>Mini Hydrodynamic Electricity System | Regional/National<br>Village/National | Replaces Diesel/Improved Cattle Sales<br>Replaces Diesel Fuel |

LESOTHO MINISTRY OF RURAL DEVELOPMENT
ORGANIZATIONAL CHART

CHART #10

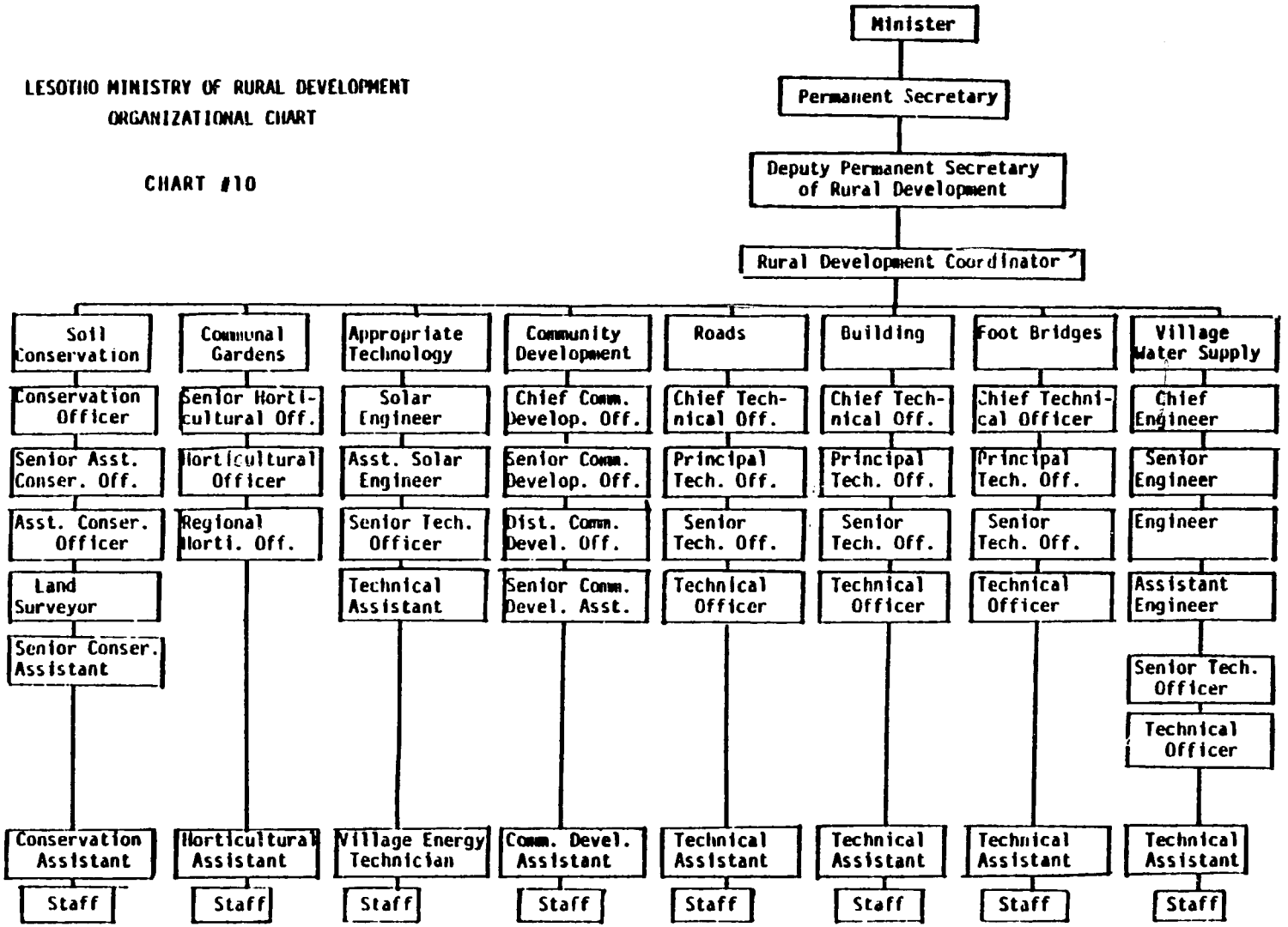


CHART NO. 11

## VILLAGE ENERGY USE - PER FAMILY OF FOUR

| FUEL | CALORIC VALUE DRY WT BTU/LB | COST $/M BTU | AVERAGE CONSUMPTION LBS/DAY/FAMILY | ESTIMATED CONSUMPTION PER DAY/FAMILY | EFFECTIVE TEMPERATURE °F | COMMENTS |
|---|---|---|---|---|---|---|
| Cow Dung | 3837 | (0.0) | 7.40 | 1.71lbs (6523 BTU) | 600 | no flame |
| Wood (wattle) | 8600 | (0.0) | 8.22 | 1.85lbs (15910 BTU) | 1300 | flame |
| Brushwood | 7800 | (0.0) | | | 1500 | fast combustion |
| Aloe | 7400 | (0.0) | | | | fast combustion |
| Kerosene (paraffin) | 19465 | 20.40+ | .20lts | .10lbs (1947 BTU) | 2000 | expensive |
| Gasoline (petrol) | 18571 | | | | | |
| Diesel | 19200 | | | | | |
| Solar (Winter) | 916/ft$^2$(hz)<br>1712/ft$^2$(vt) | 1.15<br>10yrs. | | 70,000BTU<br>125,000BTU | 90<br>150 | space heating |
| Soft coal | 11154 | | | | 1600 | |
| Charcoal | 12505 | | | | 1500 | |
| Pedal Power (grain grnd) | 500/hr* | 4.5<br>10yrs. | | 4,800BTU | 70 | grain grinding |
| Solar Cell | 50BTU /ft$^2$/hr | | | | | |
| Ethanol | 11000 | | | | | |

*efficiencies accounted for

Appendix E

## EQUIPMENT AND MATERIALS LIST

I. Equipment Lists (See Summary Cost Estimates and Financial Plan)

A. Media Equipment and Documentation Supplies - Item B.1.

B. Curriculum Materials - Item B.2.

C. Laboratory and Scientific Equipment - Item B.3.

D. Regional Training Workshop Equipment - Item B.4.

E. Trainees Tool Kits - Item B.5.

II. Demonstration Energy Saving Devices Construction Materials

Equipment List

A. Media Equipment and Documentation Supplies

| | | |
|---|---|---|
| 1. | 10 small 35mm cameras @ 50 | $1000 |
| 2. | 35mm film | 2000 |
| 3. | Processing of 35mm film | 2000 |
| 4. | 16mm movie camera | 1000 |
| 5. | 16mm film | 1000 |
| 6. | Processing of 16mm film | 2000 |
| 7. | Preparation of training film or slides | 4000 |
| 8. | Bolex 1600 movie projector | 1600 |
| 9. | Preparation and printing of reports | 9400 |
| 10. | Preparation and printing of documents | 3000 |
| 11. | Preparation of pamphlets (e.g. - "How to Build a Mud Stove") | 3000 |
| 12. | Translation and printing of pamphlets | 5000 |
| 13. | Preparation of slide shows | 3000 |
| 14. | Dark Room set-up | 3000 |
| | TOTAL | 40,000 |

B. Curriculum Materials

400 sets for training VETs

| | | |
|---|---|---|
| 1. | Construction blueprints and drawings | |
| | a. Mud woods stoves | $4,000 |
| | b. Dung burning stoves | 4,000 |
| | c. Community Greenhouse | 4,000 |
| | d. Solar growhouse | 4,000 |
| | e. Other designs as they are identified | 8,000 |
| 2. | Handbooks | 14,000 |
| 3. | Textbooks | 12,000 |
| | TOTAL | $46,000 |

C. Laboratory and Scientific Equipment

| Article | Units | Total Cost |
|---|---|---|
| 1) ITT Programable Calculator | 1 | 1,600 |
| 2) Honeywell 24 Channel Strip Chart Recorder | 4 | 12,000 |
| 3) Fluke Hotwin Animometer | 3 | 600 |
| 4) Epply Solar Pyronometer | 4 | 5,200 |
| 5) Epply Pyroheliometer | 2 | 3,200 |
| 6) Solar Tracking System | 2 | 1,200 |
| 7) DANA Integrating DVM | 3 | 3,600 |
| 8) Thermocouple Win CUK | | 3,100 |
| 9) Turbine Flow Meters | 8 | 8,300 |
| 10) VTVM | 4 | 1,200 |
| 11) Max Min Thermometers | 400 | 6,200 |
| 12) Dib Tube Thermometers | 400 | 5,600 |
| 13) Capillary Tube Thermometers | 400 | 4,600 |
| 14) Thermal probes Battery operated | (5 units) | 2,700 |
| 15) Electronic Maintenance Kits | (3 kits) | 1,800 |
| 16) Total IVRADIANA Radiometer | 3 | 4,200 |
| 17) Battery Digital Data Logers | 6 | 21,250 |
| 18) Soil Analyzer Battery Operated | 2 | 6,000 |
| 19) Soil Test Kits | 50 | 2,500 |
| 20) IBM Computer Typewriter on Line | | 12,000 |
| 21) Laboratory Supplies Glassware | | 16,000 |
| 22) Dehydration, Descicant Oven | | 1,100 |
| 23) Ballance | | 450 |
| Miscellaneous Equipment | | 600 |
| | TOTAL | $125,000 |

D. RET Regional Workshop Equipment - Mokhotlong Center 1

| | quantity | cost |
|---|---|---|
| gas welding set | 1 | R700.00 |
| table or floor stand drill, multiple speed | 1 | 600.00 |
| hydraulic press | 1 | 500.00 |
| hand four speed hammer drill (e.g. Bosch Combi) | 1 | 120.00 |
| set of socket wrenches 8mm - 32mm | 1 | 50.00 |
| set of flat/ring wrenches 6mm - 32mm | 1 | 50.00 |
| adjustable wrenches 6", 8" 10" | 3 | 20.00 |
| pipe wrenches 2 x 14", 2 x 20" | 4 | 40.00 |
| pipe wrench/plier-combination 20" | 1 | 15.00 |
| bench grinder 200mm ø | 1 | 150.00 |
| set of taps and dies 6mm - 24mm | 1 | 80.00 |
| set of taps and dies 2mm - 10mm | 1 | 25.00 |
| wall tool cabinet | 1 | 150.00 |
| bench vices 100mm & 150mm | 2 | 150.00 |
| battery charger 6/12 Volt 3 Amps | 1 | 20.00 |
| mobile welding plant with 220 Volt outlet | 1 | 900.00 |
| pipe vice | 1 | 50.00 |
| pipe dies ½",... 2", depending on make | 2-4 sets | 250.00 |
| pipe cutter | 1 | 50.00 |
| set of files for steel | 6 | 50.00 |
| wood rasp | 1 | 10.00 |
| water pump pliers | 2 | 15.00 |
| multi purpose pliers 2 sizes | 2 | 15.00 |
| side cutter | 1 | 10.00 |
| hack saw & spare blades | 1 | 18.00 |
| general purpose saw & spare blade | 1 | 10.00 |
| small hack saw & spare blades | 1 | 5.00 |
| tank and washer cutter | 1 set | 20.00 |
| drill set 1mm - 13mm x 0,5mm | 1 | 40.00 |
| wood chisels 10mm, 20mm, 30mm | 3 | 20.00 |
| cold chisels 10mm, 20mm | 2 | 10.00 |
| brick bolsters 75mm, 100mm | 2 | 20.00 |
| set of drive punches | 1 | 10.00 |
| set of marking punches | 1 | 20.00 |
| vernier caliper 200mm | 1 | 30.00 |
| tape measures 2m, 3m, 15m | 3 | 50.00 |
| steel ruler 300mm | 1 | 5.00 |
| spring type divider 150mm | 1 | 10.00 |
| try square 300mm | 1 | 10.00 |
| small steel square 300mm x 500mm | 1 | 20.00 |
| slip joint pliers | 1 | 5.00 |
| fencing pliers | 2 | 30.00 |
| long chain nose pliers | 1 | 5.00 |
| round nose pliers | 1 | 5.00 |

RET Regional Workshop Equipment - continued

| | quantity | cost |
|---|---|---|
| heavy duty diagonal cutter | 1 | R10.00 |
| fencing tool | 1 | 15.00 |
| wrecking bar | 1 | 20.00 |
| set of flat screw drivers | 1 | 10.00 |
| set of philips screw drivers | 1 | 10.00 |
| spiral ratchet screw driver | 1 | 10.00 |
| set of miniature (watch maker's) screw drivers | 1 | 10.00 |
| vice grips 2 types | 4 | 40.00 |
| carpenter clamps 2 x 12", 2 x 36" | 4 | 80.00 |
| G-clamp 2 x 3", 2 x 8" | 4 | 30.00 |
| pop riveter & collection of various size rivets | 1 | 50.00 |
| riveting hammer 250 g | 1 | 5.00 |
| engineer's hammer 250 g | 1 | 5.00 |
| claw hammer 350 g | 1 | 15.00 |
| 4-pound hammer | 1 | 10.00 |
| sledge hammer 10 pound | 1 | 20.00 |
| rubber mallet | 1 | 5.00 |
| nylon mallet bounce free | 1 | 10.00 |
| tool boxes 1 large, 1 small | 2 | 40.00 |
| tool cabinet 1 floor type | 1 | 150.00 |
| angle grinder, heavy duty (AEG, Bosch) | 1 | 150.00 |
| grinding and cutting discs for above (steel, stone) | 10 | 50.00 |
| small air compressor with pressure tank etc. | 1 | 350.00 |
| oil filled welding transformer 60 - 250 Amps | 1 | 180.00 |
| welding shield | 2 | 30.00 |
| gas welding goggles | 2 | 20.00 |
| grinding safety goggles | 2 | 10.00 |
| welding and brazing rods, electric and gas | - | 100.00 |
| small lathe | 1 | 1,000.00 |
| accessories | - | 200.00 |
| raw materials to lathe (steel rods, bronze, etc.) | - | 100.00 |
| small 2-speed hand electric drill | 1 | 50.00 |
| set of radio chassis punches | 1 | 100.00 |
| motor hack saw | 1 | 450.00 |
| raw materials (angle iron, piping, sheeting, etc.) | - | 1,000.00 |
| set of bolts and nuts | - | 25.00 |
| nails, etc. | - | 50.00 |
| circular table saw | 1 | 300.00 |
| small planer, 1 HP electric drive | 1 | 350.00 |

RET Regional Workshop Equipment - continued

| | quantity | cost |
|---|---|---|
| work benches heavy duty with drawers | 82 | R500.00 |
| cleaning materials | - | 50.00 |
| paint brushes 10, 20, 50, 75mm | 4 | 15.00 |
| paint rollers 50, 100, 200mm | 3 | 25.00 |
| extension cable 50m, on reel | 1 | 50.00 |
| small electrical appliances (multiplugs, etc.) | 1 | 45.00 |
| spirit levels 2 size. | 2 | 30.00 |
| glass cutters | 2 | 10.00 |
| odds and ends | - | 460.00 |
| materials for construction, lockers/ banches | | 1,200.00 |
| 2 sets - Maseru R/D laboratory and Mokhotlong Training Center | | |
| TOTAL Cost in U.S; Dollars | | $27,000 |

E. Set of tools for Renewable Energy Technician (89 sets)

| | | quantity | cost |
|---|---|---|---|
| tool box | | 1 | R 25.00 |
| containing: | | | |
| adjustable wrenches | 6", 10" | 2 | 15.00 |
| set of files (half round, round, triangular) | | 3 | 20.00 |
| wood rasp | | 1 | 10.00 |
| water pump pliers | | 1 | 15.00 |
| multi purpose plier | | 1 | 8.00 |
| heavy duty side cutter | | 1 | 10.00 |
| hack saw + spare blades | | 1 | 10.00 |
| general purpose saw | | 1 | 10.00 |
| hand crank drill | | 1 | 20.00 |
| drill bit set, 12-piece, 1,5 - 12mm | | 1 | 15.00 |
| wood chisel | 20mm | 1 | 5.00 |
| cold chisel | 20mm | 1 | 5.00 |
| brick bolster | 75mm | 1 | 10.00 |
| set of drive puncher | | 1 | 10.00 |
| tape measure | 5m | 1 | 10.00 |
| steel square | 200mm x 300mm | 1 | 10.00 |
| long chain nose pliers | | 1 | 5.00 |
| set of flat screw drivers | | 1 | 10.00 |
| vice grip | | 1 | 10.00 |
| G-clamps | 3", 6" | 2 | 10.00 |
| claw hammer | 350 g | 1 | 10.00 |
| 4-pound hammer | | 1 | 10.00 |
| safety goggles | | 1 | 5.00 |
| radio chassis punches | 22mm, 32mm | 2 | 15.00 |
| small pop riveter | | 1 | 15.00 |
| bolts, screws, nails, rivets, etc. | | - | 10.00 |
| trimming knife | | - | 5.00 |
| paint brushes | 10mm, 50mm | 2 | 5.00 |
| caulking gun + silicone paste | | 1 | 5.00 |
| small spirit level | | 1 | 10.00 |
| glass cutter | | 1 | 5.00 |
| pad lock | | 1 | 5.00 |
| center punch | | 1 | 2.00 |
| tin snippers | | 1 | 10.00 |
| | TOTAL TOOL SET | | R365.00 |
| | 89 sets in U.S. Dollars | | $40.000.00 |

## II. Demonstration Energy Saving Devices Construction Materials

| | | |
|---|---|---|
| 1) | Fiberglass R8/$M^2$ (Filon 5g Greenhouse grade) | 25,000 |
| 2) | Fiberglass Framing and Hardware | 12,000 |
| 3) | Corrugated Sheet Metal | 8,000 |
| 4) | Timber | 22,000 |
| 5) | Paint | 2,000 |
| 6) | Nail Screens, etc. | 3,800 |
| 7) | Cement $60/cu. yd. - 520 cu. yds. | 16 ,000 |
| 8) | Metal pipe | 13,000 |
| 9) | PVC Pipe | 12,000 |
| 10) | Angle Iron Bolts, etc. | 6.,000 |
| 11) | Steel Tanks, 50 gal - 200 gals | 16,000 |
| 12) | Bicycle Parts (Pedal Power) | 3,000 |
| 13) | Screen Win (Hail Guard) | 1,200 |
| 14) | Miscellaneous | 800 |
| | TOTAL | $140,000 |

Appendix C

# LOGICAL FRAMEWORK

## Lesotho Renewable Energy Technology Project

(632-0206)

| NARRATIVE SUMMARY | OBJECTIVELY VERIFIABLE INDICATORS |
|---|---|
| Program or Sector Goal: To meet expanding energy demand, primarily among lower income groups, in ways that minimize national requirements for and usage of hard to obtain, high cost, or non-renewable energy. | Improved Rural and Settlement Urban Economy. |
| Project Purposes: To disseminate a set of renewable energy technologies (RET) throughout rural pilot areas and simultaneously to establish the institutional basis for their dissemination nationwide-through self help, entrepreneurial, and government programs-if they prove socially, technically and economically feasible. | 1) Permanent Renewable Energy organization with:<br>a) Ministry of Rural Development<br>b) Village Development Committees<br>c) Small Businesses (Rural and Urban).<br>2) Improved rural energy supply. |
| Outputs:<br>1. Trained personnel<br>2. Village Renewable Energy Process<br>3. Village technicologies introduced<br>4. Research & Dev. technologies<br>5. Research and Development Laboratory<br>6. Energy efficient house. | Magnitude of Outputs<br>140 VETs, 8 MORD staff, 2500 villagers<br>at least 4 different ones.<br>at least 2.<br>one.<br>one. |
| Inputs:<br>AID<br>1. Technical Assistance<br><br><br><br>2. Commodities<br><br><br><br><br><br>3. Local training<br><br>4. Construction<br>5. Support<br>GOL<br>1. Staff | Type and quantity:<br><br>3 long term (physical scientist, sociologist, and laboratory supervisor); 2 long term local hire; 20 person months short term.<br><br>5 vehicles, media equipment and supplies, laboratory and scientific equipment, research and development equipment, energy saving construction material, shop equipment.<br><br>travel, perdiem, lodging, supplies equipment.<br>1 energy efficient house<br>vehicle operations and maintenance $65,000 |

LOGICAL FRAMEWORK Cont.

Lesotho Renewable Energy Technology Project

(632-0206)

| NARRATIVE SUMMARY | OBJECTIVELY VERIFIABLE INDICATORS |
|---|---|
| GOL<br>2. Office Laboratory space<br>3. warehouse space and land | Eight technical and administrative positions. |

| MEANS OF VERIFICATION | IMPORTANT ASSUMPTION |
|---|---|
| Program Evaluation:<br><br>Survey and evaluation on site visits, utilization of control communities and feedback. | Assumptions for achieving goal inputs:<br>That Individuals, traditional rural organizations will accept the changes associated with this technology implementation process. |
| As evidenced by:<br>1) Ministry, Parastatal and Private Organizations.<br>2) The number and quality of renewable energy systems used.<br><br>3) The magnitude of renewable energy utilized. | Assumptions for achieving purpose:<br>1) Cooperation of GOL;<br><br>2) That the implementation and introduction process and demonstrations are socially acceptable and perform in accordance with village expectations. |
| Program Evaluation:<br><br>Inspection and Survey | Assumptions for achieving outputs:<br>Cooperation of GOL, Traditional government organizations and local leadership within MORD. |
| Inspection: | Assumption for providing inputs:<br><br>GOL, USAID and Peace Corps Inputs. |

# TELEGRAM

UNCLASSIFIED

Classification

Annex D

ACTION: AID
INFO : AMB DCM ECON ADM

06APR79 05:05

R 050031Z APR 79
FM SECSTATE WASHDC
TO IRUEHMU/AMEMBASSY MASERU 2853
INFO RUVNOC/AMEMBASSY NAIROBI 244
BT
UNCLAS STATE 084538

AIDAC, NAIROBI FOR REDSO

BEST AVAILABLE DOCUMENT

E.O. 12065 N/A

TAGS:

SUBJECT: RENEWABLE ENERGY TECHNOLOGY (632-0236) - LESOTHO

1. PID FOR SUBJECT PROJECT RECEIVED AID/W 2/27/79; REVISED PID RECEIVED AID/W 3/6/79. PID REVIEW CONDUCTED 3/13/79.

2. PID IS APPROVED. PID APPROVAL, IN THIS INSTANCE, DOES NOT INDICATE APPROVAL AT THE SCALE PROPOSED BOTH BECAUSE THE DOLLAR INPUT EXCEEDS OYB BY ALMOST DOLS 1 MILLION AND BECAUSE MULTI-DONOR PARTICIPATION MIGHT BE EASILY ORCHESTRATED IN THIS AREA ONCE AID HAS PLEDGED A MODEST COMMITMENT.

3. THE DUAL PURPOSE OF THE PROJECT IS APPROPRIATE; HOWEVER, THE EMPHASIS SHOULD BE ON THE ESTABLISHMENT OF THE INSTITUTIONAL BASIS FOR DISSEMINATION OF APPROPRIATE TECHNOLOGIES RATHER THAN UPON THE DISSEMINATION OF A SET OF TECHNOLOGIES. TO PRECLUDE THE POSSIBILITY OF THE PROJECT EMPHASIZING OPERATIONS TO THE EXCLUSION OF THE NECESSARY INSTITUTION-BUILDING, AID/W ADVISES THAT THE NUMBER OF TECHNOLOGIES TO BE DISSEMINATED THROUGH THE PROJECT SHOULD BE KEPT TO A MINIMUM, CERTAINLY NO MORE THAN 5 OR 6.

4. NOTING THAT SWISS TECHNICAL ASSISTANCE IS ALREADY IN PLACE, AID/W WOULD SUGGEST THAT THE PROJECT BE SO DESIGNED THAT THE U.S. (AID AND PEACE CORPS) TECHNICAL ASSITANCE WOULD BECOME PART OF A MULTI-NATIONAL, BUT ONLY PARTIALLY EXPATRIATE, IMPLEMENTATION TEAM.

5. THE FOLLOWING QUESTIONS SHOULD BE ADDRESSED BY USAID OR THE PP TEAM AS APPROPRIATE:

Classification

# TELEGRAM



A. WHATPORTION OF THE ENERGY NEEDS OF RURAL LESOTHO CAN XE MET FROM WOOD? WHAT IS THE SHAPE OF ENERGY NEEDS THAT CAN BE MET MORE CHEAPLY THROUGH RET OTHER THAN WOOD?

B. WHAT ARE ROUGH ESTIMATES OF THE COSTS OF THE VARIOUS TYPES OF EQUIPMENT TO BE INTRODUCED? ARE THESE COSTS COMPATIBLE WITH PER CAPITA DISPOSABLE INCOME IN RURAL AREAS?

C. WILL THE INSTITUTION TO BE BUILT BY THE PROJECT HAVE RECURRING COSTS IN EXCESS OF PROBABLE GOL BUDGET AVAILABILITY? CAN PORTION OF SAVINGS REALIZED BY INTRODUCTION OF RET BE CAPTURED TO DEFRAY RECURRENT COSTS?

D. WHY IS NO TRAINING CONTEMPLATED FOR REPLACEMENTS OF THE TA TEAM? HOW ARE THE NUMBER OF TRAINEES AND THE CONTENT OF THE TRAINING PROGRAMS DETERMINED?

E. ARE THE TECHNOLOGIES RECOMMENDED IN THE PID THE BEST IDEAS FOR LESOTHO? IS OXEN POWER FULLY EXPLOITED? IS THE EMPHASIS ON SOLAR ENERGY EXCESSIVE? (SUGGEST TEAM EXPLORE TECHNOLOGIES KNOWN TO VITA, THE NATIONAL ACADEMY OF SCIENCES AND TO WAGENINGEN AGRICULTURAL UNIVERSITY, THE NETHERLANDS INTER ALIA TO REVIEW SMALL SCALE RURAL ENERGY APPLICATIONS.

F. IS THE SUGGESTION FOR USE OF SHALLOW WELL WIND TECHNOLOGY COMPATIBLE WITH THE RURAL WATER SUPPLY PROJECT DESIGN TEAM'S FINDINGS THAT THE WIND IS TOO INCONSISTENT TO PROVIDE A DEPENDABLE POWER SOURCE IN LESOTHO?

G. IS SIMULTANEOUS DEVELOPMENT OF A VARIETY OF TECHNOLOGAECAIT T/ DIFFUSE EFFORTS AND CREATE AMBIGUITY REGARDING OBJECTIVES?

H. WHAT IS THE CURRENT POTENTIAL OF THE MINISTRY OF RURAL DEVELOPMENT TO MANAGE IMPLEMENTATION? WHAT WILL BE THE LEVEL OF TRAINING REQUIRED? WHAT IS THE PROBABLE AVAILABILITY OF BASOTHO QUALIFIED TO ENTER APPROPRIATE TRAINING?

I. WHY SHOULD ANAEROBIC DIGESTERS (BIOGAS) BE INTRODUCED TO LESOTHO? IS THERE EVIDENCE THAT FAMILY SIZE UNITS MIGHT BE COST EFFECTIVE IN LESOTHO ALTHOUGH THEY HAVE NOT GENERALLY PROVEN TO BE COST EFFECTIVE ELSEWHERE?

J. WAS THE MICRO-HYDO TECHNOLOGY DELETED INTENTIONALLY



OPTIONAL FORM 151(H
(Formerly FS-412(H)
January 1975
Dept. of State
50151-102

FROM THE ORIGINAL VERSION OF THE PID? WOULD TESTS IN REMOTE GOVERNMENT OFFICES AND CLINICS NOW USING DIESEL-GENERATED POWER IN THE 1-2 KW RANGE BE LIKELY TO INDICATE THAT MICRO-HYDRO SYSTEMS COMPETE WITH DIESEL ELECTRICITY?

K. ARE TWO U.S. TECHNICIANS ESSENTIAL? CAN'T THE SWISS TECHNICIAN BE ENCOURAGED TO REMAIN? IF A SOLAR ARCHITECT/ENGINEER IS JUSTIFIED, WHAT IS THE RELATIVE IMPORTANCE OF THE SKILLS REQUIRED?

L. ARE GLASS GREENHOUSES PRACTICAL IN LESOTHO OR ARE HAILSTORMS FREQUENT AND WIDESPREAD ENOUGH TO GUARANTEE THEIR ANNUAL DESTRUCTION?

M. SHOULD NOT FEASIBILITY ASSESSMENT BE CONSIDERED FIRST PROJECT ACTIVITY TO BE USED AS INITIAL BASIS FOR MATCHING TECHNOLOGIES AND VILLAGERS PRIOR TO FIELD TEST OF NEW SYSTEMS?

6. PP TEAM SHOULD REVIEW ONGOING WOOD-LOT PROGRAMS AND ASSESS ADVISABILITY OF INCLUDING PILOT WOOD-LOTS IN RET PROJECT.

7. REGARDLESS OF INTENT, SHORT TERM TRAINING IN U.S. WOULD PROVIDE BASOTHO WITH EXTENSIVE EXPOSURE TO INAPPROPRIATE TECHNOLIGIES OUTSIDE RELEVANT SOCIO-ECONOMIC CONTEXT. THEREFORE, THE REQUIRED SHORT-TERM TRAINING SHOULD BE UNDERTAKEN IN LESOTHO.

8. FOLLOWING ARE SUGGESTED CHANGES IN SCOPES OF WORK FOR P DESIGN TEAM:

A. PHYSICAL SCIENTIST - DELETE RESPONSIBILITY FOR PREPARING JOB DESCRIPTION FOR TRAINING SPECIALIST; ADD RESPONSIBILITY FOR PREPARING TECHNICAL PORTIONS OF DETAILED PROJECT IMPLEMENTATION PLAN. UER THE FIFTH TASK ADD (E) NATURAL AND RENEWABLE ENERGY RESOURCES, I.E.: SOLAR, WIND AND WATER. ALSO ADD A NINTH TASK: DEVELOP PROPOSED EQUIPMENT LIST AND DETAILED COST ESTIMATES.

B. SOCIAL SCIENTIST:

(1) REWRITE EXISTING TASK 5 TO READ: QUOTE CONDUCT VISITS

TO SELECTED RURAL AREAS TO ASSESS (A) VILLAGE LEVEL TASKS THAT MIGHT BE ENERGIZED, IN ACCORD WITH LOCAL PRIORITIES

AND DESIRES, (B) CURRENT ENERGY USES AND PRACTICES, AND (C) LOCAL SOCIOLOGICAL, CULTURAL AND INSTITUTIONAL FACTORS THAT MAY SUGGEST WHICH TECHNOLOGIES SHOULD BE INTRODUCED AND HOW THIS SHOULD BE DONE UNQUOTE.

(2) ADD, AS A SEPARATE TASK PRECEDING TASK 7: QUOTE - PROPOSE A DATA-GATHERING AND EVALUATION SYSTEM TO DETERMINE WHICH DEVICES SHOULD BE TESTED IN WHICH VILLAGES. SUCH A SYSTEM WOULD TAKE INTO ACCOUNT VILLAGERS' ENERGY PRIORITIES AND DESIRES; ALONG WITH LOCAL ECONOMIC AND INSTITUTIONAL CONDITIONS BEARING ON THE APPROPRIATENESS OF SPECIFIC SYSTEMS FOR SPECIFIC VILLAGES UNQUOTE.

(3) ADD: QUOTE PREPARE DETAILED JOB DESCRIPTION FORTHE SOCIAL SCIENTIST TO BE INCLUDED ON THE PROJECT IMPLEMENTATION TEAM UNQUOTE.

C. ECONOMIST. ADD, AS A NEW TASK: CARRIES OUT ILLUSTRATIVE BENEFIT-COST ANALYSES OF PROPOSED TECHNOLOGIES. RETURNS MAY BE MEASURED IN BBL OF PETROLEUM SAVEDOR NOT IMPORTED, PERSON HOURS SAVED AND/OR VOLUME OF WOOD SAVED.

9. IN ADDITION TO PID, PP DESIGN TEAM SHOULD BE PROVIDED WITH FOLLOWING PUBLICATIONS, COPIES OF WHICH ARE BEING POUCHED TO USAID MASERU AND TO REDSO/EA:

A. ECONOMICS OF RENEWABLE ENERGY SYSTEMS, A MONOGRAPH BY DAVID FRENCH, AFR/DR/SDP.

B. ENERGY IN THE DEVELOPMENT STRATEGY OF THE SAHEL, CLUB DU SAHEL, OCT 78.

10. RENEWABLE ENERGY WORKSHOP/TRAINING SPECIALIST POSITION SHOULD BE ELIMINATED FROM PP TEAM AND REPLACED BY SOCIAL SCIENTIST WITH SKILLS IN BOTH TRAINING AND TECHNOLOGY ASSESSMENT. VANCE

ANNEX E

## STATUTORY CHECKLIST

### 6C(2) - Project Checklist[1/]

Listed below are, first, statutory criteria applicable generally to projects with FAA funds, and then project criteria applicable to individual fund resources: Development Assistance.

A. General Criteria for Project

1. App. Unnumbered; FAA Sec. 653(c); Sec. 634A.

| | |
|---|---|
| (a) Describe how Committees on Appropriations of Senate and House have been or will be notified concerning the project; | (a) This project was included in the FY 1979 Congressional Presentation. |
| (b) Is assistance within (Operational Year Budget) country or international organization allocation reported to Congress (or not more than $1 million over that figure plus 10%)? | (b) Yes |
| 2. FAA Sec. 611(a)(1). Prior to obligation in excess of $100,000, will there be (a) engineering, financial and other plans necessary to carry out the assistance and (b) a reasonably firm estimate of the cost to the U.S.? | (a) N.A. (Construction less than $100,000).<br>(b) Yes |
| 3. FAA Sec. 611(a)(2). If further legislative action is required within recipient country, what is basis for reasonable expectation that such action will be completed in time to permit orderly accomplishment of purpose of the assistance? | No legislative action required. |
| 4. FAA Sec. 611(b); App. Sec. 101. If for water or water-related land resource construction, has project met the standards and criteria as per Memorandum of the President dated Sept. 5, 1973 (replaces Memorandum of May 15, 1962; see Fed. Register, Vol. 38, No. 174, Part III, Sept. 10, 1973)? | This is not a water or water-related land resource construction project. |

1/ FY 1979 country checklist submitted with the Rural Water and Sanitation Project, 632-0088

| | |
|---|---|
| 5. FAA Sec. 611(e). If project is capital assistance (e.g. construction), and all U.S. assistance for it will exceed $1 million, has Mission Director certified the country's capability effectively to maintain and utilize the project? | Not applicable. |
| 6. FAA Sec. 209, 619. Is project susceptible of execution as part of a regional or multilateral project? If so why is project not so executed? Information and conclusion whether assistance will encourage regional development programs. If assistance is for newly independent country, is it furnished through multilateral organizations or plans to the maximum extent appropriate? | No. |
| 7. FAA Sec. 601(a); (and Sec. 201(f) for development loans). Information and conclusions whether project will encourage efforts of the country to:<br><br>(a) increase the flow of international trade;<br>(b) foster private initiative and competition;<br>(c) encourage development and use of cooperatives, credit unions, and savings and loans associations;<br>(d) discourage monopolistic practices. | The project is designed to lessen the dependence upon imported fuels and food and to encourage small private firms to manufacture and sell energy saving devices. It would very well encourage development of cooperatives and discourage the importation of many items. |
| 8. FAA Sec. 612(b); Sec. 636(h). Describe steps taken to assure that, to the maximum extent possible, the country is contributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized to meet the cost of contractual and other services. | GOL will contribute approximately 4.4% of the project costs. This is considered reasonable in view of Lesotho's international political climate, its status on the UN's list of "least developed countries," and its limited financial resource. To initiate this project, eight new positions have been established and funded in the Ministry of Rural Development. |

| | |
|---|---|
| 9. FAA Sec. 612(d). Does the U.S. own excess foreign currency and, if so, what arrangements have been made for its release? | Not an excess foreign currency country. |

B. FUNDING CRITERIA FOR PROJECT

1. Development Assistance Project Criteria

| | |
|---|---|
| (a) FAA Sec. 102(b); 111; 113; 281a. Extent to which activity will (a) effectively involve the poor in development, by extending access to economy at local level, increasing labor-intensive production and the use of appropriate technology, spreading investment out from cities to small towns and rural areas, and insuring wide participation of the poor in the benefits of development on a sustained basis, using the appropriate U.S. institutions; (b) help develop cooperatives, especially by technical assistance, to assist rural and urban poor to help themselves toward better life, and otherwise encourage democratic private and local governmental institutions; (c) support the self-help efforts of developing countries; (d) promote the participation of women in the national economies of developing countries and the improvement of women's status; and (e) utilize and encourage regional cooperation by developing countries? | (a)(b)(c)(d). This project is designed to specifically introduce appropriate technology to the rural poor in such a way that they are able to individually or collectively build or utilize energy devices that will improve their living conditions. To a large extent the project will be implemented by women and the energy saving devices will primarily benefit women. |
| (b) FAA Sec. 103, 103A, 104, 105, 106, 107. Is assistance being made available: (include only applicable paragraph which corresponds to source of funds used. If more than one fund source is used for project, include | |

relevant paragraph for each fund source.)

| | |
|---|---|
| (1) (103) for agriculture, rural development or nutrition; if so, extent to which activity is specifically designed to increase productivity and income or rural poor; | Several of the energy devices that will be introduced by this project are related to increasing agriculture and the preservation of food. This could well result in a family gowing more food than they can use during the off season and therefore making it available for sale. |
| (2) (106) for technical assistance, energy, research, reconstruction, and selected development problems; if so, extent activity is. | The specific intent of this project is to introduce energy saving devices and relieve the dependence upon imported fuels and diminishing wood supply. |
| (c) (107) Is appropriate effort placed on use of appropriate technology? | Yes |
| (d) FAA Sec. 110(a). Will the recipient country provide at least 25% of the costs of the program, project or activity with respect to which the assistance is to be furnished (or has the latter cost-sharing requirement been waived for a "relatively least-developed" country)? | A waiver will be requested. |
| (e) FAA Sec. 110(b). Will grant capital assistance be disbursed for project over more than 3 years? If so, has justification satisfactory to Congress been made, and efforts for other financing or is the recipient country "relatively least-developed"? | No, life of project is 3 years. |
| (f) FAA Sec. 281(b). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilizes the country's intellectual resources to | The particular energy saving devices introduced by this project will be determined by a study of the rural poors needs and desires. No relation |

| | |
|---|---|
| encourage institutional development; and supports civil education and training in skills required for effective participation in governmental and political processes essential to self-government. | to training in civil education. |
| (g) FAA Sec. 122(b). Does the activity give reasonable promise of contributing to the development of economic resources, or to the increase of productive capacities and self-sustaining economic growth? | Yes |
| International Air Transport. Fair Competitive Practices Act, 1974. If air transportation of persons or property is financed on grant basis, will provision be made that U.S.-flag carriers will be utilized to the extent such service is available? | Yes |
| FY 79 App. Act Sec. 105. Does the contract for procurement contain a provision authorizing the termination of such contract for the convenience of the United States? | NA |

## WAIVERS AND APPROVALS

1. Waivers and Approvals Required.

1. Waiver of the 25 percent cost sharing requirement contained in Section 110 (a) of the Foreign Assistance Act of 1961 as amended.

---

2. A procurement waiver to permit the purchase of shelf items imported from other free world sources in excess of the total amount allowed by AID Handbook I Supplement B, 18A, 4b.

II. Waiver Justification

1. Waiver of the 25 Percent Cost Sharing Requirement Contained in Section 110 (a) of the Foreign Assistance Act.

Lesotho is on the United Nations Conference on Trade and Development list of relatively least developed countries. Lesotho will be contributing or over percent of the project total. Much of this contribution will be incremental budget expenditures rather than contributions in kind. The waiver is thus requested in view of Lesotho's position as an RLDC and its sizable contribution toward project costs.

---

2. Shelf-Item Procurement Waiver

The project provides for the construction of one house in Lesotho for the project manager and for the procurement and construction of several different energy saving devices.

The house will be of a unique design that utilizes and demonstrates energy saving devices. The cost of the house is estimated to be about $45,000, of which about $27,000 will be material cost.

The energy saving devices such as solar water and space heater, solar food dryers and cookers, improved round it over grow hole and greenhouses will be manufactured from locally purchased materials, $150,000 is budgeted in the project for this purpose.

In both cases, the project manager house and the energy savings devices, the intervals utilizes are lumber, paint, hardware, glass fiberglass, steel

sheets etc. The house will be constructed early in the project and the energy saving devices throughout the project life. As a result there will be hundreds of relatively small purchases made. Since practically more of these material has its source and origin in Lesotho, but is imported from the Republic of South Africa, there will be many purchases of shelf item totally approximately $175,000. This is a demonstration project one it is most important to show that the energy efficient house and the energy savings devices can be contructed with locally purchased materials. To purchase these materials from the U.S. or any other country would be contrary to the demonstration aspects of this project. Therefore a waiver is requested to exceed the total shelf item procurement allowed by Handbook 1, Supplement B, 18A 4b.

APPENDIX G

# INITIAL ENVIRONMENTAL EXAMINATION

| | |
|---|---|
| PROJECT LOCATION: | LESOTHO |
| PROJECT TITLE: | LESOTHO RENEWABLE ENERGY TECHNOLOGY |
| PROJECT NUMBER: | 632-0206 |
| FUNDING: | FY 1979 |
| PERIOD OF PROJECT: | THREE YEARS |
| IEE PREPARED BY: | USAID, JANUARY, 1979 |
| ENVIRONMENTAL ACTION RECOMMENDED: | NEGATIVE DETERMINATION |

CONCURRENCE: Frank W. Campbell — Feb 14, 1979

Frank W. Campbell
Acting Director
USAID/Maseru

Date

ASSISTANT ADMINISTRATOR'S DECISION:

APPROVED _____

DISAPPROVED _____

DATE _____

UNCLASSIFIED

# Department of State

INCOMING TELEGRAM

PAGE 01 MASERU 00532 01 OF 02 040327Z 5185 MASERU 00532 01 OF 02 040327Z

ACTION AID-31

INFO OCT-01 AF-10 EB-08 /058 W
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INFO AMEMBASSY NAIROBI

UNCLAS SECTION 1 OF 2 MASERU 0532

AIDAC

NAIROBI FOR REDSO

E.O. 12065: N/A
TAGS: N/A
SUBJECT: RENEWABLE ENERGY TECHNOLOGY PID 632-0205

REF: MASERU 0498,

1. TEXT OF REVISED IEE AS FOLLOWS:

INITIAL ENVIRONMENTAL EXAMINATION

LESOTHO RENEWABLE ENERGY TECHNOLOGY (0632-0205)

I. PROJECT DESCRIPTION
THE PROJECT IS DESIGNED TO DISSEMINATE A SET OF RENEWABLE ENERGY TECHNOLOGIES (RET) THROUGHOUT RURAL PILOT AREAS AND TO ESTABLISH THE INSTITUTIONAL BASIS FOR THEIR DISSEMINATION NATIONWIDE IF THEY PROVE SOCIALLY, TECHNICALLY, AND ECONOMICALLY FEASIBLE. THE PROPOSED PROGRAM WILL INTRODUCE AND DEMONSTRATE TECHNOLOGIES RESPONDING TO THE BASIC HUMAN NEEDS IN RURAL LESOTHO THAT ARE LOW COST, USE INDIGENOUS SKILLS AND MATERIALS, AND ARE EASILY MAINTAINED. THE INTRODUCTION OF A TECHNOLOGY WILL BE ACCOMPLISHED THROUGH THE EXISTING COMMUNITY DEVELOPMENT PROCESS AND WILL MATCH THE SPECIFIC NEEDS OF A RECIPIENT PILOT AREA WITH A PROVEN RET SOLUTION. BY CAREFULLY INTRODUCING TECHNOLOGIES TO RECIPIENTS, THE PROGRAM CAN GROW AT A RATE ACCEPTABLE TO THE PEOPLE AND THEIR GOVERNING STRUCTURE.

THE INDIVIDUAL TECHNOLOGIES TO BE INTRODUCED AND DEMONSTRATED ARE:

(1) SHALLOW-WELL WIND AND HYDRAULIC RAM PUMPING SYSTEM;
(2) THERMOSYPHON SOLAR WATER HEATING SYSTEM;
(3) SELF-HELP SOLAR WATER SYSTEM;
(4) SOLAR RELIANT GREENHOUSE;
(5) PASSIVE SOLAR HEATING, COOLING, AND VENTILATING SYSTEM;
(6) LOW POWER SOLAR CELL SYSTEM;
(7) SOLAR COOKERS, OVENS, AND DRYERS;
(8) IMPROVED WOOD STOVES; AND
(9) ANAEROBIC DIGESTORS.

IN ADDITION TO INTRODUCING, DEMONSTRATING, AND EVALUATING THE FEASIBILITY OF THE ABOVE SYSTEMS, THE PROJECT WILL CREATE THE INSTITUTIONAL CAPABILITY WITHIN THE MINISTRY OF RURAL DEVELOPMENT TO CARRY OUT AN EXPANDED RET PROGRAM SHOULD THE RESULTS OF THE PILOT PROJECT PROVE SUCCESSFUL. BY THE END OF THE THREE YEAR PILOT PHASE A SET OF ACCEPTABLE TECHNOLOGIES WILL HAVE BEEN IDENTIFIED WITH THE POTENTIAL TO: (1) MAKE A SUBSTANTIAL CONTRIBUTION TO RESOLVING PROBLEMS OF A NATIONAL SCALE SUCH AS SOIL EROSION; (2) HELP LESOTHO DEVELOP SUBSTITUTES FOR COSTLY AND DIFFICULT TO OBTAIN ENERGY SOURCES SUCH AS OIL; (3) PROVIDE RURAL HOUSEHOLDS WITH IMPROVED COOKING AND HEATING FACILITIES; (4) HELP THE GOVERNMENT OF LESOTHO EXTEND SOCIAL SERVICES (E.G. RURAL CLINICS) TO THE POPULACE AT LOWER COSTS OR, IN SOME CASES, EXTEND SERVICES THAT FOR LACK OF ENERGY WOULD BE OTHERWISE IMPOSSIBLE.

IN ORDER TO ACHIEVE THE OBJECTIVES OF THE PILOT PROJECT AID WILL FURNISH THE FOLLOWING INPUTS:

-TECHNICAL ASSISTANCE TO BUILD THE INSTITUTIONAL BASIS FOR A NATIONAL RET PROGRAM;
-TECHNICAL ASSISTANCE TO ADMINISTER THE PILOT DEMONSTRATION PROGRAM;
-PARTICIPANT TRAINING FOR BASOTHO STAFF WHO WILL EVENTUALLY PLAN AND IMPLEMENT THE GOVERNMENT'S RET PROGRAM;
-VEHICLES; AND
-COMMODITIES AND EQUIPMENT.

THE ESTIMATED LIFE OF PROJECT COST IS $1,514,000 WITH THE GOL CONTRIBUTING $360,330 IN SALARIES, LOCAL TRAVEL, PER DIEM, OFFICE SPACE, AND EQUIPMENT.

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## INITIAL ENVIRONMENTAL EXAMINATION

The renewable energy project is an effort to adopt and transfer an existing technology to Lesotho. The technology uses the energy from the sun, wind, falling water and anerobic digestors to substitute for energy usually derived from fossil fuels. The processes are perfectly compatible with the existing environment. The small-scale renewable energy technologies proposed in the PID have been selected in part because they are either environmentally benign or specifically because they promise to reduce environmentally destructive practices such as incipient deforestation. The whole point of the RET program is to design, develop and transfer technologies which harness already distributed renewable energy in small quantities to a dispersed rural population. In all cases the recommended technologies reduce the negative environmental, health, and social impacts currently associated with fossil energy-based technologies.

While the project is comptable with the existing physical environment, it will have some effect upon

the cultural environment. It will not destroy existing cultural practices but may require or induce some changes in practices. However, a negative determination is recommended since this is a pilot project, and will be tested in a confined and controlled area with ample opportunity to evaluate its effects. The project team will have available the services of a social scientist who will analyse the influences that the project will have on the culture.

## IMPACT IDENTIFICATION AND EVALUATION FORM

| Impact Areas and Sub-areas | Impact Identification and Evaluation |
|---|---|
| A. Land Use | |
| 1. Changing the character of the Land through: | |
| a. Increasing the population | |
| b. Extracting natural resources | N |
| c. Land clearing | N |
| d. Changing soil character | N |
| 2. Altering natural defenses | N |
| 3. Foreclosing important issues | N |
| 4. Jeopardizing man or his works | N |
| 5. Traffic access | N |
| 6. Land use planning | N |
| 7. Squatter, other development | N |
| B. WATER QUALITY | |
| 1. Physical state of water | N |
| 2. Chemical and biological states | N |
| 3. Ecological balance | N |
| C. ATMOSPHERIC | |
| 1. Air additives | N |
| 2. Air pollution | N |
| 3. Noise pollution | N |
| D. NATURAL RESOURCES | |
| 1. Diversion, altered use of water | N |

2. Irreversible, inefficient commitments _____ N

3. Wildlife _____ N

E. CULTURAL

1. Altering physical symbols _____ N

2. Dilution of cultural traditions _____ U

F. SOCIOECONOMIC

1. Changes in economic/employment patterns increased wages in rural areas _____ H

2. Changes in population _____ N

3. Changes in cultural patterns _____ L

4. Dislocation and relocation of area residents _____ N

5. Support facilities _____ L

G. HEALTH

1. Changing a natural environment _____ N

2. Eliminating an ecosystem element _____ N

3. New pathways for disease vectors _____ N

4. Safety provisions _____ H

H. GENERAL

1. International impacts _____ N

2. Controversial impacts _____ N

3. Larger program impacts _____ N

4. Aesthetics _____ N

N - No environmental impact
L - Little environmental impact
M - Moderate environmental impact
H - High environmental impact
U - Unknown environmental impact

## LESOTHO-NEEDS/RET IMPACT MATRIX

| Identified Needs | RET DESCRIPTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Shallow Well Wind Systems | Small Scale Hydro and Hydraulic Ram | Solar Hot Water | Solar Reflant Greenhouse | Passive Solar H/C/V | Solar Cell Communications | Solar Cookers, Dryers and Ovens | Improved Wood Stoves | Methane Digestors |
| A. Domestic: | | | | | | | | | |
| 1. Thermal Energy Source | | | x | x | x | | x | x | x |
| (a) Cooking | | | x | | | | x | x | x |
| (b) Heating | | | x | x | x | | | | x |
| 2. Improved Thermal Performance of Houses | | | x | x | x | | | | |
| 3. Water | x | x | | x | | | | | x |
| (a) Potable | x | x | | x | | | | | x |
| (b) Agricultural | x | x | | x | | | | | x |
| 4. Food Supply | x | x | | x | | | | | x |
| 5. Communications-Radio | | | | | | x | | | |
| 6. Rural Electrification | | x | | | | | | | |
| 7. Human and Animal Waste Disposal | | | | | | | | | x |
| 8. Overburden Women | x | | x | x | x | | | | x |
| B. Agricultural: | | | | | | | | | |
| 1. Traction | | | | | | | | | x |
| 2. Animal Food Supply | x | | | x | | | | | x |
| C. Socio-Economic: | | | | x | x | x | x | x | x |
| 1. Rural Employment | x | x | x | x | x | x | x | x | x |
| 2. Income Generation | x | x | x | x | x | x | x | x | x |
| 3. Technically Trained People | x | x | x | x | x | x | x | x | x |
| D. Environmental: | | | | | | | | | x |
| 1. Overgrazing | | | | x | | | | | x |
| 2. Deforestation | | | x | x | x | | x | x | x |

Annex M

MINISTRY OF RURAL DEV.
RECEIVED
11 JUL 1979
REF. NO.
P.O. BOX MS 686

10th July, 1979.

Frank Campbell Esq.,
Acting Director,
USAID,
P.O. Box 333,
MASERU - 100.

Dear Mr. Campbell,

Renewable Energy Technology Project

I refer to the draft project proposal for the above project jointly discussed with USAID on 5th and 6th June, 1979.

The general concepts underlying the project, the proposed approach and the proposed technologies are all fully acceptable to Government. I am afraid that we cannot give our formal approval and detailed comments on the document untill the Permanent Secretary of the Ministry of Rural Development returns to Lesotho in ten days time. However I hope you can initiate USAID's review of the project proposal in the meantime, to ensure that we do not lose the funds for this important project.

Yours sincerely,

J. MAJI (MLS).
Deputy Director, Planning.

BEST AVAILABLE DOCUMENT

ANNEX I

# THE ECONOMICS OF RENEWABLE ENERGY SYSTEMS FOR LESOTHO

From the economic point of view, renewable energy technologies for developing countries are of two major kinds: systems whose benefits are largely quantifiable, and systems whose benefits are unquantifiable or subjective. Techniques of economic analysis will vary according to the category into which a system falls.

## A. Technologies With Quantifiable Benefits*

In many cases, the predicted benefits of a renewable energy system can be quantified. Economic benefits of a growhole or a greenhouse, for example, are the market value of the seedlings or of the produce grown within. Benefits of a hand-driven grain mill are equivalent to commercial milling charges which no longer need be paid. Generally, these values can be estimated with a reasonable degree of accuracy.

An energy system will be worth testing if its benefits over time seem likely to be greater than its costs. This calculation will differ somewhat depending on the perspective from which it is made - that of the person who will ultimately invest in the system, or that of the society. These differing approaches are outlined below.

In all cases, we assume that the society must judge a system's benefits to be greater than its costs in order to encourage its use. If net benefits are sufficiently great, the society may even wish to subsidize a system which investors themselves might otherwise find unattractive. In the ideal case, a system will seem economic both to society and (unsubsidized) to investors.

1. The Investor's Point of View. In principle, to view the economics of a new energy system from the investor's point of view is

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* The discussion here is necessarily superficial. For a more thorough treatment of these issues see David French, The Economics of Renewable Energy Systems in Developing Countries (Report to U.S. AID and the al Dir'iyyah Institute, January 1979.)

relatively straightforward. We begin by estimating benefits and cost to the buyer for each year of the system's expected lifetime. By subtracting costs from benefits, each year's net benefits can be found. For a hypothetical greenhouse expected to collapse at the end of five years, the calculation might appear as shown in Table I.

TABLE I: NET BENEFITS OF GREENHOUSES TO INVESTOR (in Rands)

| | yr1 | yr2 | yr3 | yr4 | yr5 |
|---|---|---|---|---|---|
| Benefits | | | | | |
| Market value of vegetables | 100 | 100 | 100 | 100 | 100 |
| - Costs | | | | | |
| Labor | 80 | 30 | 30 | 30 | 30 |
| Materials | 100 | -- | -- | -- | -- |
| Seed and Fertilizer | 20 | 20 | 20 | 20 | 20 |
| = Net Benefits to Investor | -100 | 50 | 50 | 50 | 50 |

We must now decide whether the R200 in net benefits spread over Years 2-5 will be viewed by the investor as adequate compensation for the R100 in net costs incurred in Year 1. At issue here is the fact that money promised in the future is worth less than the same amount of money in hand today. Moreover, the longer it takes an investor to get future money, the more he or she will "discount" its value in the present.

Mathematically, we determine the present value of future money by multiplying each year's benefits by the appropriate "discount factor". At an annual discount rate of 30%, for example, discount factors are .769 for Year 1, .592 for Year 2 and so on. In this case,

each Rand promised at the end of Year 1 is taken to be the same value to the investor as .769 Rand at the project's outset, a Rand two years away is worth .592 Rand, etc.

At a discount rate of 30%, Table II shows the adjustments required to find the "present value" of each year's benefits as of the beginning of the project.

TABLE II: PRESENT VALUE, BENEFITS OF GREENHOUSES TO INVESTOR (in Rand)

| | yr1 | yr2 | yr3 | yr4 | yr5 |
|---|---|---|---|---|---|
| Net Benefits (from Table I) | -100 | 50 | 50 | 50 | 50 |
| X Discount Factor (30%) | .769 | .592 | .455 | .350 | .269 |
| = Present Value of Benefits to Investor | -76.90 | 29.60 | 22.75 | 17.50 | 13.45 |

By adding together the present value of benefits for all five years, we find that total Net Present Value (NPV) of the greenhouse is R6.40. Since any project with a net present value greater than zero is economically sound, we can assume that the potential buyer would consider the greenhouse an attractive investment.

Alternatively, we can find a technology's annual rate of return to the resources the investor must commit to it. We do this by experimenting with various discount rates until we find one which yields a net present value of zero. This is the investment's Internal Rate of Return (IRR), which in the case of our hypothetical greenhouse is roughly 36%. The rule here is to make investments having an internal rate of return higher than the discount rate. Since we have assumed the applicable discount rate to be 30%, the greenhouse again appears to be economically sound from the investor's point of view.

In practice, a certain humility is required in using these data to predict the reactions of potential investors to new energy systems. In the above, little account has been taken of such factors as these: actual cost and benefit figures may vary from place to place; our discount rates may only imperfectly reflect local realities (although 30% is a reasonable worldwide average for rural areas of developing countries); risks and uncertainties may seem greater to investors than to project economists. Adequately to allow for these forces, we should probably seek systems whose estimated IRRs are significantly above discount rates (i.e., whose NPVs are significantly above zero. Of course, the final test of our analysis will come only when investors choose to buy (or to reject) the systems we are offering for their consideration.

2. The Society's Point of View. Regardless of how new energy systems appear to individual investors, national governments will wish to make their own estimates of the value of these systems to society as a whole. In general, the procedures to be followed are the same as those outlined above. However, adjustments must be made to allow for shadow prices (especially labor costs and discount rates), social costs, and national policy objectives.

a. Shadow Wages. Investors in new energy systems will pay the market wage to laborers working on their project. From the national point of view, however, the actual (or "shadow") cost of this labor is the value of other tasks from which the workers are being diverted. Since persons in rural areas are often unemployed, the cost to society of mobilizing labor for our hypothetical greenhouse project might range from zero (assuming no alternative work available) to perhaps half the market wage (assuming workers would otherwise be employed half-time at other tasks).

b. Shadow Discount Rates. Discount rates from the investor's point of view are more or less equivalent to prevailing, unsubsidized interest rates on rural borrowing. In line with the relatively short time horizons of rural investors, these rates range from 20% to 65% or more in rural areas of developing countries. Society, on the other hand, will take a longer view, concentrating on future growth as well as immediate benefits. Typically, the social (or "shadow") discount rate is therefore assumed to be in the order of 12%.

c. Social Costs. To encourage use of a new energy system, society may be forced to absorb costs which do not enter into the

calculations of private investors. In the case of our greenhouse project, for example, it is likely that heavy extension costs will be involved for local training in the construction and use of the new system. On a continuing basis, smaller levels of assistance may be required to deal with horticultural problems arising from year to year.

d. Policy Objectives. Governments will have non-economic objectives as well as strictly economic ones. Assume, for example, that our greenhouse is to produce cabbages which would otherwise have to be imported from neighboring countries. In the case of Lesotho, this would be in line with the high priority attached to greater self-sufficiency in food production. If the greenhouse was otherwise economic, this political objective would simply reinforce the decision to promote the system's use. If the greenhouse had negative benefits, on the other hand, our analysis would show the cost to society of pursuing self-sufficiency through this system.

In Table III, we show the calculations required to consider our hypothetical greenhouse from the society's point of view. Here, we estimate the shadow wage to be one-half the market wage. Extension costs are added. The social discount rate is assumed to be 12%. From society's point of view, the greenhouse's NPV is R6.29; the system's IRR is roughly 20%, compared with a social discount rate of 12%. Especially when coupled with the national desire for agricultural self-sufficiency, these figures make the greenhouse seem quite attractive.

TABLE III: BENEFITS OF GREENHOUSE TO SOCIETY (in Rands)
(changes from Tables I and II indicated by *)

| | yr1 | yr2 | yr3 | yr4 | yr5 |
|---|---|---|---|---|---|
| Benefits | | | | | |
| Market Value of Vegetables | 100 | 100 | 100 | 100 | 100 |
| - Costs | | | | | |
| Labor* | 40 | 15 | 15 | 15 | 15 |
| Materials | 100 | -- | -- | -- | -- |
| Seed and Fertilizers | 20 | 20 | 20 | 20 | 20 |
| Extension Services* | 100 | 10 | 10 | 10 | 10 |
| = Net Benefits to Society | -160 | 55 | 55 | 55 | 55 |
| X Discount Factor (12%)* | .893 | .797 | .712 | .636 | .567 |
| = Present Value of Benefits to Society | -142.88 | 43.84 | 39.16 | 34.98 | 31.19 |

B. Technologies With Unquantifiable Benefits

In some cases, the predominant benefits of new technologies will be impossible to measure. In rural Lesotho, for example, such devices as roof insulation and improved stoves will act primarily to reduce the amount of dung collected for cooking and heating. It would be theoret-

ically possible to estimate the monetary value of labor saved through these systems. However, at least as important are such quantifiable benefits as the value to the soil of dung burned, the reduction in eye and respiratory diseases where dung smoke is vented outside of homes, and the generally cleaner domestic environment which would result. In such cases, there is little point in trying to calculate IRRs and NPVs.

Nonetheless, there is a range of more or less economic questions which should be asked about these energy systems before making any decision to support their use. Again, the approach will differ somewhat depending on whether we adopt the perspective of the government or that of the system's purchasers.

1. The Investor's Point of View. In trying to predict whether rural investors will find attractive an energy system with unquantifiable benefits, we need to consider at least the following issues: the relationship between capital requirements and financial resources, the extent to which benefits are considered valuable by investors themselves, and the extent to which benefits are likely to be clear and substantial. Only if a system promises to meet all three tests can we hope for success in encouraging its use.

a. Capital Requirements. By investigating local purchases of consumer and capital goods, we can estimate the resources available to buy new energy systems. In Lesotho, miners' remittances allow some farmers to buy plows (c.R40), cultivators (c.R60), and even planters (cR120). Beds (up to R100) and other expensive household items may also be purchased. Although not all farmers have access to this level of resources, such figures do suggest that cash is fairly widely available to install energy systems of low or moderate cost.

b. Value of Benefits. The things a new energy system does must be felt by potential investors to be of personal value. Few people, for example, would buy improved wood stoves simply to preserve stands of trees which are preventing erosion of other people's land. A reduction in labor to fetch wood for one's own fire, on the other hand, will be taken more seriously. Although the stove designer may place equal value on reductions in deforestation and work, we cannot assume the investor will share this view.

c. Visibility of Benefits. The potential buyer must be able clearly to visualize a new system's benefits. While venting dung smoke outside a home could reduce eye and respiratory diseases, this relation-

ship may not be forcefully apparent to the occupant. Similarly, the agricultural value of saving dung for fertilizer use may not be sufficiently vivid to attract investments in more efficient dung-burning stoves. Whether such benefits are "real" or not will be less significant than whether they are visible to potential investors.

2. The Society's Point of View. All else equal, planners will wish to feel that an energy system's benefits to society (even if unquantifiable) will be greater than its costs. Although much of this calculation will ultimately be intuitive, we can at least help sharpen the issues in economic terms.

Suppose, for example, we are considering use of insulation for rural homes. We know the cost of weaving and installing the insulation. We can also estimate the value of labor which would otherwise have to be devoted to collecting dung for heating. What we cannot estimate are such benefits as improvements in soil quality through leaving dung on the ground, reduction in eye and respiratory diseases through decreased burning of dung, and greater overall cleanliness in the domestic environment.

Using the analytical framework outlined in Section A.2, above, we can represent society's point of view toward the economics of this system as shown in Table IV.

TABLE IV: BENEFITS OF HOME INSULATION TO SOCIETY (in Rands)

| | yr1 | yr2 | yr3 | yr4 | yr5 |
|---|---|---|---|---|---|
| Benefits | | | | | |
| Less Labor for ful Collection | 30 | 30 | 30 | 30 | 30 |
| Improved Soil<br>Improved Health<br>Cleaner Domestic Environment | X | X | X | X | X |
| - Cost | | | | | |
| Construction Labor | 25 | -- | -- | -- | -- |
| Material | 30 | -- | -- | -- | -- |
| Maintenance | 10 | 10 | 10 | 10 | 10 |
| Extension Services | 40 | 5 | 5 | 5 | 5 |

We can then calculate what "X", the insulation's unquantifiable benefits, would have to be for the system to be economically worthwhile. Given the information in Table IV, only an X of at least R7.30 would give the system a positive NPV at a discount rate of 12%. The experts are then left to judge whether the insulation's benefits, in terms of soil conditions, health and cleanliness, could reasonably be expected to reach this annual level. Such judgments will be extremely crude, but they are better than no economic judgments at all.

C. Economic Information-Gathering

In designing an energy project, the forms of analysis outlined above are required to help decide which systems are most likely to be appropriate for field testing. Such conclusions should be viewed as only preliminary, however, until surveys are made of actual conditions in the specific areas where systems may be installed. Field tests themselves must also be carefully structured and monitored in order to provide useful information for evaluating the project.

1. Surveys. The first objective of a rural energy survey should be to find out what villagers believe are their most pressing problems, along with preferred ways of dealing with these. There is simply no point in inflicting energy systems on people who feel their most urgent concerns to lie, say, in nutrition or road construction. Nor does it make sense to ignore ways in which villagers themselves would like to proceed in dealing with their problems. Only after interviews in a wide sampling of villages will it be possible to match energy systems with places where they might be responsive to local desires.

More carefully to judge the economic potential of these systems, it is also necessary to acquire specific economic data. Local variation in these data may make a considerable difference in the extent of system's feasibility. Where an energy system frees people from the labor involved in hauling dung, for example, economic benefits will consist largely of alternative work which can now be done. A dung-conserving device could therefore be quite profitable in one area (where new work was readily available) and quite unprofitable in another (where few productive opportunities existed). Only when we have solid information on local conditions can we predict which will be the case.

Adequately to analyze the economics of new systems, we will need local survey data on at least the following items:

--probable value of the system's output (if measurable in market prices);

-- alternative employment opportunities (to measure shadow wages, as well as to find benefits where the system chiefly releases labor from former tasks);

-- costs of site preparation and installation of the system;

-- direct operating costs;

-- extension costs of introducing and maintaining the system;

-- market interest rates for local borrowing (to estimate investor's discount rates);

-- characteristic local investments (to judge available resources).

A given system need not be in place before these data can be collected. Instead, knowledge of a device's technical characteristics can be combined with local economic information to arrive at estimates of its costs and benefits. To maximize chances than an energy project will succeed, at least preliminary work along these lines should be carried out as part of the project before decisions are made to test new systems in the field.

2. Field Tests. Field tests should be monitored to record the economic performance of energy systems being used. This requires that a written record be maintained of values for all variables listed above. From time to time, an economic analyst should update estimates of the system's economic appeal from the perspective both of investors and of the society as a whole. Such analysis should be supplemented by interviews with users, in order to determine how the systems are perceived from a more subjective point of view.

To be meaningful, pilot field tests should be structured as nearly as possible according to patterns which would prevail if the systems were being more widely distributed. For example, unless the government anticipates that a device will later be subsidized for general use, initial buyers should be expected to pay a significant portion of the system's cost. To do otherwise--as where prototypes are simply given away--is to falsify the experiment to the point where its results have little significance in economic (or any other) terms. If we have done our job of analysis well, we should be able to assume that the systems involved are sufficiently economic to be able to carry a large measure of their own weight from the very outset of the project.

# DISCUSSION OF PRIORITY TECHNOLOGIES

## I. Village Energy Consumption.

It is estimated that a typical family in a Lesotho mountain village uses 95,000 BTUs per day of locally collected fuel (brushwood, dung, etc.). Most of this energy is used in cooking on an open fire. The combustion efficiency of an open fire is approximately 2.1% and therefore the useful heat of this typical Basotho family's fire is actually 2,000 BTUs per day. To bring one liter of water (at 50°F) to a boil in Lesotho, it requires 320 BTUs. The fuel consumption is therefore equivalent to the boiling of 6.25 liters of water per day per family for cooking purposes. However, much of the waste or unused heat actually heats the rondavel with hot, smoky air. The consumption of 95,000 BTUs per day by a village household is equivalent to 27 kilowatt hours per day, which is as much as an average urban household (fully electric) consumes in Maseru.

It has been determined that fuel savings can be achieved primarily in the cooking process. Therefore, the PP team has recommended as a priority technology the design and construction of efficient dung and wood burning stoves. The heat source required in the cooking process should be a steady slow burning flame, but weather conditions and household influences make the traditional open fire very irregular in heat yield. Open fire efficiencies have been recorded as low as 1.5%, with an average of 2.1% and a maximum of 6%. By using any of the mud stove designs described below, efficiencies of 10% and more are regularly obtained. Thus the fuel required is reduced to one-fifth of the fuel presently used by a typical Basotho family.

## II. Characteristics of Village Fuels.

Energy consumption per family unit for several fuel types in Lesotho is shown in Chart No. 11, entitled "Village Energy Use - Per Family of Four." This data was obtained by Malcolm and Lynda Lillywhite from interviews with villagers and from a thesis by Mark Best of the University of Cape Town. The data is based on a very small sampling in mountain regions, but is probably the only such data for Lesotho. This chart shows various caloric values for fuels and the potential fuel usage impact for proposed alternatives such as solar heating, mud stoves and grain grinding. The chart also shows various "effective temperatures" for each fuel. The effective temperatures help determine the ways fuels can be used. For example, solar energy would be used for space heating because its effective temperature is in the order of 100°F, while dung and wood would still be needed for cooking at temperatures of 650°F and 1300°F respectively. However, a reduced quantity of these fuels would be realized because of inherent efficiencies of the proposed mud stoves.

Other observations made from this village energy use data must be made with caution. However, it can readily be seen that fuels available to villagers differ in heat value and utilization. Dried dung is a low-grade fuel, wood is medium-grade and paraffin is high-grade. It will not be possible to eliminate the use of these fuels by the Basotho nor is it desirable. However, the consumption can be reduced from 50 to 80%. All of the RET alternative fuels are low grade fuels. This is demonstrated by the low "effective temperature" and the low caloric values (e.g., solar energy and pedal power).

## III. Wood and Dung Mud Stoves.

### 1. Criteria for Lesotho's Mud Stove.

There are essentially two types of fuel available in the mountain areas: brushwood and cow dung. The cow dung is available in two forms: field dung in hand shaped cakes (khapane) and kraal dung which is dried in blocks (liso). In some areas, mostly lowlands, more solid wood is available in small quantities, i.e., poplar, willow, black wattle, eucalyptus and peach. Indigenous trees like wild olive have virtually become extinct except near streams and rivers. A very common fuel for the lowlands is aloe leaves.

The combustion characteristics of these fuels are different and these differences are important in stove design and use. These combustion characteristics are summarized below.

Combustion Characteristics of Village Fuels

| | Liso/Cobs | Dung Cakes Khapane | Brushwood | Wood | Aloes/Stalks |
|---|---|---|---|---|---|
| Size | Large/small | Any size | Any size | Long | Large |
| Ignition | Slow | Slow | Quickly | Good | Good |
| Combustion | Slow | Slow | Very fast | Fast | Very fast |
| Flames | Little | Little | Very strong | Strong | Very strong |
| Smoke | Much | Very much | Little | Little | Little |
| Ash | Very high | High | Little | Little | Very little |

2. Mud Stove Design.

The following design criteria have been identified by the PP team:

(a) Draft. While fast burning shrubs do need a draft restriction, the dung fire may burn more efficiently with a stronger draft.

(b) Size and Shape of Combustion Chamber. For slow burning dung and maize cobs a high chamber is preferable with the large main pot located directly above the fire. For fast burning shrubs, stalks, aloes, etc., a shallow, deep (long) chamber is preferable.

(c) Materials. There is little real clay in Lesotho. In most cases the mud available is silicate, basalt or mixtures of the two. The addition of sand and dung will make the mud more workable, less prone to crack, more porous (for better insulation) and more resistant to scratching and chipping.

(d) Construction. The materials necessary to build a mud stove are: mud, stone of any kind preferably flat faced (preshaped mud blocks can also be used), dung, sand, some pieces of flat metal which can be made by cutting and flattening empty cans which are available in most parts of the country. The tools necessary are: a shovel or spade, empty tin cans to tunnel into the mud, pick, sledge hammer to break boulders, wheel barrow (not essential), small builder's trowel and a tape measure.

(e) Construction Time. The actual construction time for a single mud stove is not long, but curing of the mud takes several weeks. One week should be allowed for the initial base to set and another two to four weeks are necessary for the stove tunneled to dry. For demonstration only, a mud stove can be built and fired in two days. For training purposes, two weeks should be allowed.

IV. Pedal Powered Grain Grinder.

1. Pedal Power. Pedal power, as an inexpensive dependable source of mechanical motion has been used successfully in some developing nations such as Nigeria, Malaysia and China. There is enormous energy potential lying fallow in human legs. The scale of that potential can be illustrated by the popular use of bicycles in European cities where the cost of gasoline has always been high.

There are many advantages to the bicycle. It uses no mechanical engine or petroleum fuel. The "engine" driving it, the legs, can also carry it when necessary over rough ground and steep mountains. It is relatively inexpensive to produce and yet has extremely high efficiency (95%). It is a simple technology and as such can be repaired by the owner and it has relatively inexpensive spare parts.

A number of attempts have been made to use modified bicycles to drive household equipment, electric generators, pumps and the like. Some of these mechanisms have become very useful and are worth adopting and adapting to use in Lesotho. Besides the common bicycle for transportation, the use of pedal power is particularly interesting for village grain grinding.

2. Pedal Powered Grain Grinder.

(a) System components for the grain grinder are: a simple high efficiency grain grinder, a framework of metal or wood to carry one or two persons, a chain (or V-belt) drive to link the pedals to the shaft of the grinder and in many cases a fly-wheel to overcome load shocks which may occur during operation of the mill.

(b) The Drive. Chain drive is most suitable for high torque, low speed. For high speed, low torque the V-belt is more suitable and is also best for quick ratio change. The chain has a higher transmission efficiency than the V-belt.

(c) Fly Wheels. Fly wheels are preferably made of metal but concrete filled scrap tires and similar improvisations can be used for low speed. Fly wheels must be very well balanced and well supported.

(d) The Mill. Two types of mills are suitable for this purpose. The first is the type used for coffee grinding made of two burrstone plates with grooves. This is the simplest and most appropriate to Lesotho and therefore is the type proposed by the PP team. This type of grinder is efficient and relatively inexpensive to build. The second type is the roller mill which crushes the grain. Though extremely efficient, it primarily produces flakes. Several stages are required to grind it into flour and presently flakes are not popular in Lesotho. These mills are also much more complicated and expensive than the burrstone mill described above.

## V. Grain Storage

As a necessary complement to the grain grinding technology, the PP team has suggested the introduction of grain storage methods to the rural Basotho. Approximately 20% of the grain produced annually in Lesotho is lost through poor storage techniques. Very simple storage technologies can be implemented using local resources and skills.

Perhaps the most sensible method is a grain crib raised off the ground at least 3 feet with rodent baffles attached to the legs. The grain crib can be woven of the locally available grasses and then smeared with a dung and mud mixture which will make them insect-proof and also keep the moisture out.

Another method is a vessel made of thin-walled stabilized cement. These vessels can be cheaply made using a stuffed bag as a mould. This method is not as appropriate, however, as cement is needed to be added to the clay and dung mixture to make the vessel rodent-proof. The cement would have to be imported.

In either case, it would be wise to implement a drying technology to insure that the grain is free of insects and excess moisture prior to storage. One of the candidate technologies proposed by the PP team is a solar food dehydrator. The implementation of this technology for grain drying as well as vegetable, fruit, and meat drying should be seriously investigated as a support technology for grain storage.

## VI. Community Passive Solar Greenhouse

This community solar reliant greenhouse design is a low-cost solar heated and cooled permanent structure made of mud, dung, and rocks with a fiberglass covering. It is designed to provide a nutritionally superior, inexpensive and year-round vegetable supply. This greenhouse will operate in most areas of the world without an auxiliary heating and cooling system. The greenhouse is a free-standing structure and must have unshadowed northern exposure.

The unique feature of the solar reliant greenhouse is its ability to maintain a comfortable temperature range without any utility energy systems. This is accomplished by operating the greenhouse manually during the day to accommodate the weather conditions and "sealing" the greenhouse at night. The solar reliant greenhouse will capture, store and manage the sun's energy by virtue of its integrated energy conservation design without electrical or mechanical systems. Solar radiation is captured when the sun's rays transmit through the transparent fiberglass glazing and are absorbed by the black surface of the water containers or other dark mud surfaces within the greenhouse. The absorbed solar energy is transformed to heat which raises temperature of these masses. The warmer masses in turn emit thermal infrared radiation which cannot escape back through the transparent fiberglass glazing at the same rate that the incoming solar radiation does. This results in the trapping of heat energy inside the greenhouse barrels and is called the greenhouse effect. It is this heat trapping process that occurs between the earth and the earth's atmosphere that provides almost all of the natural heating and cooling on earth. Likewise, the heat trapped in the designated

areas of the greenhouse can also provide heating and cooling. However, this trapped heat can also become the biggest problem associated with the solar reliant greenhouse if proper ventilation is not maintained.

The solar reliant greenhouse should be oriented due north for best performance. Periods of improper operation during the extreme cold months may require the use of a small back-up fire or mud stove to prevent frost formation. The greenhouse should be situated to allow maximum direct solar exposure during the winter months and, if possible, partial shading during the hottest summer months (e.g., deciduous trees or moveable insulation). The greenhouse also needs to be in a relatively open area to utilize the summer breezes to help ventilation.

The solar reliant greenhouse has been designed to use human energy (labor) to manipulate the temperature control devices within the structure to eliminate expensive mechanical systems and to eliminate or minimize any utility cost for heating and cooling. The exhaust vents may be opened or closed automatically with passive actuators. Additional automation may be incorporated if desired, but this should only be necessary when labor is scarce or expensive.

## VII. Food Drying

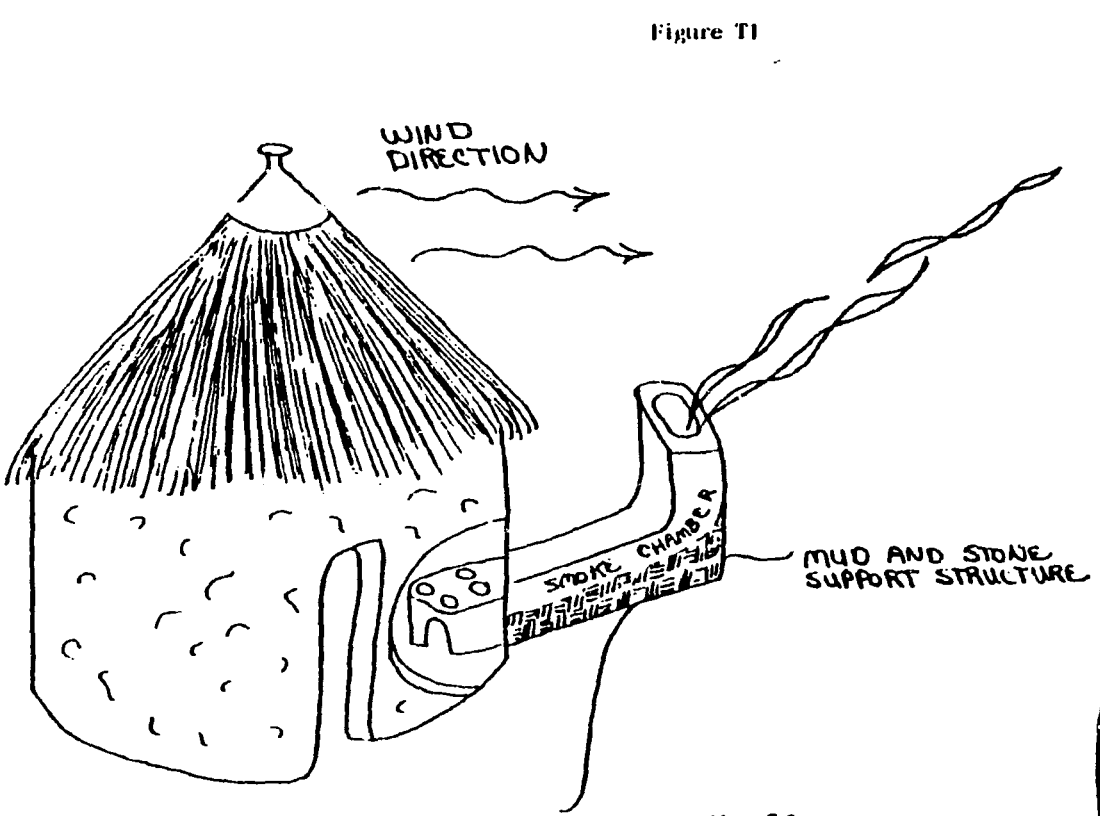
Although food dehydration was not identified as a priority technology the probability of this technology finding its way into the village is good. Therefore, a brief discussion of this technology is given below.

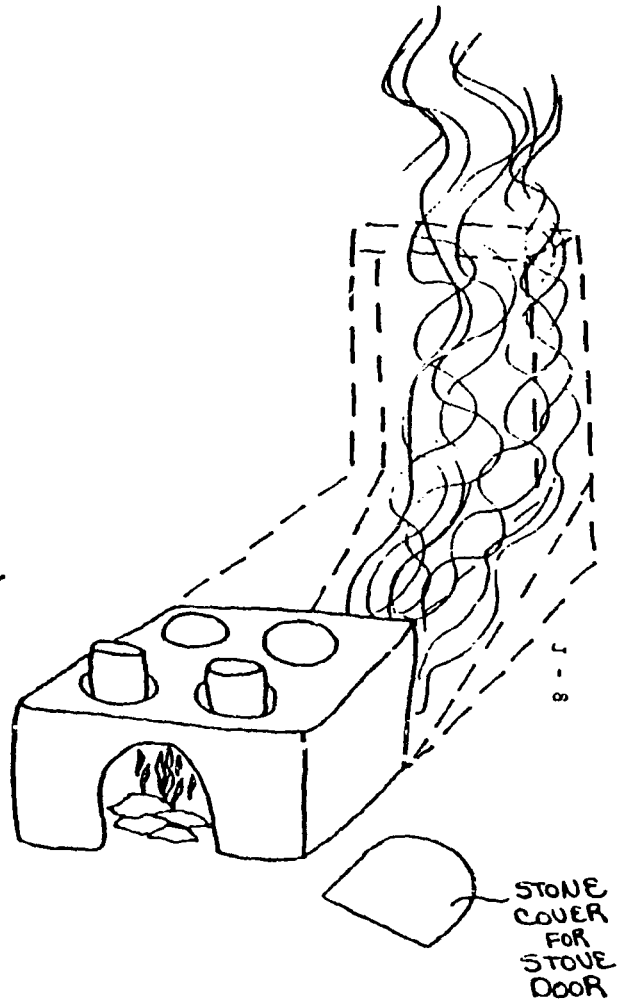
1. Background. While dehydration is the oldest form of food preservation known to man, very little is understood about the fine points of the art. Little effort has been made to compare the cost effectiveness or nutritional content of solar dried foods versus canned or frozen foods. Anyone building or using a solar food dryer will be contributing to the development of this revived method of preservation. Solar crop drying is and has been practiced extensively in many parts of the world. It has been very effective in the Middle East, North Africa and southwestern America. These areas have warm, dry days which make solar dehydration very effective. Traditionally, natural sun drying techniques take advantage of clear, warm, rainless seasons such as occur in the southwest United States. Food laid directly in the open to dry is subject to contamination from air-borne dust and debris, insects and animal and human interference. To reduce this contamination and improve project quality, it is essential that food be dehydrated in an enclosed structure. This dehydration will not only protect the food from contamination but will reduce moisture content to levels necessary to preserve dried foods for a satisfactory period of time.

2. Design. Because certain foods must be dehydrated in the dark and at varying temperatures in different climates and weather, the dehydrator box which holds the food needs a cover for shading and a flat plate passive (convective) solar air heater to provide hot air when the shutters are in use or when large quantities of food are being dried. The cover is used to protect the 'dark dry' foods from the sunlight which heats the dryer through the attached air heater. The solar collector and dehydrator box (when unshaded) are heated directly by the sun, which transmits through their glazed tops and is absorbed by the dark interior surfaces. The absorbed solar energy is transformed into heat, raising the temperature of the air and forcing it to move upward through the box and around the food (convection). This hot air gently extracts and evaporates the water in the food and carries the moisture out through the vents. This slow removal of moisture is called dehydration. Dehydrated food can be stored at room temperature for long periods without spoiling. The formation of heat by transforming solar energy into thermal energy is called "the greenhouse effect." This is the only source of heat in the food dehydrator.

# WOOD AND DUNG BURNING MUD STOVE

Figure TI

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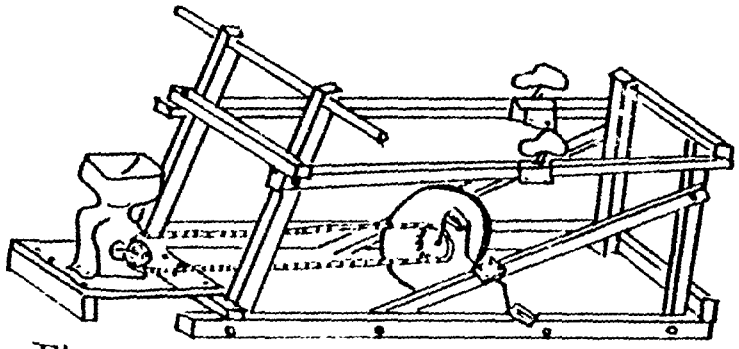
SOLSTICE. DESIGNS

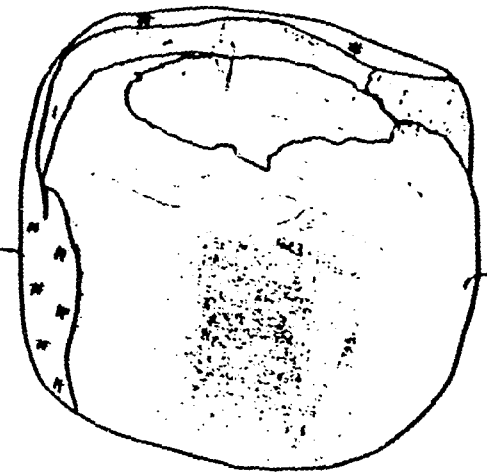
# GRAIN GRINDER

Figure T2



THE DYNAPOD: PEDAL POWERED UNIT
(Alex Wier, UITA)

# GRAIN STORAGE



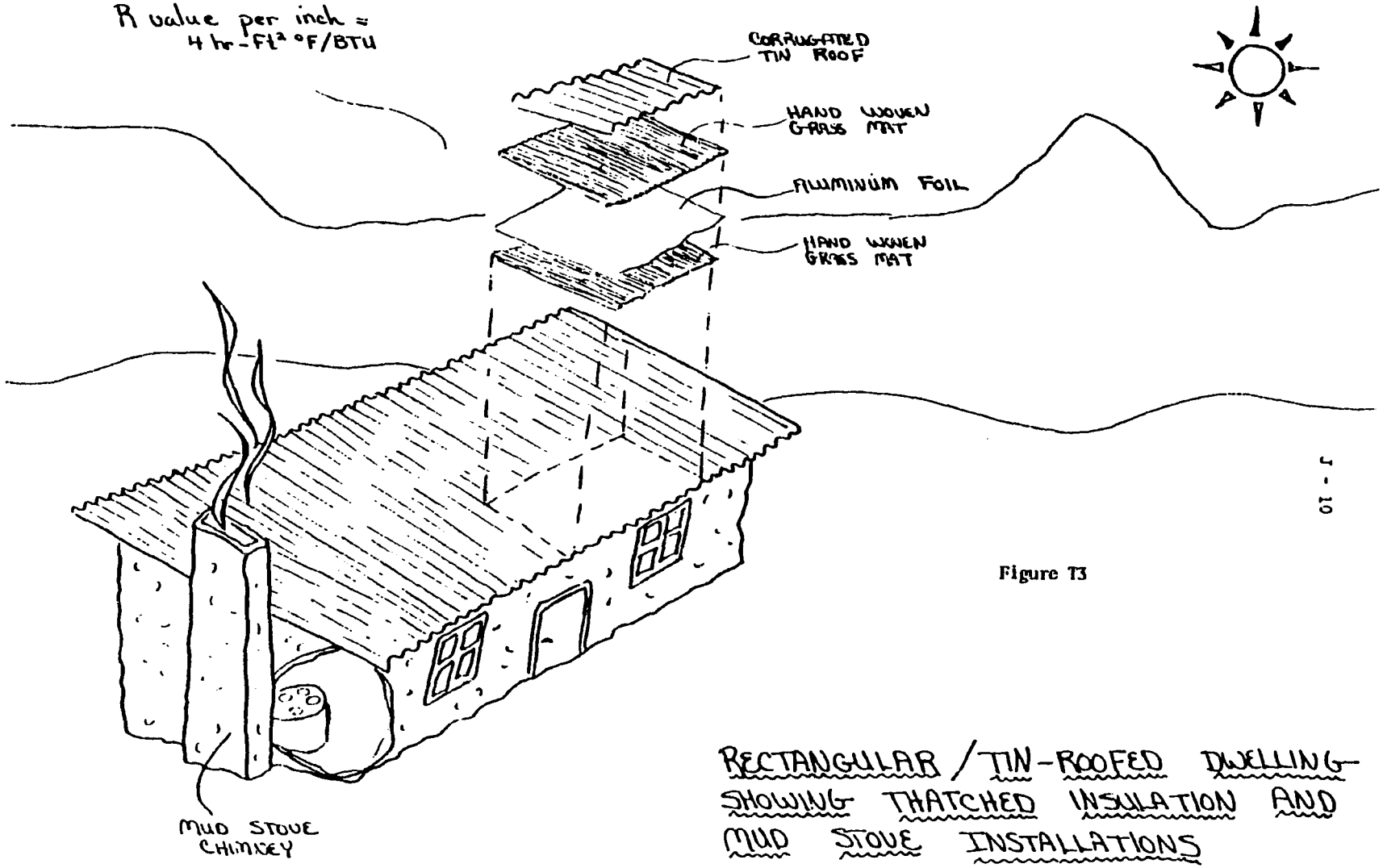



Figure T3

RECTANGULAR / TIN-ROOFED DWELLING SHOWING THATCHED INSULATION AND MUD STOVE INSTALLATIONS

Figure T4 Construction of passive domestic batch solar water heater using Thatch Insulation. Made by Botswana and Bosotho.

Figure T5

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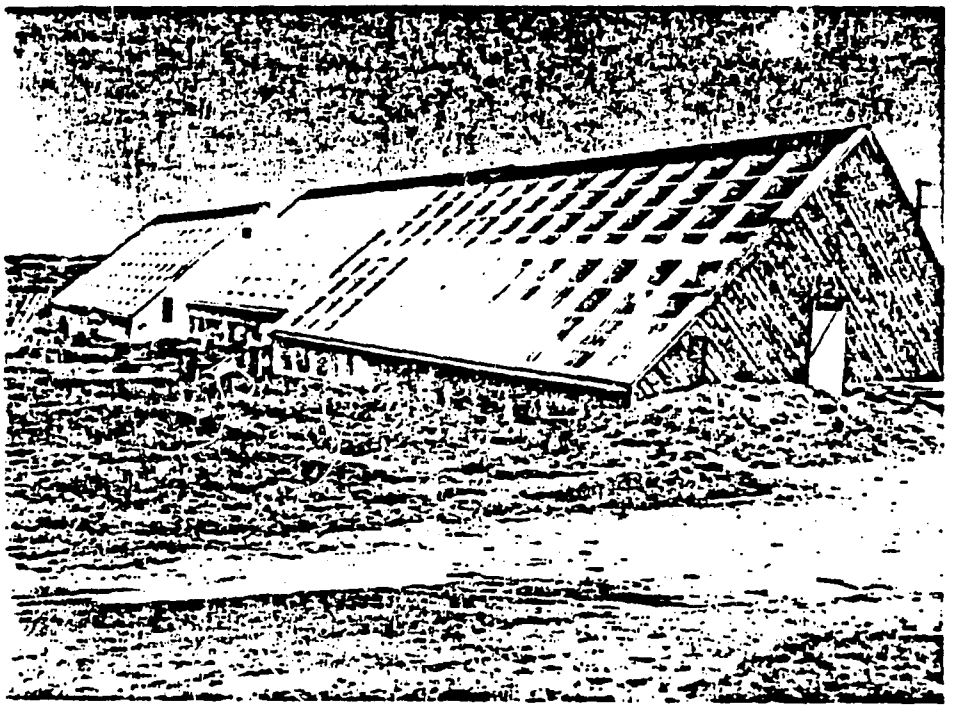


Figure T6 Community Passive Solar Greenhouse in Cheyenne, Wyoming of the type which will be used by the RET Project.

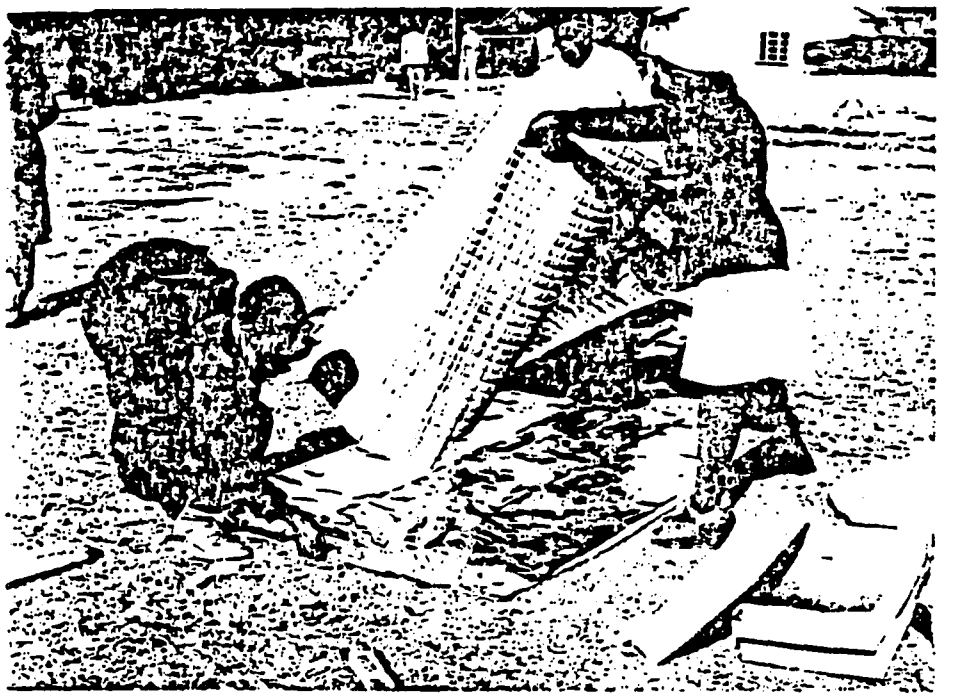


Figure T7 Making of multi-layered thatch insulation by Botswana trainees.

# GROW HOLE GREENHOUSE

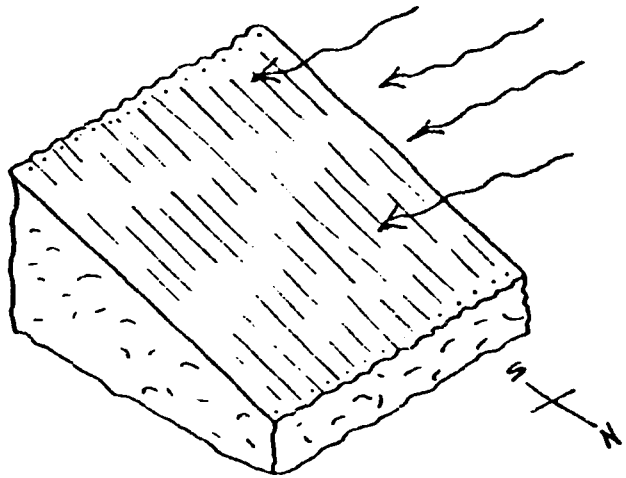
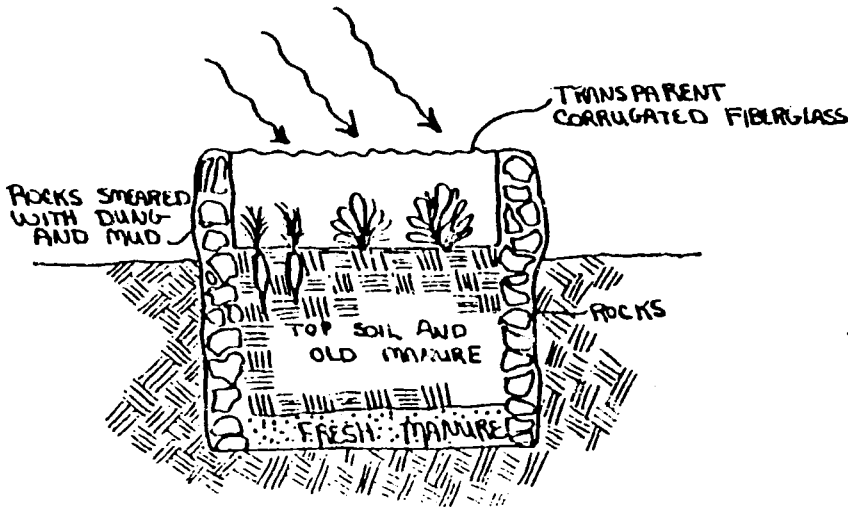
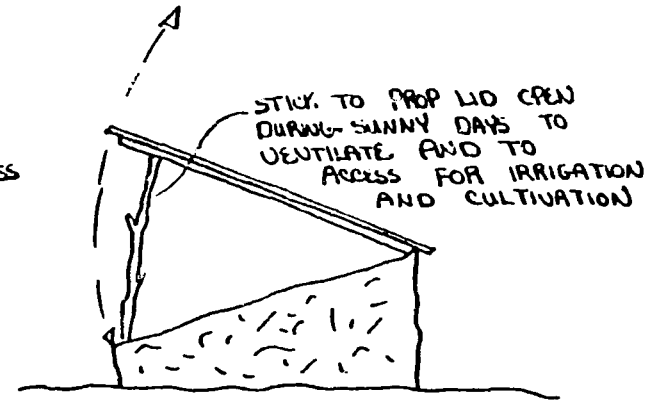



Figure T8

GROW HOLE WILL MAINTAIN WARM TEMPERATURES, EVEN DURING WINTER MONTHS, BY WARMTH OF THE SUN AND HEAT FROM DECOMPOSING MANURE. CAN BE USED TO START SEEDLINGS AND TO GROW "SHORT" CROPS TO MATURITY IN THE WINTER. (e.g. beets, carrots, onions, spinach, lettuce)

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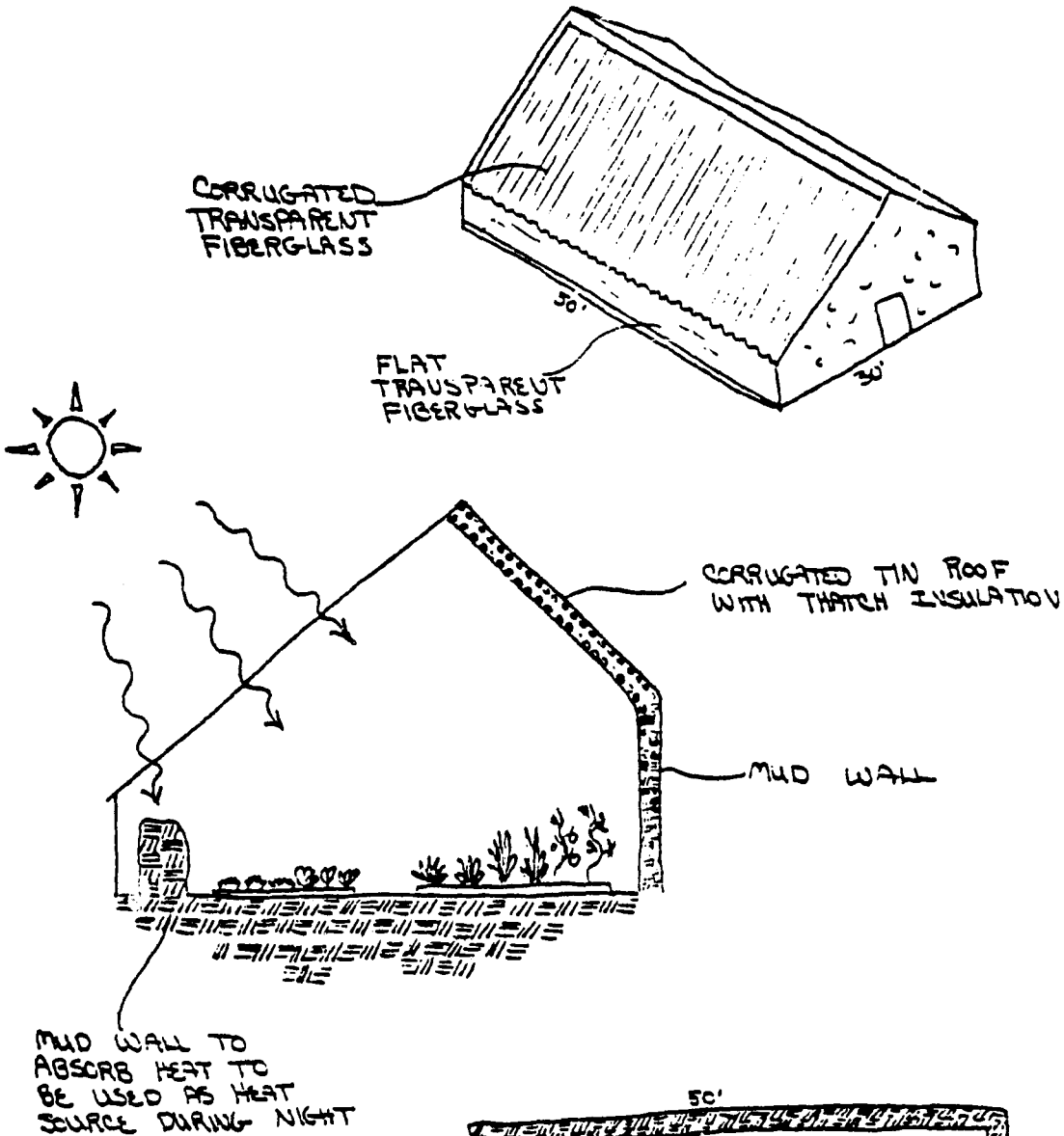
# COMMUNITY PASSIVE SOLAR GREEN HOUSE

Figure T9



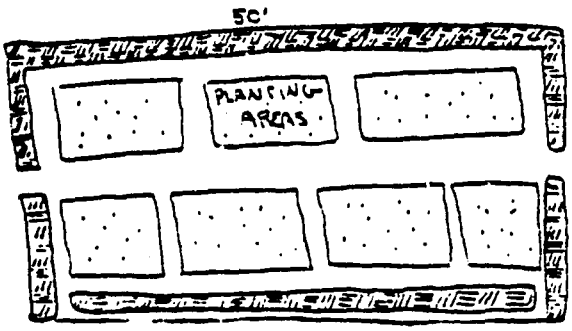




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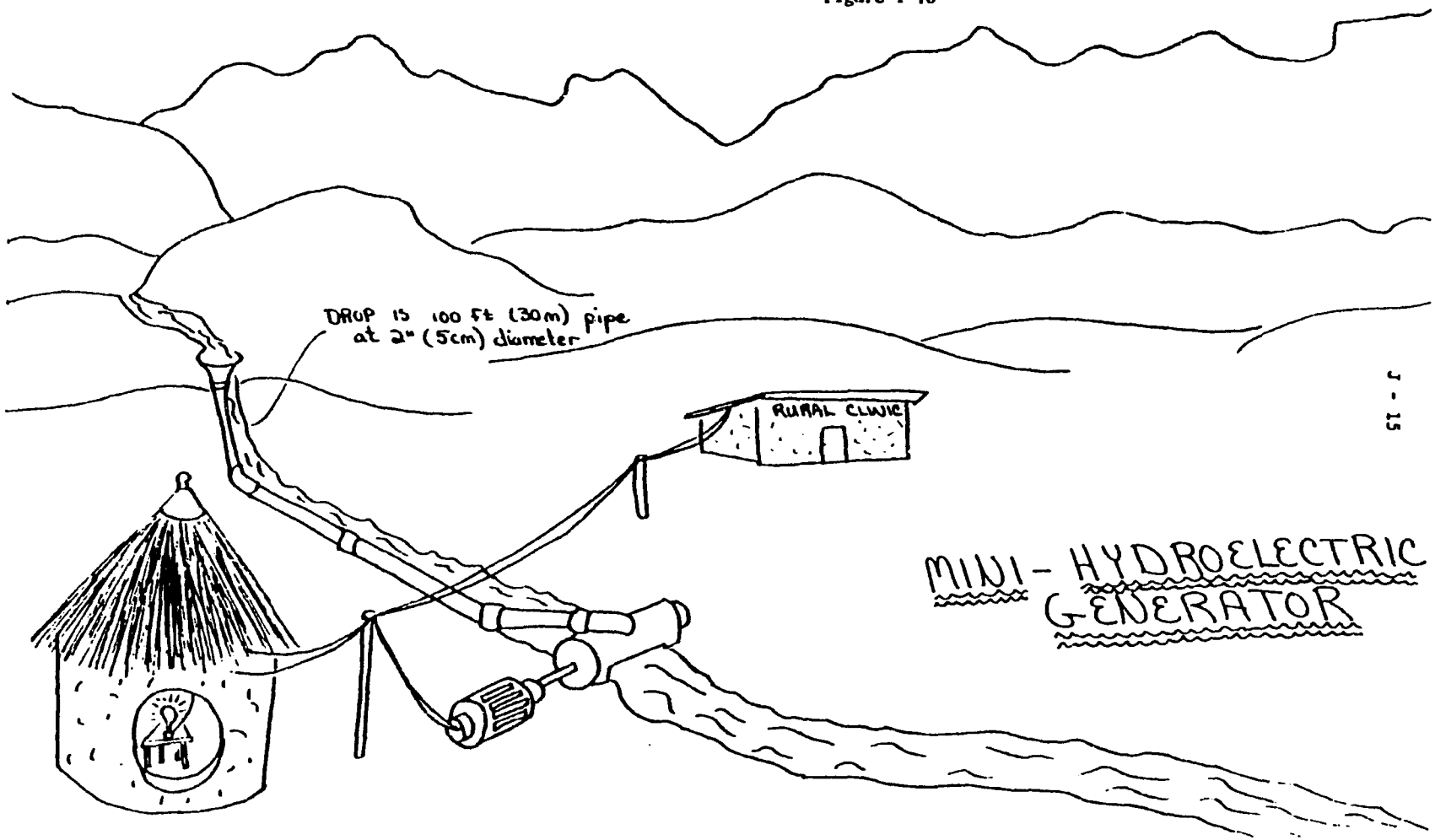
Figure T 10


DROP IS 100 ft (30m) pipe
at 2" (5cm) diameter
RURAL CLINIC
MINI - HYDROELECTRIC
GENERATOR

# FEEDLOT ANEROBIC DIGESTER

Figure T 11

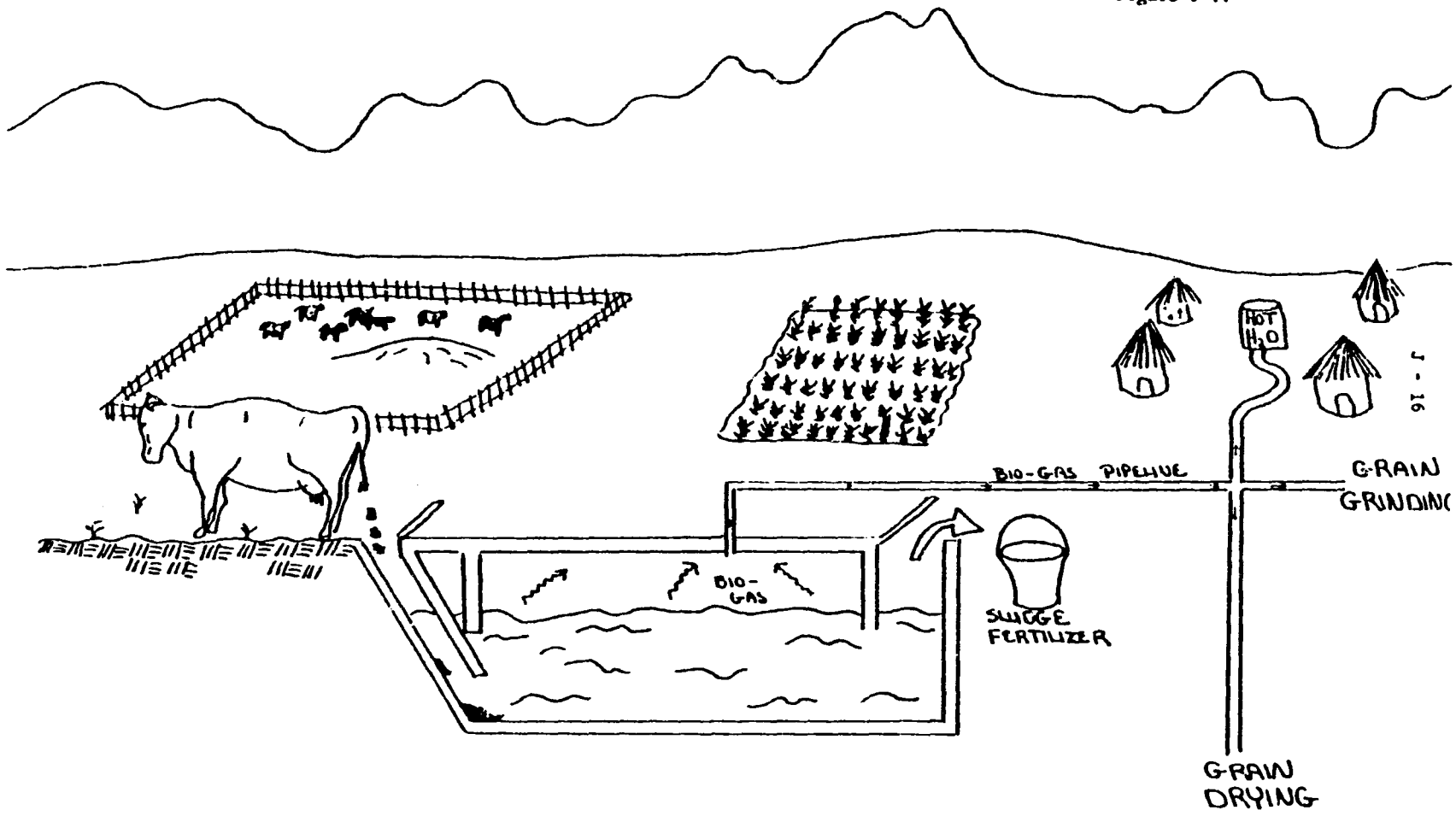


Figure T 12 Botswana trainees making mud solar cooker.

## I. Project and GOL Personnel

The job descriptions of the project's key personnel are described herein. In addition, recommendations for Peace Corps Volunteers and MORD AT Unit positions are also included. These recommendations are made in an effort to secure the breadth and quality of skills necessary to execute the RET project.

### A. Program Coordinator (Physical Scientist or Engineer).

The Program Coordinator shall be an employee of the U.S. contractor responsible for implementing the RET project. The Program Coordinator must report programatically to the Rural Development Coordinator of MORD and liaise with the USAID Program Manager. The Program Coordinator must also report through normal corporate channels of the contractor to insure that contractual obligations are met.

#### 1. Scope of Work

(a) Manage and supervise project responsibilities and project personnel.

(b) Supervise fiscal management of project and contract funds.

(c) Act as primary facilitator between project activities, GOL and USAID.

(d) Design with short term consultant and other staff members final and prototype RET units, research technology units and any other designs needed for the RET project.

(e) Insure technical and scientific soundness of all RET experiments and designs.

(f) Coordinate and manage training programs.

(g) Act as primary trainer for technical, managerial and process functions for MORD AT Unit personnel and VET trainees.

(h) Maintain thorough understanding of all demonstration RET designs and a close contact with the village using these units.

(i) Make regular verbal and written progress reports to all supervisors and to personnel of USAID and MORD collaborating groups on technical perfomance of RET units and general project progress.

(j) Act as project liaison to GOL Ministries.

2. Minimum Qualifications.

(a) Undergraduate Degree in Physical Science or Mechanical Engineering (graduate work or degree are preferred).

(b) At least five years experience in RET design development or research.

(c) At least five years experience in RET or related management or supervisory responsibility.

(d) A demonstrated RET design and engineering capability.

(e) A working knowledge of Sesotho or willingness and commitment to learn Sesotho.

B. Field Supervisor (Social Scientist).

The Field Supervisor (Social Scientist) shall work on contract with or as an employee of the U.S. contractor responsible for implementing the RET project. The Field Supervisor shall report to the RET Program Coordinator.

1. Scope of Work

The Field Supervisor shall have the following responsibilities:

(a) Review the social, economic and social anthropological literature on Lesotho, with specific reference to village life, the problems of development and energy-related activities and needs.

(b) Experience residence in a village in order to become thoroughly familiar with Basotho culture and village life in Lesotho, and to gain a grasp of villagers perceptions of energy-related priorities in development.

(c) Become generally familiar with the principles and technologies in the field of renewable energy.

(d) Have responsibility for the research, design, implementation, management and monitoring of the social, cultural and economic aspects of the RET project, and to ensure that the project's activities are economically and sociologically sound and are responsive to local priorities and needs.

(e) Design and implement village research into energy problems, as perceived by villagers themselves, along with the village-level resources (financial, social and institutional) available to address these problems.

(f) Coordinate sociological, economic and physical aspects of the design of renewable energy technologies.

(g) On the basis of at least preliminary research, and in conjunction with the Program Coordinator, and Process Documentation Group, selected possible sites for implementing RET activities.

(h) In conjunction with the district community development staff, meet with villagers and village representatives to agree on technologies to be tested and to select villagers for training as Village Energy Technicians.

(i) In conjunction with district community development staff and other support personnel ensure that village energy technicians receive sufficient support.

(j) Establish effective village-level management procedures for both individually and communally managed technologies.

(k) Establish procedures for monitoring the effectiveness of the economic and sociological design, and the cultural acceptability of the technologies.

(l) Coordinate and manage a system of ongoing evaluation, or process history, as outlined in the Project Paper.

(m) Coordinate and liaise with the Rural Sociologist and other staff in the Rural Development Management Unit within the MORD.

(n) Draw on and supply information to the socio-economic data bank in the planning unit of the Ministry of Agriculture.

2. Qualifications.

(a) A post-graduate degree in Sociology or Social Anthropology or an undergraduate degree in a similar field with research experience.

(b) Working knowledge (or a commitment to acquire this) of principles of economic analysis of small-scale energy systems.

(c) Research experience in rural Lesotho and working knowledge of Sesotho, or similar research experience and a commitment to learn Sesotho and take up at least a period of residence in a rural village.

(d) Experience in applied social research and the ability to work in an interdisciplinary team.

(e) Administrative experience or ability.

C. Laboratory Supervisor (Physical Scientist or Mechanical Engineer)

The Laboratory Supervisor shall work on contract with or as an employee of the U.S. contractor responsible for implementing the project. This position will report to the Program Coordinator.

1. Scope of Work

(a) Supervise and coordinate all activities of the R & D Laboratory in Maseru and in each rural impact area.

(b) Maintain technical quality of RET designs and units.

(c) Participate in the design and coordinate installation and operation of the R&D technologies.

(d) Act as trainer for all aspects of the RET program.

(e) Prepare regular progress reports on laboratory activities.

2. Minimum Qualifications

(a) Undergraduate degree in Physical Science or Engineering (with experience in thermodynamics or thermophysics preferred).

(b) At least three years experience in laboratory procedures.

(c) A demonstrated knowledge of RET designs and engineering.

D. Peace Corps Volunteer Qualifications

1. Research and Development Laboratory Coordinator.

(a) Undergraduate degree in science or engineering graduate degrees preferred.

(b) Three years experience in laboratory work.

(c) Experience in media or photographic work.

2. Rural RET Training Center Coordinator

(a) Two years volunteer experience (Lesotho preferred).

(b) Technical or mechanical background or have a high mechanical ability.

(c) Willingness and ability to work with Basotho by living in rural village.

E. MORD A.T. Unit Personnel Qualifications.

1. A. T. Unit Supervisor.

   (a) Undergraduate degree in Physical Science or Engineering.

   (b) Aptitude and interest in administrative and supervisory responsibility.

   (c) Good mechanical aptitude.

   (d) Willingness to live and work in rural areas for short periods of time (2-3 months).

2. Assistant Solar Engineers (two positions, 1 male, 1 female)

   (a)Complete high school education.

   (b) Aptitude for economic and financial analysis.

   (c) Experience or aptitude in mechanical skill.

   (d) Experience in mechanical drafting or art.

   (e) Formal training or willingness to receive such training in social science.

3. Senior Technical Officer (two positions, 1 male, 1 female)

   (a) Good understanding of rural village environment (should have lived there).

   (b) Experience in mechanical skills.

   (c) High school level capabilities in mathematical skills.

4. Technical Assistants (four positions, at least two females)

   (a) Agressively interested in helping the rural people of Lesotho.

   (b) Willingness to live in rural villages.

   (c) Mechanical aptitude.

## Collaborating Ministries And Projects

| Project Type | Ministry | Contact | Area of Co-operation |
|---|---|---|---|
| (1) Wood lots | Agriculture | AC Baines<br>Deputy Director | Project location, data on on fuel use, provision of village fuels. |
| (2) Planning Section (sociological Data Bank) | " | Ms Moshoeshoe<br>J. Gay<br>T. Guma | Data Bank on sociological needs. |
| (3) LASA | " | G. Wilkens<br>J. Eckert | Resource Material on Agric and related issues on Lesotho. |
| (4) Food and Nutrition Co-ordinating Office (FNCO) | PM's Office | Mrs. Phafane<br>J. Anderson | Data on Nutrition, and cooking habits. |
| (5) Village Level Food Preservation Project | Agriculture-Nutrition Division | Mrs. Mokhachane | Co-op on ? food drying. |
| (6) Siloe Rural Development Project | MinRuDev (Donor Sashakhewan Gov.) | Mr. R. Dagleish | Potential lowland Project sits. |
| (7) Mafotholeng Rural Development | MinRuDev (Donor Oxfam) | M. Taole (Oxfam Mr. J. Parson) | Potential lowland Project sits. |
| (8) Rankakana | PHAL (Private Health Assoc. of Lesotho) | Ben Pekeche (?) | Potential Moonkin Project sits. |
| (9) | | | |
| (10) Rural Dev. Management Unit | MinRuDev. (UNDP-funded) | not started | Sociological & survey support. |
| (11) Communal gardens | MinRuDev. | Edwin Sello | Co-op on establishment of green houses, growholes |
| (12) Village water supplies | MinRuDev. | A. Hatmenn | Shaving facilities in MinRuDev. technical section ?Training Officer. |
| (13) A.T. Unit | Ministry of Commerce & Industry BEDCO | J. Mesfin | Research production of RETs. |
| (14) Thabana Rural Dev. | MinRuDev. (UNDP Donor) | not yet started<br>FAO Rep.<br>Gary Bayer | Potential lowland Project site. |

| Project Type | Ministry | Contact | Area of Co-operation |
|---|---|---|---|
| (15) Cana High School | Min. of Educ. | Peace Corp | Potential lowland site |
| (16) Community outreach programme | " | | village selection |
| (17) Thaba Khupa A.T. unit | Min of Agric | | R & D |
| LDTC | Ministry of Education | | curriculum material evaluation |

## Glossary of Abbreviations

AID - Agency for International Development

ATU - Appropriate Technology Unit of MRD

BEDCO - Basotho Enterprises Development Company

FTC - Farmers Training Center

GOL - Government of Lesotho

LDTC - Lesotho Distant Training Center

MORD - Ministry of Rural Development

PP - Project Paper

REDSO/EA - Regional Economic Development Service Office East Africa

RET - Renewable Energy Technology

RDL - Research and Development Laboratory

VET - Village Energy Technician