PD-AAW-025 6500041

SUDAN RENEWABLE ENERGY PROJECT

Fourth Annual Work Plan

July 1986

SREP

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NATIONAL COUNCIL FOR RESEARCH

ENERGY RESEARCH COUNCIL

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I. Introduction

A. Project Focus

The Sudan Renewable Energy Project (SREP), implemented by the Energy Research Council of the National Council for Research, is preparing its fourth annual work plan (July 1986 - June 1987). SREP (now designated as SREP I to distinguish it from the proposed follow-on project, SREP II), is scheduled for completion by November 30, 1986. However, USAID is now planning a follow-on project which essentially will be an extension of SREP I. SREP II will continue many of the same activities as in SREP I, but will add a new activity, the study of the application of renewable energy technologies for water pumping. SREP II would extend the life of the current project by two years.

This fourth year work plan will cover the transition period for the two separately funded technical assistance contracts. The plan will address the final activities of SREP I and the initial activities of SREP II. This transitional plan by its nature will not be able to address totally all issues on project implementation, short-term technical assistance, training and long-term advisors until the USAID has finalized its "Project Paper Supplement" which is the project description and budget for SREP II.

Also, the local currency budget for SREP I and SREP II is now being discussed by USAID and the Sudan Ministry of Economic Planning and Finance. Tentative agreement has been reached between USAID and the Ministry, but neither has finally approved the proposed local currency budget. However, for planning purposes, the fourth annual plan will use the proposed figures.

Four of the five priority areas addressed in the third annual work plan will be continued. These are:

-- Fuelwood/Forestry
-- Charcoal Stoves

-- Mechanized Farming and Charcoal Production
-- Briquetting

The woodfuel combustion portion of the briquetting project will be discontinued and photovoltaics applications will become part of the water pumping activity area. Water pumping will be a new area of activity and will provide a new approach to technology development and commercialization. The various renewable energy technologies will be compared to a common end-use, i.e., water pumping for irrigation and domestic consumption. This approach will affect the organizational structure of the Energy Research Council/Renewable Energy Research Institute, which has traditionally organized its staff around technology areas. In addition, an attempt will be made to coordinate the water pumping projects of international donors. Coordination will include technical assistance and field testing activities. If this coordination can be accomplished, it will serve as a model for other development projects in Africa.

B. USAID Evacuation from Sudan

In April 1986, the American personnel of the SREP, i.e., the Chief of Party and the five Peace Corps Volunteers, were evacuated from Sudan along with most USAID and U.S. Embassy staff and their dependents. The evacuation occurred because of U. S. Embassy concern for the general security of U.S. citizens in Sudan.

While the evacuation has disrupted SREP activities, both the ERC/RERI staff and Georgia Tech have tried to minimize this disruption. The program has continued under the leadership of Dr. El Tayeb Idris, SREP Coordinator, and Gaafar El Faki, SREP Assistant Coordinator. In addition, the Chief of Party, Donald Peterson received approval from USAID permitting previously scheduled training activities for Sudanese staff to proceed through May and June, 1986.

Three of the five Peace Corps Volunteers, Mary Clarkin, Brad Tyndall and Jon Dorre, were approved by USAID to work in Atlanta (the

location of Georgia Tech), on activities in which they had been engaged in Sudan prior to the evacuation. This involved completing a draft of a charcoal stove book, which had been previously planned by the SREP Dissemination Unit, and developing plans for a manually operated briquetting system. The two activities were completed during June 1986. Finally, the draft fourth annual work plan was written in Atlanta by the Chief of Party, with inputs from the project leaders of the individual technology areas. It is gratifying that SREP continued to progress even during the evacuation period. As the final draft of this plan is written (late May, 1986) it is not certain if or when the PCVs and Chief of Party will return to Sudan.

The USAID Project Officer for SREP was also evacuated from Sudan, but has remained in Nairobi, Kenya, to complete the draft of the Project Paper Supplement (PPS) to the SREP. He is writing the PPS with assistance from the USAID Regional Energy Advisor and Georgia Tech staff.

II. Report on Third Year Implementation (July 1985 - June 1986)

A. Institutional Development

1. Organizational Structure

The SREP is a project jointly sponsored by the Government of Sudan and USAID. The ERC is the counterpart organization for Georgia Institute of Technology (GIT), the technical assistance contractor for the project. The director of the ERC is the designated coordinator of the project for the Government of Sudan and the counterpart to the Chief of Party from Georgia Tech, who is responsible for administering the technical assistance contract in Sudan. They, in turn, report to the ERC Board through a 6-member technical committee which oversees general program policy and direction.

Most of the manpower to implement the SREP comes from RERI. Other staff are seconded from other government institutions and/or hired on personal services contracts.

Also, the ERC cooperates with government organizations and private enterprises which are involved in renewable energy activities in Sudan. For example, the SREP has developed a strong working relationship with the Forest Administration, particularly in the fuelwood and charcoal production area. Several foresters have been seconded during the past three years to the Seleit shelterbelt project and to the charcoal production/shelterbelt project operating on two mechanized schemes in the Damazine area. The FAO has co-sponsored with ERC a study of conversion factors for charcoal production and a study of charcoal earth kiln efficiencies. SREP has also worked closely with the private voluntary organizations such as CARE and Plan/Sudan on charcoal stove dissemination.

2. Staffing/Technical Assistance

a. Overseas Consultants

The SREP in December, 1985 received additional funding from USAID for up to 10 person months for short-term technical consultancies beyond the original contract. In the third implementation year, 12 person months of short-term technical consultancies were provided, which left six person months to be used for the remainder of the contract through November 30, 1986.

The overseas short-term consultancies provided during the third year through April, 1986, were:

Carolyn Huskey (Information Center)	5.5 p/m
Arthur Brown (Marketing of Charcoal Stoves)	1.5 p/m
Ben James (Production of Briquettes and Charcoal Stoves)	1.5 p/m
Dr. Hosni El Lakany (Fuelwood/Forestry)	1.5 p/m

Jim Winslow (Automotive Technician)	1.5 p/m
	12.0 p/m

b. Local Consultants

The SREP has continued to rely on Sudanese experts as consultants to implement the program. During the past year the following local consultancies were provided:

- Hamza Hamoudi	- Project Leader, Fuelwood/Forestry
- Kalafalla Sid Ahmed	- Project Leader, Mechanized Farming and Charcoal Production
- Hanafi Obeid	- Mechanized Farming and Charcoal Production
- Ust William Ibrahim Asaad	- Briquetting Design
- Jamal Sharfack	- Charcoal Stove Production
- Omer Al/El Kariem	- Agro/forestry
- Ali Khalid Ali	- Mechanized Farming
- Ali Beheiry	- Information Center

C. Peace Corps

The five Peace Corps Volunteers continue to work in the field testing and dissemination of charcoal stoves, experimentation with briquetting prototypes and the implementation of fuelwood/forestry projects. Each volunteer has developed counterpart relationships within the RERI staff. The ERC has recognized their contribution and has strongly recommended the continuation of Peace Corps involvement in the SREP II.

3. Participant Training

During the last year, the first cycle of the joint program between the University of New Mexico and the University of Khartoum was

completed and six MSc. degrees were awarded to members of the RERI and Forestry Research Center. The six students completed the following theses:

Hisham Mohy El Din - Solar Passive Tracking
Ibrahim Ahmed El Zein - Generating Electricity from the Wind
Siddig Adam Omer - Solar Heating for a Soft Drink Company
Belig Suliman - Charcoal Production from Cotton Stalks
Mohamed Ahard El Fadel - Fuelwood Production
Hassan Abdalla Mohamed - Photovoltaic Applications for Pumping

The continuation of the Renewable Energy Technology MSc. Program has been recommended and is planned under the SREP II. However, the next MSc program will not have a U.S. university component. All academic work will take place at the University of Khartoum, with a visiting professors providing technical advice in course development.

Short-term training has focussed on developing staff within the SREP to achieve the immediate objectives of the project. Receiving specific training were:

Gumma Ibrahim	--	Computer applications in developing countries, Stanford, U.S.
Maha Hassan Osman and Khalafalla Sid Ahmed	--	Agro-forestry field visit, Egypt
Dr. El Tayeb Idris Eisa	--	Study tour on water pumping and biomass energy application, Kenya and Botswana.
Dr. Azmi Zein El Abdin	--	Study tour to Kenya to review photovoltaic application in rural areas of Kenya.

Dr. El Sheikh Magzoub Dr. Azmi Zein El Abdin Shadia Naser El Din Somaya Mohamed Suliman Amin Kamil Mohammed Awatif Mahmoud Elnour Maha Hassan Osman	--	Marketing course, Georgia Tech, Atlanta, U.S.
Gaafar El Faki	--	Management and policy course related to research institutes, Denver Research Institute, U.S.
Dr. Mohamed Osman Sid Ahmed	--	Renewable Energy Applications Seminar, Egypt

B. Technology Development and Dissemination

1. Grants Program

The Renewable Energy Development Grants (REDG) Program is one of the unique components of the SREP. It has allowed the ERC to mobilize the support of other organizations, community groups and individuals to implement the objectives of the project.

During the first two implementation years, 48 grants were given for a total of LS 580,867. The distribution of the grants by priority area are described in following chart.

During the third implementation year, 25 grants were given for a total of LS. 536,861. While the number of grants decreased (there were 30 grants given in the second implementation year), the annual expenditure increased. This increase in average grant amounts stemmed from SREP policy change from giving small grants to individual farmers and villages to giving larger grants to irrigated and rainfed agricultural schemes. (See following chart which list grants for the third year).

Renewable Energy Development Grants

Awarded During First and Second Year Implementation

Priority Area	No	Budget		Disbursed Through April, 1986	
		LS	USD	LS	USD
Forestry/Fuelwood	35	376,508	-	305,818	-
Charcoal Stoves	6	154,284	-	97,322	-
Charcoal Production	1	9,150	-	5,950	-
Woodfuel Combustion	1	33,725	-	31,225	-
Photovoltaic	5	7,200	50,500	6,000	47,925
TOTAL	48	580,867	50,500	446,315	47,925

Renewable Energy Development Grants

Awarded during Third Year Implementation

Priority Area	Geographic Area					Disbursed as of April 1986
	Kordofan LS	Central Region LS	North Region LS	Khartoum LS	Eastern Region LS	LS
1. Fuelwood/Forestry						
Markha Awag El Dereb.....	15,000					15,000
Turbat Hamra	18,467					16,000
El Khieran.....	675					675
U of Gezira Shelterbelts.....		16,000				16,000
Gezira Aba - Nursery.....		17,000				12,000
Assalaya Sugar Co.		23,000				19,137
Gezira - 65 Nursery.....		23,000				15,000
Al Halim Nirgani..		750				*seedlings
Public Nurseries..		15,000				1,350
D.R.P. on species trials for bio-mass production for energy.....				48,000		27,785
Esilat Company...				21,800		13,200
NAPC.....			50,248			42,000
Sahara Company...			42,000			42,000
El Rahad Corp....					47,000	12,350
Goz El Nagara....		26,036				
Blue Nile Agr Corp.....		52,600				
Hawata Forest Cr.		27,250				
Hamadualla Nur...		15,800				
El Roseires Nursery.....		3,665				
Um Teilabat Nursery.....		920				
Seleit (3rd Grant).....				20,000		

(Continuation of REDGs Under Third Year Implementation)

Priority Area	Geographic Area					Disbursed as of April 1986 LS
	Kordofan LS	Central Region LS	North Region LS	Khartoum LS	Eastern Region LS	
2. Charcoal Stoves						
NEA Survey.....				57,400		25,180
3. Technical Journal						
University of Khartoum.....				7,000		3,000
4. Additional Grants						
Timade El Tahir..		950				950
Sedu.....				800		800
	34,142	208,471	92,248	155,000	47,000	278,934

Total Grants Awarded = LS 536,861

Total Amount Disbursed as of April 1986 = LS 278,934

*Seedlings given instead of funds.

Monitoring and evaluation of REDGs' implementation have continued, using the same review procedures as in the previous two years. To assist in the field evaluations of REDGs in fuelwood/forestry, the SREP contracted fuelwood/forestry specialist Dr. Hosni El Lakany to independently evaluate these REDGs. His recommendations will be discussed under the Fuelwood/Forestry Project Area.

The grants administrator, Nahid Hassein, ensures that grant follow-up and monitoring are carried out in a timely fashion. She also coordinates the review of new applications using SREP guidelines. Most grant proposals are reviewed and decided upon within six weeks of receipt of a completed application.

2. Fuelwood/Forestry

As a result of the agro-forestry seminar Agricultural and Forestry: Towards an Abundant Harvest (AFTAH) held in August, 1985 in Khartoum, and follow-up work by the fuelwood/forestry and dissemination staff, many applications for grants were submitted to initiate activities on these irrigated agricultural schemes. The applications were received directly from irrigated schemes as well as from Regional Forest Administration offices in Central, Eastern and Northern Regions and also Northern Kordofan Province. Ten new grants (part of the twenty-six grants awarded in this implementation year) have been awarded and eight applications are now under consideration. All proposals are for nursery establishment, with the exception of one which is to continue nursery and shelterbelt development in an irrigated scheme, the Seleit Company Ltd, north of Khartoum.

Many of the grants to individual farmers on small farms have not achieved the planned objectives because of lack of water for irrigation. This is particularly true around Soba where the majority of the small farm grants were awarded. The past year's results have shown that greater care must be given to on-site evaluation of the grant applications to determine that a reliable basic water supply is available.

Since the AFTAH seminar, the emphasis in awarding grants for fuelwood/forestry has been on the larger schemes in the irrigated areas.

On one scheme, the Rahad Scheme, the SREP grant has covered the cost of dissemination activities to promote tree planting, a briquetting project, and a charcoal stove production and dissemination project. RERI staff have been working to convince the farmers in the scheme of the value of the shelterbelts around their food crops.

During this implementation year, the SREP contracted Dr. Hosni El Lakany of the Desert Development Center of the American University in Cairo, Egypt, to evaluate the fuelwood/forestry grants. He recommended the SREP continue to support the private farm and village forestry projects, but that more projects be initiated in the irrigated schemes, which are based on agro-forestry. He also emphasized the need for adequate technical assistance to complement the financial assistance. He suggested that economic and social evaluations be undertaken on the irrigated projects and that all projects incorporate and utilize dissemination staff.

3. Charcoal Stoves

During this implementation year the charcoal stove program advanced in a number of areas, which included increased dissemination and commercialization activities, improvements in stove designs, and geographical expansion of the SREP program.

While the promotion of existing all-metal stove designs continued, a stove development component was conducted simultaneously. Results from consumer feed-back through household surveys, and laboratory and field testing led to the adoption of four basic models for dissemination: three all-metal ("El Duga") stoves and a metal-ceramic ("El Jiko") stove.

On the supply side, training workshops for charcoal stove producers continued to be the main vehicle for dissemination. In addition to formal workshops, a new concept of "flying" or informal workshops was tested with success in Omdurman. This concept is a more informal approach which eliminates some of the ceremonial and organizational requirements and thus reduces investment of time and money in its preparation. Five formal and four flying workshops were held. Physical output of the training efforts by March 31, 1986 resulted in 100 participants in the Khartoum area, Central Region and Kordofan. The SREP is attempting to train as many metal workers as possible because experience has shown that the undisciplined nature of the stove producers does not result in prolonged or consistent production.

Cooperation with organizations such as FAO, CARE, the Forest Administration and Plan/Sudan continued to be the most viable means for geographical expansion of stove dissemination. SREP grants were used to promote such cooperation. Up to the end of March 1986, two grants for stove dissemination activities in this implementation year were awarded for a total of LS. 90,055.

Efforts to increase stove production included the study of production economics and the use of alternative raw materials. A higher level of production is being sought, through involvement of small and medium workshops in stove production. The method of supporting the workshops initially may be accomplished through the awarding of grants to private metal and ceramic workshops. These grants may be awarded through competitive bidding.

In October 1985, the El Jiko stove, long popular in the Kordofan, was introduced to the Khartoum area. When efforts to promote the production of the stove through an area-wide contest failed, it was decided to introduce the stove in conjunction with the 1,000 Stove Survey.

During this implementation year through the end of March 1986, a total of 8,220 improved stoves (mainly the all-metal stoves), were produced in Khartoum, Gezira and Kordofan.

On the demand side, market demonstrations, the publication of promotional materials and the 1000 Stove Survey represented the major activities of the dissemination staff. Market demonstrations were the major SREP activity in the first half of the implementation year, but gradually gave way to localized demonstrations in residential areas where SREP staff involvement was reduced. Local surveyors employed in the 1000 Stove Survey were chosen to administer and implement such demonstrations at a minimim cost to the stove producers involved. New promotional materials produced this year included stove calendar and handouts explaining how to operate the various stoves. Concepts for a TV commercial also were tentatively developed with the aid of a professional Sudanese public relations firm.

In field studies, the ERC/RERI conducted its most ambitious household survey to date. One thousand households in the Khartoum area were surveyed to measure the acceptability of three different charcoal stove designs. The survey required the recruiting and training of 50 field surveyors, the production of 1000 stoves in a 45-day period, the design of 5 separate survey instruments, weekly visits to the 1000 households and receipt of 5,000 surveys for review and analysis. This work was accomplished in four months.

The dissemination staff continued to produce the monthly stove production reports begun in March 1985. Sales and production data from Gedaref, El Obeid and the Wad Medani areas were included in these reports.

In general, the stove program expanded considerably in the areas of design, production, dissemination and marketing. To document the knowledge gained from these experiences, SREP is preparing a charcoal stove reference book for general publication.

4. Mechanized Farming and Charcoal Production

This year the SREP began to implement a program to establish shelterbelts on mechanized rainfed schemes and to use the cleared

forest within the schemes to produce charcoal. The ERC gave grants to four organizations to help support this initiative. The grants were given to set up two nurseries in Damazine and Roseries and to two mechanized schemes: Damazine Agricultural and Animal Production Company Ltd. (DAAPC) and the Arab-Sudanese Blue Nile Agricultural Company Ltd. (ASBNA).

In addition, considerable technical assistance was provided to the mechanized schemes through seconded foresters from the Damazine Forest Administration and through periodic visits by ERC/RERI forestry staff. Because both the shelterbelt and charcoal production initiatives are new concepts, they have taken more preparation time than anticipated. Despite delays, progress has been made. The two schemes have begun the construction of a flying nursery, because a year-round water supply for the seedlings is not available (The term "flying" indicates that it is only temporary). Seedlings will be provided by Roseries and Damazine nurseries. It is expected that by the end of June, 1986, 10,000 seedlings will be planted for shelterbelts and shade.

The two nurseries are expanding their existing seedling capacity to accommodate the two schemes' requirements. Because of administrative delays, the Damazine nursery expansion did not begin until recently. However, it was expected to produce 3,000 seedlings by May, 1986.

The production of seedlings at the Roseries Research Nursery is expected to total 20,000 this year, with greater production anticipated in the future.

Charcoal has been produced on the DAAPC Scheme only, since legal problems have prohibited further land clearing on the ASBNA Scheme. With the use of two independent contractors, 150,000 sacks (80 lbs/sacks) of charcoal are to be produced from 5,000 feddans of land to be cleared.

5. Fuelwood Combustion

The fuelwood combustion project area focused on improving efficiencies of brick kilns. This area was selected based on the National Energy Administration's survey which reported that the greatest technical and economic potential for combustion system improvement was in the brickmaking industry. Preparations were made to measure the efficiency of brick kilns both theoretically and through field tests. While theoretical efficiencies were calculated, the field tests were never conducted because of delays in securing foreign technical assistance. Short-term technical assistance was scheduled on three separate occasions and had to be delayed due to U.S. Embassy restrictions on travel to Sudan.

In addition, there was considerable debate over the proper instrumentation needed to adequately measure kiln efficiency. Foreign consultants from The Netherlands estimated instrumentation costs at $50,000. Considering all the above factors and the other priorities of RERI, it was decided to terminate the fuelwood combustion component of this project.

6. Briquetting

Toward the end of the Second Annual Work Plan, the SREP briquetting team attended a training course at Georgia Tech on briquetting processes and binding technology. The team also discussed the preliminary design of a prototype briquetting machine with Georgia Tech Research Institute staff. During the first five months of the Third Annual Work Plan, the briquetting team finalized the prototype design, and constructed and lab-tested a complete briquetting system with help from local and foreign consultants. The briquetting system consists mainly of the briquetting machine itself, a mixer, a mixing tank with a ladder, a circulating pump, a compressor and a steel plate grinding mill. The briquetting machine was designed in such a way that it can be manually operated using a power screw or pneumatically driven using a compressor and air cylinder arrangement.

From November 1985 through February 1986, the team conducted a series of field tests to produce different types of briquettes from varying proportions of charred cotton stalks fines, paper fiber binder and other additives. From these experiments, the briquetting team was able to determine the different factors that influence the briquetting process. Based on experience from testing the first prototype, a second prototype briquetting machine was designed, fabricated and then tested. Qualitative and water boiling tests for the briquettes were also carried out using different kinds of stoves (the El Jiko, modified traditional stove and the "Canun El Duga" - the original all-metal improved stove designed to use charcoal fines which are traditionally thrown away). Other measurements were made to determine calorific value, moisture content, volatiles, ash content and fixed carbon of the briquettes. All these tests were conducted at Soba Research Center (this center was built from October 1985 to January 1986 under the supervision of the team). In February 1986, a survey was conducted to determine home acceptability of the briquettes. Analysis of the survey data indicated that a majority of housewives accept briquettes composed of 95% fines, 5% binding material and no additives. However, this conclusion needs further investigation to verify this result.

From March 15 to May 23, 1986, the team carbonized and briquetted cotton stalks at an average production rate of 1000 briquettes per day. The briquettes produced were distributed to 100 farmer housewives, in the different villages of the Rahad Scheme at an average of 1 kg of briquettes per day per household for a period of three weeks. At the end of this period, the housewives were asked to assist in filling a questionnaire. This questionnaire was developed mainly to measure the acceptability of and to forecast the future market demand for briquettes.

In March 1986, the briquetting team, with the help of Dr. Ahmed Hassan Hood, ERC, designed and supervised the fabrication of 6 kilns, each 2.71 m in diameter, for carbonizing cotton stalks in a private

workshop in Fao City, Rahad Scheme. From March 15, to May 23, 1986, the team conducted field demonstrations at Village 10 of the Rahad Scheme to carbonize cotton stalks for briquetting. The briquettes were distributed to farmers to determine acceptability. A questionnaire was developed to measure the acceptability and to forecast the future market demand of briquettes.

7. Photovoltaic Applications

The original intent of this photovoltaic applications project was to determine whether small businesses could be assisted with seed funds to defer the initial costs of buying an inventory of photovoltaic systems. The assumption of many entrepreneurs was that markets could be created if subsidized models were introduced to demonstrate their usefulness. The experience from the past two years of field testing and consumer acceptability is that this assumption does not appear to be correct. Despite the fact that consumers have been impressed with the equipment, the high initial costs have limited sales drastically. In all cases where sales have been made at the true market value, the purchases were by international organizations that are implementing development projects in isolated rural areas of Sudan. Therefore while a market exists, it is small.

During the past year, the Photovoltaic Project conducted several field tests of equipment purchased through REDGs. Four battery-operated lantern systems with centralized photovoltaic recharging were installed in the Gezira and North Regions. Sixty-five self-contained recharging lanterns were distributed throughout Sudan. Seven sodium vapor lamps were installed primarily in the Rahad Scheme, Gezira and Khartoum Province. A solar refrigerator was also installed in the village of Tokar in May 1985. All devices continue to work. The RERI staff has made frequent field visits to assist in maintenance and to observe the operation of the equipment.

Of the four grants given in the photovoltaic field only one grantee has completed an economic feasibility of its system, that

being the centralized recharging lantern system. It appears that the system does have potential in isolated areas where the alternative is batteries.

Other work conducted by the photovoltaic group which will be useful to future projects is the "Economic Evaluation of the Use of Diesel Engines, Electric Power Grid and Photovoltaic Panels for Water Pumping in Sudan," which will be submitted by the end of 1986. This work will be beneficial for the future water pumping project now being organized for the Fourth Annual Work Plan. Future activities for photovoltaic applications will be undertaken in the context of this water pumping project.

8. Dissemination

The Dissemination Unit of the RERI continues to expand both in the number of staff assigned and in the number of activities it conducts. The work now conducted can be divided into two components: the dissemination/extension component and the energy information component.

The dissemination/extension component has included market analysis in its scope, considering consumer preferences when formulating dissemination strategies. In general, the staff now appreciates the inter-relationship of market analysis, production and dissemination.

The unit continues to conduct charcoal stove producer workshops. It has published a new pamphlet describing the work of the ERC as well as reports on the application of renewable energy technology applications.

Another important component of the Dissemination Unit is the newly formed Renewable Energy Information Center. The objectives of the center are:

- to provide technical information on the applications of renewable energy technologies for Sudan. A bibliographical service of documents available also has been established.

- to establish a renewable energy technology network in Sudan. This includes maintaining a directory of organizations involved in renewable energy technology application and a listing of projects by technology.

- to establish communication with organizations in Africa and the Middle East that are involved in similar activities.

The center is becoming the focal point for most renweable energy technology studies. It has definitely strengthened the RERI capability to research applications of renewable energy technologies.

C. Procurement

Prior to this implementation year, approximately $140,000 was spent on procurement (through June 1985). In this implementation year, another $124,000 was spent through April 30, 1986. The expenditures can be broken down in the following categories (figures are approximations):

Item		
Laboratory Equipment	--	$ 12,000
Vehicles and Spare Parts	--	80,000
Computers and Information Center	--	27,000
Field Test Equipment	--	5,000
	Total	$124,000

Total expenditures through the third year implementation is therefore $264,000.

D. Budgets and Expenditures

1. Georgia Tech Technical Assistance Contract. The expenditures through April 30, 1986 total approximately $2,411,000. With the estimated expenditures through June 30, 1986, and the unexpected evacuation expenses, there will be a balance of approximately $530,000 to continue the SREP beyond July 1, 1986. If current expenditure rates are maintained, it may be possible to extend the current SREP contract beyond the present termination date of November 30, 1986 into March of 1987.

2. Trust Fund (Please see following chart)

3. Project Account Fund (Please see following chart)

SUDAN RENEWABLE ENERGY PROJECT - TRUST FUND

REPORTING DATE: April 30, 1986

Cost Category	Budget	Disbursement This Period	Cumulative Disbursement
1. Office Support	93,000	3,445.00	88,228.66
2. Local Travel: SREP			
: USAID	69,339	59.40	44,338.40
3. Miscellaneous	60,000	.00	11,760.00
4. Housing : SREP	308,000	5,781.00	72,867.91
: USAID			169,298.72
5. Communication	82,000	.00	40,363.59
6. Grants Administration			
- Administer	15,661	.00	3,900.00
- Field Evaluations	.00	.00	.00
7. Peace Corps Volunteers Support	505,440	8,558.58	339,878.64
TOTAL	1,133,440	18,629.98	848,666.62

Project Account
Third Annual Work Plan
Financial Report April 30, 1986
(Revised Budget, Effective December 31, 1985)**

·oject ·ea	Charcoal Stoves	Mechanized Farming	Fuelwood/ Forestry	Woodfuel Combustion	Photo-voltaics	Diss.
)st ıtegory						
[. Consult. & Subcont.						
- Budget	10,000.00	20,000.00	20,000.00	15,000.00	10,000.00	5,000.00
- Cum. Exp.	1,133.87	6,323.23	23,040.01	13,130.02	772.50	3,996.19
:. Field Test Support						
- Budget	10,000.00	15,000.00	5,000.00	10,000.00	10,000.00	10,000.00
- Cum. Exp.	20,432.28	7,118.87	6,266.30	160.00	2,835.45	2,567.24
.I. Materials & Equipment						
- Budget	30,000.00	5,000.00	5,000.00	25,000.00	5,000.00	55,000.00
- Cum. Exp.	19,276.58	25,214.60	2,561.61	44,871.32	8,567.00	48,345.87
'. Training Activities						
- Budget	-0-	-0-	-0-	-0-	-0-	25,000.00
- Cum. Exp.	-0-	-0-	-0-	-0-	-0-	24,257.79
. TOTAL						
- Budget	50,000.00	40,000.00	30,000.00	50,000.00	25,000.00	95,000.00
- Cum. Exp.	40,842.73	38,656.70	31,867.92	58,161.34	12,174.95	79,167.09

TOTAL BUDGET	290,000.00
TOTAL EXPENDITURES	260,870.73

Other Project Cost	
Grants	
- Budget	450,000.00
- Cum. Exp.	293,356.38
Incentives	
- Budget	60,000.00
- Cum. Exp.	47,738.20
Travel	
- Budget	50,000.00
- Cum. Exp.	68,417.87
Miscellaneous	
- Budget	-0-
- Cum. Exp.	53,187.20
TOTAL	
- Budget	850,000.00
- Cum. Exp.	723,570.38

III. Fourth Annual Work Plan (July 1, 1986 - June 1987)

A. Institutional Development

Over the past two years the ERC/RERI has become recognized as the Sudanese government organization involved in the development and commercialization of renewable energy technologies. Future institutional development will continue to focus on project and institutional management skills to be coupled with the existing technical skills in the respective technology areas. This development will be accomplished through selected short-term training and on-the-job training by working directly with local and foreign consultants.

Two unique components of the RERI which do not exist in any other Sudanese organization are the information center and the dissemination/commercialization activities of the Dissemination Unit. These components will continue to be developed in the coming year.

In the following description of job training, participant training, and technical assistance, the details for the latter part of the year will not be available since this work will be part of the SREP II which has not yet been completely formulated nor approved by USAID. However, the general direction should be maintained throughout the year.

1. On-the-Job-Training

As a means of providing on-the-job-training, RERI staff as well as staff from other institutions will work with both local and foreign consultants in those areas which are of high priority, and where the involved institutions have limited experience. In all cases, one or more counterpart personnel will work with each short-term overseas consultant.

2. Participant Training

Long-term academic training for a Renewable Energy Technology MSc. at the University of Khartoum is to be included in the SREP II. Preliminary estimates are that 10 students will participate. This program will be conducted exclusively at the University of Khartoum with no U.S. component. However a visiting professor from the U.S. will be provided for one year.

Three Masters degrees are to be included in the SREP II. These would be two-year programs at U.S. universities to be selected by the candidate and the RERI. The emphasis of these Masters would be on marketing, project management, project evaluation, and administration.

Short-term training will continue to focus on improving the management and organizational skills of RERI staff. Training planned through November, 1986 include:

- Ibrahim Saad	Information Center Management VITA, U.S.
- Fethi Mohamed Salah	Information Center Management, VITA, U.S.
- 2 Foresters to be Determined	Agro-Forestry Field Trip, Egypt
- 2 Senior Staff	Arid Lands Seminar, Egypt

SREP II will also provide short-term training which will cover:

- arid lands management; Egypt
- water pumping; Kenya, Somalia, and Botswana
- charcoal stove production; Kenya
- marketing; U.S.
- applied research management; U.S.

An annual training plan for 1987 will be prepared in December and presented to the Institutional Committee of the RERI for review and USAID approval.

3. Technical Assistance

a. Local Consultancies

As in the past two years, SREP will use long-and short-term consultancies to undertake specific tasks and assist RERI staff in overall implementation of projects. Long-term consultancies will include the continuation of most of the existing personal service contracts, which are:

- Hamza Hamoudi	Project Leader, Fuelwood/Forestry
- Khalafalla Sid Ahmed	Project Leader, Mechanized Farms
- Omer A/El Kariem	Fuelwood/Forestry
- Ali Khalid Ali	Fuelwood/Forestry
- Ali Beheiry	Information Center

Other short-term technical assistance will be financed through the individual projects.

6. Overseas Consultancies

There are six (6) person months of overseas technical short-term consultancies now available to the SREP. It is projected that this technical assistance will be allocated as follows:

- Briquetting (Ben James or other)	1 pm
- Follow-up to Water Pumping (Vaughn Nelson and Jeff Kenna or Richard McGowan)	2 pm
- Charcoal Stove Design (Tim Wood)	1 pm
- Economic Analysis of Fuelwood Projects (William Riall)	1 pm
- Final Report (Matthew Gamser)	1 pm

The above short-term consultancies will be provided before the end of the SREP I, now scheduled for November 30, 1986.

Twenty-eight (28) person months of short-term technical assistance tentatively are planned for SREP II, allocated approximately as follows:

Briquetting		3 pm
Fuelwood Production		6 pm
Charcoal Stoves		3 pm
Water Pumping		10 pm
Dissemination		6 pm
	TOTAL	28 pm

B. Technology Development and Dissemination

1. General Strategy

The overall strategy of technology development, commercialization, and dissemination will continue in this implementation year. As the RERI becomes more involved in this process of technology transfer, it is considering the consumer's needs and perceptions through market analysis. Also, production consideration has become part of this commercialization process.

The SREP approach of using grants to enlist the support of the private sector, local government, and other governmental organizations will also continue.

The SREP objective is to demonstrate renewable energy technologies and methods of disseminating and commercializing these technologies. Larger scale application and/or commercialization must come from other private and government organizations.

2. Fuelwood/Forestry

The fuelwood/forestry activities of the SREP have attracted much attention in the past year since they appear to be a successful means of promoting the planting of trees by various groups and individuals. This year the emphasis will be on providing more technical assistance to the individual grantees and quantifying the apparent gains of afforestation. This will be done through evaluation of the impact of shelterbelts on crop production and the micro-climate and the economic cost benefit analysis of individual agro-forestry initiatives.

The overall objective is to begin to develop a model administrative unit to provide technical assistance to farmers and communities, to finance these initiatives and to evaluate the results. This information could be used by the Forest Administration in forming its national extension program.

Project: Fuelwood/Forestry

4th ANNUAL WORK PLAN

Activity	1986 Jul	Aug	Sep	Oct	Nov	Dec	1987 Jan	Feb	Mar	Apr	May	Jun	Responsible
1. Organize economic evaluation of Seleit agro-forestry effort													SREP Project Leader
2. Economic evaluation of SREP fuelwood/Forestry grants with foreign technical assistance													Dissemination Director and Foreign Consultant
3. Conduct series of workshops on agro-forestry in the irrigated farming area													Dissemination Unit
4. Experiment with drip irrigation for agro/forestry (Um Inderaba and Temerd Hag El Tahir)													Project Leader and RERI Mechanical Engineer
5. Develop in conjunction with the community project extension program from local forestry offices an administrative model to provide technical assistance													RERI Staff and Forest Admin.
6. Develop agro-forestry community projects with equal emphasis on food production as well as fuelwood													RERI Staff RERI Staff

3. Charcoal Stoves

Based on the previous year's experience, the RERI will be focusing on improved and increased production, and better sales and distribution of efficient charcoal stoves. Also, greater emphasis will be put on the promotion of the metal ceramic stove.

Producer workshops will continue but the more informal "flying" workshop, which is more cost-effective, will be promoted. Also, stove demonstrations will go beyond the market place, and community meeting places will be used.

The stove design center at Soba will begin operation in this implementation year. The building for the center was completed last year and plans are now underway to begin design work for stoves using charcoal and various types of briquettes. The stove center is to be the national design and testing center for all organizations interested in charcoal stoves.

The monitoring of stove production and sales as well as market surveys, will continue to measure consumer preference and reaction to different stove designs.

Project: Charcoal Stoves

4th ANNUAL WORK PLAN

Activity	1986 Jul	Aug	Sep	Oct	Nov	Dec	1987 Jan	Feb	Mar	Apr	May	Jun	Responsible
1. Monitor stove production and sales. Develop a more comprehensive system and include use of non-SREP staff.	Monthly Reports												Dissemination, Unit, Shadia, Mary
2. Stove training													
- Small-scale producer workshop			X			X			X			X	Diss Unit - Amin, Somaya, Brad
- Medium scale producer technical assistant			—			—							" " " " "
3. More extensive production of El Jiko stove	—	—	—	—	—	—	—						Diss Unit - Amin, Brad
4. Workshops on quality control and availability of scrap metals (conducted in "flying" workshop fashion).		—			—			—			—		Diss Unit - Amin, Brad
5. Radio/TV campaign to educate people on stove use and linking producers with sellers.	—	—	—		—	—	—	—	—	—	—		Diss Unit - Awatif, Somaya, Maha
6. Draft and publish charcoal stove book.	—	—	—										Brad, Mary, Gaafer
*7. Stove design center operating at Soba													
- design of stove using briquettes from groundnut shells		—											Amin, Foreign Consultant
- design of stove using briquettes from charred cotton stalks. Other improvements on existing stove design			—										Amin
- design of stoves using charcoal			—	—									"
8. Market surveys to determine consumer preference				—				—			—		Gaafar, Mary, Somaya

*The Charcoal Stove Design Center will be under the leadership of Dr. El Sheikh Magzoub the remainder of the charcoal stove activities will be the responsibility of Gaafar El Faki.

4. Mechanized Farming and Charcoal Production

The mechanized farming and charcoal production project will continue the activities of the past year, i.e., work with the four entities that received grants from the SREP:

- -- Damazine Agricultural and Animal Production Co., for charcoal production and shelterbelt establishment.
- -- Arab-Sudanese Blue Nile Agriculture Co. Ltd., for charcoal production and shelterbelt establishment.
- -- Damazine Forestry Division, to establish a nursery.
- -- Research Nursery of Roseries, to expand the nursery.

A special point will be made to initiate charcoal production early so it will not interfere with crop planting.

Project: Mechanized Farming and Charcoal Production

4th ANNUAL WORK PLAN

Activity	1986 Jul	Aug	Sep	Oct	Nov	Dec	1987 Jan	Feb	Mar	Apr	May	Jun	Responsible
1. Seedling planting and beating up													Schemes, assisted by Ali
2. Grass clearance													Schemes
3. Seed collection													Research officer, Schemes
4. Demarcation of Strips													Schemes, Khalafalla
5. Organize labor and Management for charcoal making													Schemes, Khalafalla, Jim Adams
6. Charcoal Making													Schemes, contractors or individ charcoal burners
7. Shade and Ornamental tree planting													Schemes, Ali

5. Briquetting

The goal of the briquetting team during the first month of the Fourth Annual Work Plan is to complete the preliminary report on the results of this year's field testing on the Rahad Scheme. The report will discuss:

- the design, fabrication and assembly of the complete briquetting system,

- carbonization and briquette production techniques,

- home acceptability survey and relevant analysis,

- chemical analysis (water boiling tests, calorific values, ash content, volatiles, fixed carbon, etc.),

- field demonstration at Rahad Scheme,

- economic analysis and future market demand.

In August and September, 1986 the team will begin to design hydraulically and manually operated prototype briquetting machines with local and foreign technical assistance. These systems will be constructed by private workshops in the Khartoum industrial area during October and November. The briquetting machines will be tested at the Soba Research Centre and then taken to the Gezira Scheme between March and April, 1986 for the purpose of spreading briquetting technology in a wide area. Some Gezira villages will be selected for field demonstration. The final report will be prepared during May and June 1987. By that time, dissemination of briquettes could begin

Project: Briquetting

4th ANNUAL WORK PLAN

Activity	Jul	Aug	Sep	1986 Oct	Nov	Dec	Jan	Feb	Mar	1987 Apr	May	Jun	Responsible
1. Preliminary report													Briquetting Team
2. Design of three prototype briquetters - hydraulic - air cylinder - manually operated													Above, Local and Foreign Consulta
3. Prototype construction													Private Workshop
4. Prototype testing													Briquetting Team
5. Acceptability survey conducted to determine consumer interest of briquettes													" "
6. Field investigation at Gezira													" "
7. Final report and start dissemination													Above, Dissemination Unit

6. Water Pumping

It is intended that the water pumping project emerge as a major component of the SREP II. Since this project is to begin with this Fourth Year Plan, more detail will be given in order to provide a clear understanding of the direction. The plan of action is taken from Dr. Vaughn Nelson's Water Pumping Requirements for Rural Areas. Dr. Nelson's one-month consultancy during March, 1986, set the groundwork for a long-term study on renewable energy technology applications for water pumping.

The project will attempt to coordinate ongoing and planned water pumping activities which consider renewable energy technologies as a power source. In this way, foreign technical assistance, capital investment for prototypes, and national professional capabilities can be more efficiently used. Since the ERC/RERI currently has three donor organizations either implementing or planning to implement water pumping projects, the initial coordination will be with these three groups. They are the Dutch CWD, the German SEP/GTZ, and the USAID/SREP The head of the SEP/GTZ project has already expressed interest in this joint effort and Dr. El Tayeb Idris, director of ERC, has had preliminary discussions with CWD on the subject.

While the above organizations will initiate the joint study, it is hoped that other organizations would also participate.

Phase I (July 1986 - December 1986)

This phase will draw together existing related information on water pumping which includes collection and analysis of data on ground water availability, population distribution in rural areas, water requirements for crops, livestock and humans, and renewable energy technology applications now being used in Sudan. This phase will set up the framework for the study and identify the information gaps. It is expected that this phase will also entail the organization of a

steering committee to oversee the study and to enlist the participation of all international and national organizations. Specific activities will include:

a. Renewable Energy Resources:
Analyze existing primary and secondary sources of data on renewable energy resources availability: solar, wind, biomass, river flow. Based on this data, recommendations for future data collection would be made, giving number and location of proposed sites.

b. Diesel pumping systems:
Compile information on the types and sizes of diesel water pumps now being used in Sudan, particularly in rural areas. Data to be collected would include:
- number of pumps sold and in use
- average installation cost per KW (new systems)
- average maintenance and operation costs
- average number of operating hours per year
- financial and economic analysis of systems

c. Ground Water Sources:
Compile information on ground water resources by region, depths, and potential water yield.

d. Water requirements by end-use:
Develop listing of water requirements, using existing studies by universities and national and international organizations. End-uses would include:
- human consumption per capita
- livestock consumption per head
- irrigation requirements for small horticultural crops
- irrigation requirements for field crops, using various methods of irrigation
- irrigation of shelterbelts
- irrigation of agro-forestry

e. Inventory of wells:
Update the existing inventory of wells now in operation or drilled in cooperation with the National Water Corporation.

f. Inventory of Renewable Energy Water Pumping Projects:
Update the inventory of current projects under way in Sudan through reports and personal interviews. This inventory will include solar, human, wind and hydro wind power pumping systems.

The emphasis of the study will be on the long-term operation of any system as opposed to its efficiency. This will include maintenance and labor costs and the actual percent of time the system is in operation over an extended period of time. (at least one year).

Phase I will result in a description by region, if possible, of pumping requirements by end-use, water resources available, and potential for renewable energy technology application in that region. In many cases information may need to be presented on a monthly or seasonal basis.

This report would also define the information that would need to be obtained, in Phase II.

Phase II (January - June 1987)

Phase II will be a continuation of data collection initiated in Phase I. Also, new field sites will be selected to be used to install and evaluate different renewable energy technologies. In many cases, collection of data will be done by those receiving the pumping service.

Renewable energy systems are to be evaluated at different power levels ; 0.1 kw or less, 0.1-1 kw, 1-5 kw, 5-10 kw, and 10-50 kw. The evaluations will be carried out by the RERI staff. It now appears

that the most cost-effective systems will be in the lower ranges, i.e. less than 10 kw.

The primary objective in determining the efficiencies of renewable energy technologies will be to develop RERI personnel in the techniques of data collection and analysis. It is not to establish the efficiencies for the systems, since that has been conducted in other countries on similar systems and could be adapted for use in Sudan. Again, emphasis is to be placed on long-term operation. The pumping systems are to be kept operating.

Project Water Pumping

4th ANNUAL WORK PLAN

Activity	1986 Jul	Aug	Sep	Oct	Nov	Dec	1987 Jan	Feb	Mar	Apr	May	Jun	Responsible
1. Inventory													RERI Water Pumping Team
- Renewable energy resources													
- Diesel pumping systems													
- Ground water resources													
- Water requirements by end-use													
- Inventory of wells													
- Inventory of renewable energy water pumping projects													
2. Field Testing													RERI Staff
- Selection of renewable energy projects installed and available for field testing													
- Purchase and install other RET prototypes													
- Evaluation of current pumping costs for diesel system													
- Develop arrangements for long-term data collection of RET system performance collection													
- Data collection													

C. Procurement

Very little procurement will be made for the remainder of SREP I. Purchases that are now in process will be completed. These purchases include spare parts for vehicles, computer parts, and books and publications for the information center. The total procurement will not be more than $10,000.

D. Budget by Project Area

The following chart outlines the budget for each project area. Additional funds will also be provided when SREP II is approved. These funds will support Long-Term Training at the University of Khartoum (LS. 125,000), and activities in Applied Forestry Research (LS. 150,000).

Project Account Budget by Project Areas

(Sudanese Pounds LS)

Project Area	Consultancy & Subcontract	Field Test Support	Field Test Material & Equipment	Training Activities	Total
Fuelwood/Forestry	40,000	15,000	15,000		70,000
Charcoal Stoves		10,000	20,000		30,000
Mechanized Farming and Charcoal Production	20,000	5,000	-	-	25,000
Briquetting	25,000	5,000	20,000	10,000	60,000
Water Pumping	25,000	10,000	25,000	-	60,000
Dissemination	5,000	11,000	50,000	20,000	86,000
Sub-Total					306,000
Grants					500,000
Travel & Maintenance					50,000
Incentive					60,000
Long Term Local Training					125,000
Applied Forestry Research					150,000
TOTAL					LS 1,191,000