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Final Evaluation of Renewable Energy AIP

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Administered by USAID/Dakar, Senegal

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EXECUTIVE SUMMARY

PREPARED BY: Dr. Timothy S. Wood, Volunteers in Technical Assistance

DATE: October 12, 1983

PROJECT: Senegal Renewable Energy--Improved Cookstoves

COUNTRY: Senegal

COST: $317,700

PERIOD OF PROJECT: March 1, 1980 - December 31, 1983

1. What constraint did this project attempt to relieve?

   High consumption of fuelwood for domestic cooking which contributes to the rapid rate of deforestation in Senegal.

2. What technology (knowledge, skills or practices) did the project promote to relieve this constraint?

   The construction, use and maintenance of low-cost energy-efficient cookstoves. The specific skills involved included identifying suitable sand and clay materials, testing for proper mixture, and using it to build one of several different stove models.

   Project personnel were also instructed in effective methods for teaching others to build such stoves.

3. What technology did the project attempt to replace?

   Use of the less efficient open fire and charcoal "malgache" stove.

4. Why did project planners believe that intended beneficiaries would adopt the proposed technology?

   It was thought that the obvious benefits of an effective stove would draw women away from their traditional cooking practices. The apparent success of similar projects in Guatemala and in Upper Volta lent support to this assumption.

5. What characteristics did the intended benificiaries exhibit that had relevance to their adopting the proposed technology?

   Most of the intended beneficiaries were rural women of small financial means. Their readiness to adopt the use of aluminum cooking pots and metal tripod pot holders seemed to indicate a relaxation of ties to strictly traditional practices.

6. What adoption rate has this project achieved in transferring the proposed technology?

   Of the estimated 6,000 stoves constructed during this project, approximately 60% are believed to be still in regular use. A 1982 survey found that in the training program for rural women, 89% of the stoves were built be trainees following the training sessions. Of these, 15% had been destroyed but 91% of those remaining were in regular use. A men's training program promoting a more complex stove model achieved 43% stoves built after training, of which 11% were destroyed and 54% of those remaining were in regular use. The urban stove component has experienced serious problems in the adoption rate, probably due to inappropriate stove models and poorly defined dissemination strategy.

7. Has the project set forces into motion that will induce further exploration of the constraint and improvements to the technical package proposed to overcome it?

   Field studies were undertaken in 1981 and 1982 to assess the impact of the project. Follow-up visits to training sites and a recent survey of several hundred stove owners also provide feedback information to project managers. Limited laboratory testing and improvement of stove models remains a general weakness of the project. A need for more effective training techniques was also recognized.

8. Do private input suppliers have an incentive to examine the constraint addressed by the project and to come up with solutions?

   With the emphasis on owner built stoves using a sand-clay mixture, there has so far been little incentive for entrepreneurs to participate in spreading the technology. Recent plans for the development of portable stove models include a strong role for the private sector.

9. What delivery system did the project employ to transfer technology to intended beneficiaries?

   The project has relied on fixed and mobile teams of trainers, collaborating with organized groups (PVO's, government agencies, local organizations) to conduct training sessions for intended beneficiaries. The sessions include early site visits and post-session follow-up by a woman extension worker. In a few cases, at the request of other organizations, training sessions have been held for their own personnel who would themselves conduct further sessions.

10. What training techniques did the project use to develop the delivery service?

In general, the first stoves built during training sessions are made by instructors as demonstrations, with assistance from trainees. Subsequent stoves involve more direct participation of trainees under supervision of the instructor.

Experience has shown that good stove builders are often poor instructors. A week-long visit from an educational consultant proved extremely useful.

11. What effect did the transferred technology have upon those impacted by it?

In a 1981 study of 100 households where stoves had recently been installed, 23 families experienced wood savings of 40-60%. For 20 families, savings were negligible. Other families had savings between these extremes: 60 households showed a mean fuel savings of 41%, and 20 households showed a mean of 10%. Low fuel savings was attributed to misuse or poor condition of the stoves.

I. OBJECTIVES

The objective of the cookstove project, as set forth in the 1979 Project Paper, was "the development and testing of woodburning and charcoal cookstoves made of local materials"(1). The document went on to suggest that the stoves should economize on fuel, be affordable to the rural population and be socially acceptable. Details on project implementation were unspecified, except that a first year of laboratory and field testing should be followed by wider dissemination.

With the arrival of project consultants from the Aprovecho Institute in 1980 (and again in 1981) the original objectives were greatly expanded (9, 14). They now included developing a new trade in Senegal (stove builders) and spreading the stoves to 1/2 million rural and 1/4 million urban households by 1984. The stoves should cost "almost nothing" and use at least 50% less fuel than traditional open fires.

These new goals were echoed in 1981 by the project manager when he affirmed the intention to train 10,000 people to build 300,000 to 500,000 stoves within three years (15).

Thus there was almost from the very beginning the sense of a crusade towards massive diffusion of the new stove technology. Although these sights were lowered considerably in the third and fourth years of the project, the emphasis on numbers has remained a heavy influence, although it was not part of the original objective.

II. WHAT HAS BEEN ACCOMPLISHED?

A. Stove Testing and Development:

At least eight wood or charcoal-burning stoves have been developed and

tested since the start of the project (18, 28). These include the following:

1. A simple one-pot wood-burning stove with a single entry for fuel and no chimney, which evolved from the "Louga Stove" proposed by Aprovecho and now known as the "modele de base" or the "Coumba Gueye" stove;

2. A one-pot wood-burning stove built on a raised foundation, with a single fuel entry and chimney;

3. A stove similar to number two but having pot-holes and therefore somewhat larger;

4. A two-pot wood-burning stove with two separate entries for fuel and a single chimney;

5. A one-pot, chimneyless charcoal stove similar to number one in appearance, but with a grate and somewhat smaller dimensions;

6. A one-pot charcoal stove with chimney;

7. A charcoal stove with two pot-holes, one for entry and one chimney;

8. A charcoal stove with two pot-holes, two fuel entries and one chimney.

Naturally, these stoves vary considerably in their performance, cost, and acceptability. The one common feature is that all are made of widely available sand and clay, making them very affordable for people who build their own. In fact, almost from its inception the CERER stove program has been widely known as the "Ban ak suuf" program, meaning "clay and sand" in Wolof.

In addition to being made from local materials, certain stoves meet the original criteria in other respects.

1. <u>Fuel efficiency</u>

   a) Laboratory tests. In 1982, a series of water-boiling tests was conducted at CERER to determine their efficiencies relative to traditional stoves under controlled conditions (18). The stoves tested included the four basic wood-burning models and their charcoal-burning counterparts as follows:

   Model A: traditional open fire with metal tripod (for wood-burning series) or widely-used metal charcoal stove.

   Model B: One-pot stove without chimney.

Model C: One-pot stove with chimney.

Model D: Two-pot stove with chimney in which only one pot is used while the second pot-hole is covered with a lid.

Model E: Same stove as D but using two pots.

Test results show a fuel savings of 30-44% in woodburning stoves compared to the traditional open fire (Table 1). The value for Stove E may be unrealistically high if temperatures over the second burner are too low for most cooking (34). Among charcoal stoves the savings are considerably lower.

Table 1
Results of Comparative Testing Among Four Wood-Burning and Four Charcoal-Burning Stoves

	Model				
	A	B	C	D	E
Wood-Burning Stoves:					
Mean Efficiency:	0.12	0.19	0.17	0.18	0.22
% Fuel savings compared to A:	-	35	30	33	44
% Fuel savings if baseline efficiency is 15%:*	-	19	12	17	30
Charcoal-Burning Stoves:					
Mean Efficiency:	0.25	0.28	0.27	0.27	0.31
% Fuel savings compared to A:	-	11	8.5	7.5	19

* While open fire efficiency here is measured as 12%, other studies have found values ranging from 2% to as high as 27%. The type, size and condition of wood has an important effect, but perhaps more important is the movement of air past the fire. Baldwin (34) has tested the efficiency of open fires in households in Upper Volta and calculated values of 17% for indoor fires, 15% out of doors. Since this parameter is so sensitive and yet so critical to the outcome of a testing series, it is useful to see how the cited results can change when a reference value of 15% is used in place of 12%.

b) Field Tests

During the spring and summer of 1981 two women extension workers measured fuel consumption in 100 households where CERER stoves had recently been installed (20). For one week they measured wood consumption as the family cooked using their traditional equipment. During the second week, fuel consumption was measured using the new stove. Results are shown in Table 2. Essentially, only one stove out of four or five (23%) showed fuel savings of 40-60%, satisfying one criterion laid down early in the project.

Table 2.

Fuel Efficiency of Improved Stoves Compared to the Traditional Open Fire

Number of Households	Mean Percent of Fuel Savings
60	41
20	10
20	negligible

The study report points out that the 10% of households experiencing negligible savings were instances where the stove was too large for the normal cooking pot. In fact, both the condition of a stove and the way in which it is used are major factors in the amount of fuel saved. It would have been interesting to repeat this study after 6 months to see whether efficiencies from the first week had been maintained.

2. Affordability

In other West African countries where "improved stoves" have been built with cement or expensive labor, the final price has been a serious deterrent. On the other hand, the "Ban ak Suuf" program in Senegal has kept costs low by relying only on sand and clay as a construction medium and also by emphasizing owner-built stoves. In rural areas, the price of a stove built by a CERER trainee averages $2.50 to $4.00 per pothole (or $5-8 for a two-pot stove). The stove recipient is usually expected to provide her own sifted clay and sand.

3. Social Acceptability

There can be many different measures of "social acceptability" of a stove. Possible indicators include the degree of interest and enthusiasm on the part of stove users, the percent of stoves used properly and maintained, the number of stoves

built following a training session, and the number rebuilt or repaired when necessary. In the final analysis, these may be the most important criteria by which stoves are judged, because unless the technology is accepted as part of the local culture, its impact will cease soon after project termination.

In a survey conducted by CERER during February-June, 1982, 985 rural stove sites were visited (24). The average stove was eight months old. Slightly more than half had been built after a training session. Of the 87% of stoves extant, most were judged to be in good condition, and three out of four were used regularly. These are overall figures from the survey. However, 65% of the stoves were the simplest one-pot model, built by women who had been trained by women. These stoves had more impressive service records: 89% had been built following training sessions, and among the 85% extant, nine out of ten were used regularly.

One disturbing observation, however, was that stoves destroyed by rain or misuse were never rebuilt, and badly cracked stoves showed no signs of repair. Among stoves with chimneys, the accumulation of soot had resulted in a serious loss of efficiency. Whether this is a result of deficient training, poor follow-up or cultural reticence, it is still a problem to be dealt with.

A recent study conducted for USAID by ORGATEC (2) points out that the improved cookstove does not fill a void, but represents just an improvement over an existing technology. The open, three-stone fire has the advantages of no cost, high durability, adaptability to many pot sizes, ease of maintenance and a long cultural tradition. With such competition, any "improved" cookstove that develops real or imagined imperfections will be quickly abandoned, and the cook will return to her old, familiar ways.

Within the "Ban ak Suuf" stove program there is evidence of this pattern. It presents a major, continuing challenge to technicians and dissemination strategists alike.

B. Cookstove Promotion and Dissemination

As of June, 1983, the Ban ak Suuf program had trained over 900 people in stove building and constructed more than 5500 stoves. This has involved supporting actions taken on many diverse fronts.

1. Collaboration with other agencies, both private and governmental

In general, these agencies have participated in organizing one or more training sessions either for their own members or for villagers with whom they work. Trainees may then conduct their own sessions without the direct intervention of CERER.

The Peace Corps and Maison Familiale Rurale have been especially active in this regard. Other involved agencies have included:

Promotion Humaine
Centres d'Expansion Rurales
Association Française des Volontaires du Progres
CARITAS
ENDA
SODEVA
Volontaires Italiens

2. Publicity and promotional efforts

CERER has undertaken a number of actions to alert people to the growing problem of desertification and promote an awareness of the benefits of an improved cookstove. These have included:

- a press campaign, with radio spots, TV programs, and regular articles appearing in the Senegalese daily "Le Soleil"

- printing of 3,500 wall posters and 6,000 booklets describing methods of stove construction

- participation of CERER personnel in numerous national and international conferences and seminars

- production of a 30-minute videotape program shown on national television and used in a number of seminars, and training sessions.

C. Other Accomplishments

1. Effective use of consultants on various aspects of the Ban ak Suuf program. Initiated mostly by USAID, these have included:

- project development and one-year review by teams from the Aprovecho Institute, March, 1980 and January, 1981;

- training consultant to work with members of training teams by Bernadette de Mesmay, March-April, 1982;

- review and recommendations for urban cookstove effort by Stephen Dwyre, Universite de Dakar, July, 1982;

- overall program review and recommendations, by Therese Deneve-Steverlynck, FAO, August, 1982;

- economic evaluation by Gene Ellis, University of Denver, March 10, 1983;

- specific technical support from Sam Baldwin, technical coordinator for CILSS Woodstove Program, 1981-82.

2. Finally, the Cookstove Project has enabled CERER to develop an administrative expertise, technical capability and coordinating facility that did not previously exist. The organization is probably stronger now than ever before and increasingly experienced to administer so complex a project as the "Ban ak Suuf."

D. Summary of Accomplishments

As a whole, the initial objectives of the Cookstove Project seem to have been met, although there have been a few notable compromises. Balancing stove cost against efficiency, for example, has resulted in a situation where the simplest, most popular and least expensive stove is also the one that saves the least amount of wood. Also, with the emphasis on rapid dissemination and field testing there has been little effort to collect the field data needed for a complete "social acceptance" analysis.

III. WHAT HAS BEEN LEARNED?

A. About Technology Dissemination

Early in the project the process of spreading a stove-building technology around Senegal was viewed as being fairly straightforward. One team of two to three masons could teach the technique to 15 people in two weeks. Each of those trainees could then go on to build an average of one stove per day. Within three years the total output of six training teams would be 2,160 trained masons and 324,000 cookstoves (11, 12).

After the first few months, it became increasingly clear that this particular technology would not spread quite so easily. A number of unexpected problems arose, including the following:

1. Need for Training Skills

   There seemed little awareness among the mason-trainers about how to go about teaching people to build stoves. Often they were interested more in demonstrating their skills than in imparting them. Fundamentals such as how to test mixtures of sand and clay, or how to determine critical dimensions were often not clearly explained. The use of unfamiliar tools such as trowels and measuring tapes tended to alienate many trainees and make them uncomfortable with the building process. Finally, trainees often took a passive role in the sessions, pounding and sifting the materials but letting the instructor do the major construction.

   This problem was noted by the Aprovecho team in 1981 (14) and later by the project director (7), who proposed bringing in a special training consultant. That consultant finally arrived in 1982, attended several different training sessions and then worked directly with the trainers for five days (21). Participants indi-

cated that the sessions were extremely worthwhile and should be repeated (22).

During the preparation of this evaluation several people involved with the program suggested the use of visual aids in the training session to promote greater interest and comprehension. Small scale models such as those used in Ethiopia, or large painted cloth murals similar to the ones developed in Upper Volta, could be very useful.

2. Follow-Up

It had been assumed at first that once a woman had her stove she would know how to use and maintain it properly. Instead, many women have been reluctant to use the new stove, and, with the appearance of normal thermal expansion cracks, have abandoned them altogether. After March, 1981, a monitrice was assigned to follow every training session with a visit to the village to help women use their stoves with the correct amount of wood. She also demonstrates the proper positioning of the pot, lighting the fire, cleaning the chimney and making any necessary repairs. If the training session has been sponsored by a local organization, often it is someone from that organization who is responsible for the follow-up.

Follow-up to training and construction sessions also has the important function of providing feed-back information to all people involved in the project. The need for regular and systematic monitoring has been stressed repeatedly by advisers to the project (1, 9, 16, 28, 30, 31). Such studies are expensive and time-consuming, but they are essential for guiding these early stages of the program. The CERER survey of 1982 (24) and the earlier study in 1981 (20) provided much useful information, but also demonstrated the need for greater clarity and detail. The recent completion of several hundred information questionnaires from households with stoves, done through the efforts of Peace Corps volunteers, demonstrates that CERER is intensifying its efforts to obtain more feedback information.

A 1982 USAID energy evaluation team, in a series of site visits, found among 59 households that at least 29% of the women did not use their stoves regularly (26). Madon found the rate closer to 22%, plus 13% in which the stoves had been destroyed (24). There are indications that this failure rate is related to the particular stove model and the type of training session that fostered it (see #3 below). However, much more detailed information would be useful.

3. Different Training Strategies

Since November, 1980, there have been two types of training sessions provided by the "Ban ak Suuf" program. One is the ten-day session directed mostly by a male team of masons and constructing

one and two-pot stoves with chimneys. The other type of session is led by a team of two women; it lasts two to three days and the stove model is always the one-pot "modele de base" without chimney. The 1982 survey of 985 stoves compared the results of the women's training sessions with that of the men's, and concluded that the women's were more effective (see Table 3). This information does not reveal whether the differences between the results of the sessions is due to training effectiveness or the particular stove model promoted. However, the differences are striking enough to warrant further study.

Table 3
Comparison of Results of Men's vs. Women's Training Sessions

	Men's Training Sessions	Women's Training Sessions
% stoves built following a training session	43	89
% of all stoves built which have been destroyed	11	15
% of all remaining stoves used regularly	54	91

A further indication of the importance of training strategy comes from evaluations of the urban stove program (22, 25, 30). Overall, less than 5% of the urban stoves are constructed following a training session, and in various urban districts the usage rate ranges from 31% to 93% (25). Here is a case in which a training technique designed for rural areas has been transplanted to an urban environment, where needs and resources are markedly different. It seems evident that a different strategy of stove dissemination must be tried. In the Casamance region of Senegal, where people and their needs are different yet, still other ideas should be tested. In short, the 1981 advice of the Aprovecho team still applies: "...try out many diverse extension methods..."

4. Matching Program Resources to Scope of Work

These first few years of the "Ban ak Suuf" program have been ambitious ones--far more ambitious than originally anticipated in the Project Paper. When neither personnel nor financial resources appeared to support massive diffusion of stoves, it would have been appropriate to scale down the workplan, at least geographically. But failing to achieve dramatic short-term impact throughout rural Senegal, the program seemed to settle for a smaller

short-term impact, still throughout rural Senegal. By concentrating more on selected regions (as has been partly done in the Louga area) the program would probably have achieved greater social awareness and greater impact with much less money and effort.

The recent replacement of a single national coordinator with six regional coordinators shows a recognition that the program was spread far too thinly. Also being planned are more local and regional centers from which mobile teams can work.

5. Communication Among Program Personnel

One of the primary findings of the training consultant (21) was a serious lack of communication among members of training teams and between project personnel in general. She suggested that each person (monitrice, mason, etc.) be very clear about his or her specific role and responsibilities and that all be aware of what the others are doing. Written job descriptions and frequent meetings to discuss problems were also recommended.

B. About Cookstove Development and Testing

During the consultancies of the Aprovecho Team in 1980 and 1981 a number of charcoal and wood-burning stoves were developed. Despite the team's insistence on the need for further development and testing, very little has since been done.

With the tremendous efforts and resources that have been applied to disseminate Ban ak Suuf stoves, it is astonishing to realize how small the commitment has been to develop the stoves technically. Except for the "Modèle de Base," the stoves built today differ little in design, materials and method of construction from models proposed by the Aprovecho team in 1980. The limited testing done so far has been mostly to verify the efficiency of existing models, not to evaluate any new design or innovation.

The technical problems are quite serious. The building of a Ban ak Suuf stove is time-consuming, dirty and physically demanding. The finished stove must be protected from rain and begins to deteriorate after only a few months of use. Most women do not find the stoves hard to use, but many find them hard to use correctly (that is, with a substantial savings in fuelwood). These are just some of the problems that sould be addressed by a competent and aggressive stove technician.

CERER has long recognized the need for strong technical support but has lacked the resources to obtain it. Consequently the project has relied primarily on expatriate volunteers with limited technical background and no previous stove experience. What is needed now are the

long-term services of a professional, innovative technician who understands thermodynamics, materials, testing methods and data analysis. A Senegalese national is preferred; otherwise a compatible French-speaking expatriate, capable of training two or more Senegalese to assist him or her, would do. Finally, the technician should be someone who is sensitive to the needs of those people for whom the stoves are designed.

Certain chances for innovation may have been lost initially when the Senegal cookstove project was dubbed the "Ban ak Suuf" program, identifying "clay and sand" as the primary construction material. Clay and sand may be inexpensive, but the stoves are hard to build properly, require frequent repair and must be rebuilt every year or so. In urban regions, where clay must often be transported from some distance,"Ban ak Suuf" may simply be inappropriate, and the project is now finally looking at the feasibility of promoting metal stoves. Inexpensive metal or fired clay stoves may eventually turn out to be adaptable to rural regions as well. In retrospect, it might have been better to adopt a program name which described the fuel economy of the stoves rather than a largely unproven construction medium.

C. About Economics of the Cookstove Program

It is useful to review some of the findings of the economics consultant, who submitted his report in March, 1983 (31). They include the calculation that the total overhead costs of the 5,500 stoves built to date were between 9,000 and 11,300 CFA per stove (US $25.71-$32.28). Because more stoves are built and used following the women's training sessions, only in these stoves was the cost justified by the benefits of time and fuel savings.

The report noted the lack of important data on life-span and "regeneration" (i.e. rebuilding) of old stoves, except for indications that most stoves may not survive much beyond one year. The question is posed: "Who will rebuild the stoves, with what skills (and thus efficiencies) and under what incentives, imposing what costs and requirements on the project?"

To increase the benefits relative to costs, the "Ban ak Suuf" program would need to have stoves which:

1. are used more regularly,
2. last longer,
3. perpetuate themselves more easily,
4. save more,
5. cost less,

or some combination of these.

IV. FUTURE DIRECTIONS

A. Program Expansion

Plans for the cookstove program over the next two years call for expansion into areas that have proven most effective in the past. The number of Peace Corps volunteers assigned to the program as full-time coordinators has already increased from one to six. By April, 1984, 21 rural women will have completed four weeks of training in stove construction techniques. They will form locally based teams in each of seven defined regions to teach other women principles of stove building, use and maintenance. Meanwhile, existing teams will continue to hold training sessions at the request of village organizations, private voluntary organizations and government agencies.

B. Strengthening Technical Capabilities

The need for additional technical competence described earlier has not yet been seriously addressed by project managers. Funding must be found for this effort, without which the long-term program impact will be seriously jeopardized.

C. The Urban Stove Program

This program, which has so far been floundering, awaits the development of several viable prototype charcoal stoves and the formulation of a strong dissemination strategy. It seems clear at this point that the most likely stove will be portable and made from either sheet metal or a combination of metal and fired clay. It must compete economically with existing charcoal stoves, and should provide substantial savings in charcoal. The development of such a stove deserves high priority and can only be achieved with the assistance of an experienced and capable technician. Urban program personnel are already in place, and a viable stove model will have immediate benefits to programs in neighboring countries.

Once suitable prototypes are identified and exhaustively field tested, the process of dissemination can be handled largely through the private sector. For example a strong promotional campaign may be coupled with the commissioning of several hundred stoves from local artisans to be sold locally. Such initial efforts would be most successfully launched in small urban neighborhoods rather than entire regions such as Dakar or St.-Louis.

D. Establishing a Clear Sense of Direction

In reviewing the documents listed in this report I sense that the CERER stove project has often lacked a true perspective of where it was heading and how it would get there. Too often the introduction of efficient cookstoves has been regarded more as a crusade than as an evolving process requiring constant orientation and evaluation. The program is closer now than ever before to effective dissemintion of

the simple one-pot stove in rural Senegal, but it must not stop there. There will be other, more efficient stove models to consider, new methods of dissemination and a range of social, economic and technical problems to work out. Through it all, program managers must maintain a realistic sense of CERER's needs and capabilities.

The achievements in these first four years are impressive, even stunning. Unfortunately, this does not earn the program the assurance of any long-term impact. That achievement will require diversification, steady financing, continued innovations and much hard work.

EXECUTIVE SUMMARY

PREPARED BY:	Timothy S. Wood, Volunteers in Technical Assistance
DATE:	October 12, 1983
PROJECT:	Senegal Renewable Energy - Charcoal Production
COUNTRY:	Senegal
COST:	$110,800
PERIOD OF PROJECT:	March 1, 1980 - December 31, 1983

1. What constraint did this project attempt to relieve?

   Relatively low yields of charcoal from widespread, traditional techniques of charcoal production. Improving the yield would temporarily reduce the rapid rate of deforestation in Senegal.

2. What technology (knowledge, skills or practices) did the project promote to relieve this constraint?

   Use of the "Casamance kiln," which uses an inexpensive chimney in the kiln and a modified wood-stacking pattern to improve circulation of hot gases within the kiln. An increase in charcoal yields of over 30% has been documented.

3. What technology did the project attempt to replace?

   Traditional charcoal-making techniques, which give an average yield of 70 kg charcoal per stere (stacked cubic meter).

4. Why did project planners believe that intended beneficiaries would adopt the proposed technology?

   The improved technique provides strong potential economic incentives to the charcoal-maker. In addition to a higher yield, the charcoal is of higher quality, carbonization time is sharply reduced and the recovered condensate (tars) has a potential market value.

5. What characteristics did the intended beneficiaries exhibit that had relevance to their adopting the proposed technology?

   Intended beneficiaries were mostly extremely poor and illiterate, as well as very distrustful of both the Forestry Service and their direct employers. None of these characteristics would facilitate their adoption of the new technology.

6. What adoption rate has this project achieved in transferring the proposed technology?

   In a follow-up study of trainees from five training sessions it was found that about 65% were using the new methods.

7. Has the project set forces into motion that will induce further exploration of the constraint and improvements to the technical package proposed to overcome it?

   No. There has, in fact, been considerable resistance to the training sessions by charcoal dealers and work supervisors who apparently fear a certain erosion of their power.

8. Do private input suppliers have an incentive to examine the constraint addressed by the project and to come up with solutions?

   No. The problem of deforestation has insufficient short-term impact to create a strong incentive among private input suppliers. The direct beneficiaries of the new technique have almost no economic, political or social clout within the charcoal industry.

9. What delivery system did the project employ to transfer technology to intended beneficiaries?

   Formal training sessions for charcoal producers.

10. What training techniques did the project use to develop the delivery system?

    Forty-day sessions were held with a maximum participation of 30 trainees. Each trainee was part of a team that constructed two improved charcoal kilns, first under close supervision, then with more independence.

11. What effect did the transferred technology have upon those impacted by it?

    Little observed effect. Many of those using the improved technology feel that their employers benefit more than they; hence there is little incentive to take the new method very seriously.

I. CONTEXT OF THE PROJECT

A. Charcoal Use in Senegal

Domestic energy in Senegal is based almost entirely on fuelwood. A large portion of commercially harvested wood is converted into charcoal for use in the urban regions of Dakar and Thies. Despite its higher price, charcoal is preferred over fuelwood in urban centers. It burns cleanly with almost no smoke, it requires little storage

space and the fire needs little tending or maintenance. The demand for charcoal in Senegal is estimated to be growing by 7% per year (2).

B. Traditional Charcaol Making

Converting raw wood to charcoal involves a substantial loss of energy. The wood must be heated to near-combustion temperatures in an atmosphere of limited oxygen. Volatile components are driven off, taking with them as much as 75% of the wood's energy content. What remains is mostly the skeletal carbon known as charcoal. Additional energy losses occur as a portion of the wood is consumed to generate heat for the process.

In the traditional method of charcoal making, wood is first cut and then stacked in a large, circular mound. A central column is left open for purposes of igniting the wood. The mound is covered with green vegetation or straw, then sealed with a layer of loose soil. Burning embers are dropped into the central column which is then also sealed with vegetation and soil. By opening and closing ventilation holes around the kiln, the operator can draw the smoldering fire around the inside of the kiln, heating the wood sufficiently to drive off the volatile materials, while burning only enough wood to maintain the process. The charcoal yield is estimated at around 72 kg per stere (stacked cubic meter) of wood, although this will vary with the species and condition of wood and the skill of the kiln operator. Further details on traditional charcoal making are given in reference 36.

Charcoal making in Senegal is tightly controlled by the Direction des Eaux, Forêts et Chasses (Forestry Service). Through this agency the government establishes legal quotas for harvesting fuelwood within each administrative region. The marketing of charcoal and fuelwood can be done legally only by dealers who band together to form a group euphemistically called a "cooperative." In principle, the elected cooperative president is granted a license from the Forestry Service which allows each dealer member to cut and market wood. Dealers then employ laborers to cut and stack the wood, build and operate the kilns, and bag the charcoal in 50 kg sacks. With additional government permits, cooperative members can transport the charcoal and sell it, either directly or through another middleman. Laborers are generally paid only after the charcoal is sold, earning about 250 CFA per sack (US $.64).

It is worth noting the character of the charcoal laborers, since these are the intended direct beneficiaries of the project. Itinerant, very poor and illiterate, they depend on the wood dealer for their daily expenses and family support during the five to eight weeks necessary to produce the charcoal. They are deeply suspicious and resent being taken advantage of by both the wood dealers and the Senegalese government, between whom they perceive a political liaison. Although theoretically paid a fixed wage per sack of charcoal, realistically they must accept whatever the dealer is willing to pay, which is generally far below the legal minimum wage (1, 6, 45).

C. The Casamance Kiln

In the late 1970's an improved method for converting wood to charcoal was devised by Mr. Ed Karch, a forester and Peace Corps volunteer assigned to a UNDP-FAO forestry project in the Casamance region of Senegal. The new method differed from the traditional practices mainly in the use of a portable metal chimney to draw off exhaust gases from the bottom of the mound. The wood was thus dried and preheated, making efficient use of the heat of the kiln. A full description of the Casamance kiln is given in references 37 and 41.

Advantages of the Casamance kiln over the traditional charcoal kiln include:

- an increased yield of charcoal per unit volume of wood,
- a higher quality of charcoal (less crumbly),
- a shortened burning time and hence higher productivity,
- recuperation of tars and other condensed volatiles which have a certain market value,
- possibility of using many different sizes and qualities of wood, and
- low cost, requiring only a chimney made from locally available materials.

In addition, the new method is similar enough to traditional ways that it can be easily learned by experienced charcoal makers.

II. OBJECTIVES AND DESCRIPTION

The aim of this project is to train Senegalese charcoal makers in the use of a new technique which has demonstrated an increase in charcoal yields of more than 30% over traditional methods. If widely adopted, the new technique would slow the rate of deforestation by making better use of the present wood resources. This is essentially one means of "buying time" to allow for reforestation and alternate fuels programs to take hold (see discussion, page 25).

Nine training sessions were planned to be held over a period of 31 months (exclusive of June through September, which is the rainy season in Senegal). Thirty trainees would attend each 40-day session. Upon returning to the cooperatives, each trainee could head up a team of three workers. End of project indicators include "approximately 330 charcoal-making teams using the new 'Casamance kiln method'" (7).

During the project there would be regular follow-up visits to charcoal cooperatives to assess the success rate of the training sessions. The

collection of socio-economic information also was planned to evaluate possible constraints to the spread of the new technology.

Trainers for the nine sessions would be drawn from charcoal makers who had worked with Karch to develop the Casamance kiln. The entire project would be implemented by the Senegal Forestry Service.

III. WHAT HAS BEEN ACCOMPLISHED?

Between June, 1980 and June, 1983, seven training sessions were held with a total of 166 participants. Two additional sessions are planned before the end of the project, with maximum possible participation of 60 trainees. In addition, a special training session was held for charcoal makers at the USAID Reforestation site at Bandia.

Careful records were kept of wood input and charcoal yields of the Casamance kilns during each training session (38-40, 42-44). They confirm the benefits of the new method. Among the 32 kilns constructed, a total of 1,782 steres of wood was processed, yielding 202,295 kg charcoal. This yield of over 113 kg/stere is 38% higher than the 70 kg/stere reported by Karch (37) for traditional charcoal kilns. Surprisingly, it even exceeds the average of 103 kg/stere (22%) obtained by Karch himself. Average burning time was just under one hour/stere, which is substantially less than the time required with the traditional kiln.

A follow-up study was conducted in January, 1983, by the AID project officer and the project manager from the DIrection des Eaux et Forêts. It concluded that at least 65% of the trainees were using the new method regularly (45). However, there was no direct evidence that the technology had spread to other charcoal workers. In one instance, a trainee had devised one possible improvement to the new method by digging a radial series of shallow trenches to help circulate air under the kiln. According to the same study, those workers using the new method estimate their earnings to have increased by 30% over what they would have made with the traditional method.

IV. WHAT HAS BEEN LEARNED?

So far, there have been no technical problems with the Casamance kiln. Among factors that have constrained the carbonization project, all have been social, economic, operational, managerial or institutional. Most are serious enough to warrant specific attention, since they have contributed to a project impact which is somewhat less than initially anticipated.

A. Socio-Economic Constraints

1. The socio-economic survey conducted in January, 1983 (45), revealed marked lack of incentive among trainees to use the

improved method of making charcoal. The major impediment appears to involve the relations between laborers and the dealers for whom they work. It is a complex situation which includes the following elements:

a) The issuing of licenses to market charcoal is largely a political process, the recipients being relatively wealthy dealers with political influence. Individual charcoal workers, by being denied licenses, can legally sell their charcoal only to the dealers.

b) Dealers are said to be notoriously unscrupulous. The practice of taking charcoal from the workers and paying for it later leads to widespread fraud and deception.

c) Workers using the Casamance kiln, who produce a greater yield and higher quality of charcoal, will earn additional money only at the discretion of the dealer to whom they sell. If a worker feels the dealer is profiting from the new technique more than he, there is likely to be a disincentive to adopt the new method. The Direction des Eaux et Forêts has proposed several possible ways to resolve this situation. One is to make adoption of the Casamance kiln mandatory and to withhold harvesting licenses from cooperatives that do not comply. A longer term solution is to restructure charcoal cooperatives so that benefits are more equitably distributed among the members. Plans for the continuation of this project under Title III funding include a proposal for the first step in the restructuring process (see page 23).

2. In the initial phases of the project there appears to have been considerable opposition to the training sessions from charcoal dealers. One issue involved confusion over whether dealers should continue to pay a family support allowance while a worker was in training. There was also fear among dealers that once trained in the new technique a worker may feel greater independence and either leave his employ or organize other workers to seek more equitable treatment. These problems seem to have been the cause of the initial poor attendance at the training sessions, and they have been mostly resolved through persistent efforts of the Senegalese project manager at the Forestry Service.

B. Operational Constraints

1. Probably the most serious operational constraint to the training sessions was the difficulty in obtaining wood for the kilns. Having sufficient wood cut in advance of the session is expensive and very time-consuming. On one occasion the entire stack of wood prepared for a session was set afire by disgruntled local charcoal makers in an act of sabotage.

It was originally intended that there be enough wood for 20 kilns

to be built during each training session, each with a capacity of 60-70 steres. Charcoal from these kilns was to be sold, and trainees would share in the profits. However, in no session has there yet been wood for more than six kilns. The charcoal is still sold as planned, but the proceeds are relatively small.

The Forestry Service has proposed using wood in the training sessions which has been confiscated by the government from illegal operations. This would save both time and money while at the same time solving the problem of supply. It does however, require the use of a large truck, which is not presently available.

2. Since revenue from the sale of charcoal is substantially less than initially expected, the daily compensation provided each trainee has been reduced to 500 CFA (about US $1.30). This is less than the trainee would be earning in his cooperative, and it has become a source of some resentment. The potential long-range benefits of their training are generally not fully recognized during this period.

3. Improper timing of several training sessions has resulted in low attendance. The long start-up delay of the first session caused much skepticism in the project; the second session came just before the rainy season which is the busiest time for charcoal makers. In the special training session at the Bandia plantation, heavy rains hampered the work and caused low yields from the kilns. With greater experience in the project these timing constraints have been largely overcome (38, 39 and 40).

C. Managerial Constraints

Following the fourth training session in February, 1982, the AID project officer became concerned over the problem of low attendance. She proposed that an independent sociological study be undertaken to determine the cause. Project funds were then frozen until the proposed study could be conducted. This caused a delay of several months in the project and created some friction between USAID/Dakar and the Forestry Service (10). Eventually, funding was resumed even without the sociological study.

D. Institutional Constraints

1. The start of the carbonization project was considerably delayed because of the difficulty in establishing a project bank account within the Direction des Eaux et Forêts. While no serious harm resulted, this did contribute to an initial faltering of the project.

2. The project manager at Eaux et Forêts carries professional responsibilities outside the scope of the carbonization project. For this reason he was denied any compensation from project funds for nearly three years. The result was a certain lack of morale (6).

Understandably, USAID felt that if the project was to be taken seriously it would demand the full-time services of the project manager. On the other hand, as chief of the Forestry Service Production Division, the part-time manager was extremely well placed to tackle the social problems described earlier. The compensation issue was not resolved until early in 1983 when the AID project officer established that 50% of the project manager's time was devoted to the project. A special internal decision was made to compensate the project manager at half the normal rate.

V. FUTURE PLANS

Funding under the Senegal Renewable Energy Program is scheduled to terminate after December, 1983. The Senegal Forestry Service has requested a two-year extension of the Charcoal Production Training Program for 1984 and 1985 using Title III funding. The goal of the program is "to slow environmental degradation in two regions of Senegal where charcoal production is the greatest through the introduction into these areas of the Casamance kiln."

Provisions of the extended program include the following:

- An estimated 480 traditional charcoal makers will be trained in the construction of the Casamance kiln in the regions of Senegal Oriental and the Upper Casamance. Between January, 1984, and July, 1985, there will be 16 training sessions (4 per region per year), each extending over 40 days and involving the participation of 30 trainees.

- The program will continue to be managed by the head of the Forestry Service Production Division at Dakar. Assisting him will be two technical agents in charge of field operations, one for each region. They in turn will each supervise a mobile team of four trainers who will conduct the training programs.

- By July, 1984, the program director and his agents will have organized two model associations of charcoal workers, one in each region. The purpose will be to study the problems and potential of a truly cooperative-based charcoal industry in Senegal. They will also have access to a revolving credit fund in order to purchase chimneys, tools and fuel for charcoal transport. A project truck will be available for transporting charcoal to urban markets with fuel paid for by the associations.

VI. OBSERVATIONS AND RECOMMENDATIONS

The proposed two-year extension of the improved carbonization project has several points in its favor:

- The technology is proven. Its effectiveness in increasing charcoal yields from raw wood have been confirmed in all seven training sessions held so far under the Senegal Renewable Energy Program.

- Three years of exerience with charcoal-making training sessions have ironed out most of the early problems associated with this project. The delays, confusion, logistical and timing problems encountered in the early days of the project have been largely eliminated. There is little reason to doubt that a continuation of the training program will achieve its stated goal.

- The project would continue to be managed by the current head of the Forestry Service Production Division in Senegal. This is a person who is well-placed in the government of Senegal, very capable and strongly committed to the goals of the program.

The project will attempt a bold approach to the complex social constraints that have apparently limited the effectiveness of the Renewable Energy Program. The establishment of two model workers' associations is strictly experimental and goes directly against powerful interests in the charcoal industry. Couched within the context of a funded government program, however, it has a chance of success, and the impact could be far-reaching. The relatively small funding for this portion of the project is commensurace with its high risk. If successful, the model association program should be expanded, since it is a big element in dissemination of the new technology.

My greatest reservation about the project is that it is too limited in scope. The 480 charcoal workers to be trained represent less than half the total number in the two regions affected. There are no specific provisions in the proposal which would encourage the impact of training to grow and spread long after the two-year funding has stopped. At the very least, trainees should be given specific ideas, skills and incentive to share their training with all other workers within their cooperatives.

The proposed project places insufficient emphasis on regularly scheduled follow-up to the training sessions. Visits to former trainees at their charcoal cooperatives are essential to the project's full success. These visits serve to:

o gather data on the number of people using the new method,

o answer questions, identify problems, observe any modifications and acquire other information to be used in improving the effectiveness of future training sessions,

o observe the application of the new charcoal-making skills and correct any apparent errors, and

- maintain good relations between the Forestry Service and the charcoal producers.

Finally, before deciding on the funding for this project, AID people must consider the long-term goals:

- If the goal is to increase the productivity of charcoal producers, then the Casamance kiln can do that. However, this may only stimulate charcoal use among periurban populations unless they revise the charcoal quotas appropriately.

- If the goal is to reduce the rate of destructive deforestation, the Casamance kiln can do that, too, but only temporarily. With the demand for charcoal increasing 7% per year in Senegal, even immediate universal use of the Casamance kiln at an estimated savings of 38% per year would have limited long-term impact. The demand rate is rising so fast that after only seven years it would catch up to any savings that had been realized. Thus, while promoting efficient charcoal production may "buy time" in the short run, ultimately it has little value unless that time is used to seek a final long-term solution to deforestation.

In Senegal, as in most other poor nations, there is presently no realistic substitute for wood-based energy. This leaves two possible solutions to the growing fuel scarcity:

1. Increase the wood resources by encouraging greater tree growing (a long-term solution), or

2. Reduce the demand by making better use of existing resources (a short-term solution, valuable only for buying time).

Implementing the short-term solution is logical only if there is some assurance of increasing the future supply. Increasing that supply, however, may depend on temporarily restraining current demand.

The question for AID to consider is not whether or not to recommend continued funding of this particular project, but whether it is within the long-range interest of USAID to help provide sustainable future sources of energy in Senegal. If so, the next question would be whether this small project can be integrated with other current or planned energy projects in Senegal (not only those funded by USAID) for a realistic and beneficial long-term solution.

EXECUTIVE SUMMARY

PREPARED BY: Dr. Timothy S. Wood, Volunteers in Technical Assistance

DATE: October 12, 1983

PROJECT: Senegal Renewable Energy - Solar Fish Dryers

COUNTRY: Senegal

COST: $40,000

PERIOD OF CONTRACT: March 1, 1980 - December 31, 1983

1. What constraint did this project attempt to relieve?

   The project attempted to reduce spoilage and insect infestation of dried fish, and to improve the incomes and working conditions of the women who process fish. Current losses through spoilage and infestation are said to be as high as 50% (unsubstantiated). The drying process requires close monitoring and is relatively slow. The final products are often contaminated by fine sand and insect larvae.

2. What technology did the project promote to relieve this constraint?

   The project attempted to relieve current constraints in fish processing through the improved use of solar energy. Special "tents" made from locally available lumber and polyethylene sheeting can conceivably improve fish quality, reduce processing and storage losses and increase productivity of individual workers. Skills to be transferred through the project included construction and use of solar dryers and solar storage facilities.

3. What technology did the project attempt to replace?

   Traditionally, fish drying is done in the open air, either directly on the ground or on raised racks. Often the drying is preceeded by fermenting, salting and/or smoking the fish. The processed fish are stored at ambient temperatures, usually wrapped in loose sacking, unprotected from dermestid larvae. Heavy losses from spoilage during drying and by insect larvae during storage are generally accepted as unavoidable.

4. Why did project planners believe that intended beneficiaries would adopt the proposed technology?

   Following a period of extensive field testing of the solar devices, involving selected fish processors, it was expected that

the economic and social benefits would prove more attractive than traditional practices. However, the benefits as outlined in the project paper amount to less than 3% gross annual income of the fish processors. Additional economic benefits would be realized only if the presumed higher quality of the fish brought a substantially higher price on the market. Social benefits, while never clearly specified, presumably would include the convenience of having the fish protected from rain and blowing sand.

5. What characteristics did the intended beneficiaries exhibit that had relevance to their adopting the proposed technology?

   Fish processors were mostly women with little or no formal education. They were said to have expressed an early interest in solar drying tests, and to be willing to accept new technologies. As an example, the project paper notes that only in the past 20 years have fish processors begun to dry their fish on raised racks rather than directly on the ground.

6. What adoption rate has this project achieved in transferring the proposed technology?

   After 28 months of field testing in which the best identified models have been made available at no cost, there is still no evidence that the technology will be adopted, despite the claim of strong interest from certain fish processors. Major constraints appear to include:

   - serious technical flaws in solar dryers due to inappropriate design, inadequate testing and poor construction;
   - extremely poor interaction between project personnel and intended beneficiaries;
   - possible social obstacles within the fish-drying community during field testing, in which a few workers are reluctant to use prototype dryers unless all others have similar access.

   Economic factors may also be a major constraint, although at this point there is still insufficient information to address the economic questions.

7. Has the project set forces into motion that will induce further exploration of the constraint and improvements to the technical package proposed to overcome it?

   There is no evidence that any incentives have been created by the project within the public or private sectors to maintain, improve or diffuse this particular technology. This is not to imply that the technology is inappropriate or unneeded, only that the project has failed to match expectations.

8. Do private input suppliers have an incentive to examine the constraint addressed by the project and to come up with solutions?

   Due to the structure of the fish marketing industry, it seems unlikely that private interests alone can readily address the problem of fish losses through spoilage and infestation. Such losses are sustained less by the processors than by buyers and retailers who apparently cover their losses by buying at a low price. Unless fish processors can be assured of a higher price for a better quality product, market forces will not encourage the development of improved processing technology.

9. What delivery system did the project employ to transfer technology to intended beneficiaries?

   In Phase I of the project (prototype development) solar dryers were offered at no cost to members of loosely organized fish-drying associations. A project agent was supposed to be available to assist in initial use of the dryers and to receive input from the users. Such field work was less thorough than anticipated. Phase II of the project (large-scale diffusion) was never implemented due to a notable lack of progress in Phase I.

10. What training techniques did the project use to develop the delivery system?

    Not applicable.

11. What effect did the transferred technology have upon those impacted by it?

    Not applicable.

I. OBJECTIVES

The single objective of the solar fish dryer project, as stated in the Project Paper (1) is the "introduction of simple, solar fish-dryers and storage tents." End-of-project indicators (7) include:

- "Several models of a technically sound 'solar tent' drying and storage system which reflect user needs; are economically viable; and have been tested in fishing villages."

- "Approximately 15 systems installed in each of four village sites. A study and dissemination effort has been undertaken since June, 1983, for the prevulgarization phase of the solar tent component."

II. CONTEXT OF THE PROJECT

The transformation of fresh fish into other marketable fish products

is an ancient tradition in Senegal (2). Performed primarily by women, it may involve fermenting, smoking, salting and usually the drying of fish. Most of the work is done in the open, along the shore where fresh fish are brought in.

One preparation, called "kethaikh," is begun by lightly cooking and smoking the fish within a smoldering bed of peanut shells; next the fish are "fermented" in brine for several hours and then dried in the sun. Another product, "guedj," also is fermented and then dried following any one of several very specific procedures. Other techniques are employed to create fish products that satisfy specific local and regional tastes (reference 2 gives further details).

Since processing is done in the open, there is inevitable spoilage and infestation by fly larvae and dermestids, not to mention contamination by dust and sand. The drying fish must be collected each night and laid out again the following day. They must also be protected from seasonal rains.

It was the purpose of this project to study the extent to which the conditions of fish processing could be improved through the use of simple tent-like solar dryers. At the same time, it was conceivable that the final fish product could have a higher overall quality than that produced in the traditional way, with improved nutritional value and better storage qualities.

III. PROJECT ACCOMPLISHMENTS

A. Prototype Development

Six experimental solar dryers were assembled on a terrace roof at the Dakar headquarters of the Institute for Food Technology (I.T.A.)(47). Over a period of two months temperature and relative humidity were monitored both inside and outside each tent. Local windspeed was also measured.

B. Controlled Testing

Samples of fish were apparently dried at least once in each of the six prototype dryers, although from the account provided in the 1981 report (47) it is impossible to determine the number of tests, quantity of fish, testing procedures, methods of evaluation or actual results. The conclusions, however, are given as follows:

1. All prototypes tested succeeded in preventing the infestation of drying fish by fly and dermestid larvae;

2. Insects which had infested fish dried in the open were killed when those fish were exposed to the warm temperatures of the solar dryers;

3. Microbial activity in the fish was reduced in the solar dryer, yielding a more nutritious product than that dried in the open.

It was noted that the drying time for "kethiakh" in the solar dryers was only 36 hours, compared to 60 for the same fish dried in the open. Also, the "kethiakh" dried in the solar tents had none of the strong odor of the "kethiakh" prepared in the traditional way.

Chemical analysis of the fish included a measurement of volatile acids, which is said to indicate the level of putrifaction. Those fish dried in the solar tents showed a lower level than those dried in the open, presumably because they had dried more quickly. Also noted were the normal changes in protein and fat relative to the moisture content.

C. Field Testing

In June, 1981, twelve solar dryers of two different models were constructed at two coastal fishing towns in Senegal. Three of each model were placed at M'Bour, and three of each at Joal. Testing procedures have not been described. However, results, as indicated in a project report (47) and in a subsequent technical evaluation (48), were as follows:

1. The solar tents were very susceptible to wind damage. There was a demonstrated need for stronger polyethylene and improved construction design.

2. Studies confirmed the capability of the solar tents to protect fish from insects, spoilage, dust and rain. Those fish dried in the solar tents were judged of better quality than those dried in the open.

3. Field tests indicated a need for modifying slightly the drying procedure to avoid overheating the "guédj" and thus altering its taste.

4. It was demonstrated that during the rainy season there was no significant reduction in drying time inside the solar tents.

5. Certain design changes were indicated: a need for improved ventilation, better drying racks, better protection from rain entering the air vents, a solution to the problem of high nighttime humidity, protection of nails from corrosion, orienting the solar dryer to both sun and prevailing winds, and elimination of black plastic on all but the north side.

D. Technical Consultation

Mr. Ron Alward, a solar technician from the Brace Institute, visited the project from October 30 to November 2, 1981. He met with Messrs. Sarr and Diouf, who had done the development and testing, ald also

visited testing sites at M'Bour, Joal and at I.T.A. in Dakar. Mr. Alward reviewed the performance of the dryers in terms of durability, social acceptability, and economic viability. He made suggestions for improving design and siting for optimal performance. His report (48) suggested that the prototypes were not yet ready for general dissemination, but required three to six months of further testing and refinement. He also recommended a much closer collaboration with the potential users of the tents.

As far as can be determined, very few of the major recommendations were ever implemented.

E. Additional Testing

Field and laboratory tests were carried out during March-December, 1982 (49). The report on these tests included:

1. A description of a dryer prototype which uses masonry (or banco) in place of wood framing.

2. A description of two additional dryer models, one with a slightly peaked roof and another using masonry (or banco?) in place of wood framing.

3. A statement that field work was carried out in all seasons at M'Bour, Joal, Karabene, Diogue and at I.T.A. headquarters. The purpose was to determine user problems, receive user input, check modifications and assess durability.

4. Reasons why banco dryers have certain advantages in the Casamance despite their smaller capacity and the need to change plastic sheeting before each season.

5. A comparison of banco and Brace model dryers at Karabande with respect to changes in temperature, relative humidity (with dryers both empty and filled with fish) and the speed of air leaving the upper vent. Ambient wind speed and sky conditions were also recorded, but not related to other measurements.

6. Data reported for similar measurements at Joal and M'Bour from both Brace and banco models.

7. Production rates for various types of fish in $kg/m^2/hour$ using two types of dryers (Brace and banco), with the drying done by local people. Details are sketchy and recalculated results do not exactly match those reported, but they do indicate solar drying to be 34-41% faster in three separate trials.

8. Bacterial analysis: extremely brief, indicating a better quality product from solar dryers than from controls.

9. An economic analysis of sorts which seems to conclude that fish

processors can earn enough in one year to be able to afford the initial cost and maintenance of a solar dryer.

F. Economic Consultation

An economic consultant visiting Senegal for the Peace Corps in 1983 consented to take a look at the solar fish drying project. He reviewed the available documents and visited the sites at M'Bour and Joal, but saw no dryers that were in operation (or operable)(50). He consulted with two American solar drying experts and a French sociologist, noted some technical and sociological problems and commented on the general lack of information needed for an economic analysis. In general, he felt the overall costs of the dryers appeared high and that their lifetime may be short. He noted that while a higher quality product may be produced, there is no premium paid for high quality, so these benefits are lost.

IV. OBSERVATIONS FROM FINAL EVALUATION

In the absence of further reports from the project, it may be useful to relate the observations of this evaluator during brief visits to project sites at M'Bour, Joal and St.-Louis.

In the fishing village of M'Bour four local fish processors (two men and two women) have consented to conduct further field testing of solar dryers. An area up from the shore has been surrounded by a woven windbreaking fence to contain two large dryers, one storage shed, an improved smoking pit and several fermentation tanks. At the time of our visit (September 30) the frame of one Brace-type dryer was assembled, and a local carpenter was working on another. Supervising the operation was Mr. Alione Samb, an I.T.A. technician.

At Joal the existing dryers were in a state of total disrepair. However, a project similar to the one at M'Bour was planned for this village also.

At St.-Louis two large dryers and a solar-heated storage shed had been standing for two weeks, but had never been used. The technician in charge had been hospitalized following an auto accident. At the time of our visit the shore was practically deserted, and we were told that it was an off-season. This by itself could have explained why the dryers were not used. However, one woman, drying her fish on the ground, offered other possible explanations, even though she had never ventured near the dryer herself:

- The dryers were still too small for a normal size batch of fish.
- The dryers were too hot inside and would not dry the fish properly.
- No woman in the 370-member cooperative was willing to arouse the

resentment of others by being the only one to use the new dryers. It is better to wait until there are enough dryers for everyone than to create dissention within the group.

It was very apparent that project personnel had made little effort to work with the potential users of the dryers. Of the women we encountered, only the cooperative's president seemed to know what the potential benefits might be. Interest mounted as the I.T.A. Technical Director, Mr. Diop, talked with the women. Finally, several armloads of fish were carried up to the dryer and laid on the racks inside. The racks nearly collapsed under the modest weight, a point noted by the association's president. She also indicated ways in which the dryers could be better constructed--with a better pattern of framing and a different way of mounting the polyethylene to avoid wind damage. Finally, she was surprised to discover afer only a few minutes that oil was oozing from the fish, which she said would greatly improve its
appearance.

In short, in very little time, Mr. Diop was able to arouse the interest of potential users in a way that apparently had never been done before. This should have occurred several years ago!

A number of technical problems were noted in the newly installed fish dryers at St.-Louis. These included:

- Orientation towards the west rather than the south, which essentially shaded half of the drying racks until mid-day. If this was done to take advantage of prevailing winds for ventilation, the position of the vents should have been changed, not the entire dryer.

- The dryers were not anchored to the cement terrace on which they were placed. Although fixed horizontally with interior stakes, they could still be easily tipped in a strong wind.

- The polyethylene was not adequately supported or fastened. Water from recent rains had collected on the roof, stretching the plastic film under its weight. Some of the polyethylene had come detached and was flapping in the wind. Another section had large nail holes from an earlier installation.

- The vents appeared to be the same size, rather than the lower one 30% smaller than the high one, as Alward had suggested. Also, there was no way to close the vents to keep out wind-blown rain.

V. WHAT HAS BEEN LEARNED?

A. About Solar Fish Dryers

From project reports it would seem that traditional fish preparations

in Senegal can be made as well and possibly better through the use of a direct-gain solar dryer. Also, it appears that a simple solar dryer may yield a dried fish product which is superior in quality to that produced with traditional methods. Fish dried in a solar tent exhibit less short-term loss from microbial spoilage and insect infestation, and they are protected from airborne dust and sand.

Other conclusions drawn from nearly four years of laboratory and field testing are extremely tentative. The testing has been unsystematic, haphazard, without clear direction and apparently without a thorough understanding of scientific method or scientific reporting. There is no evidence of replicate testing or proper data analysis.

B. About Project Staffing

Any change in the personnel responsible for a project threatens to jeopardize that project. In this case, nearly everyone initially involved with the project is no longer so. The result has been a lack of continuity, commitment and direction. The implementing agency, I.T.A., appears to be chronically understaffed. Responsibility for effective transition from old to new personnel must be shared by all people involved, including the USAID project officer.

C. About Interim Evaluations

The Alward evaluation was thorough, constructive and competent. Unfortunately, it required two full months to be translated and typed at USAID/Dakar. Even so, the report seems to have had almost no impact on the project itself. The recommendations, had they been followed, would have avoided unnecessary repetition of errors and would have given the project considerably greater value. Without proper follow-up, such evaluations are worthless. Responsibility here lies with the project managers. Their failure to act should have been grounds for a complete reassessment of the project.

The Ellis consultation should have dealt with economic questions, but instead focussed on technical and social concerns. The reason appears to have been a lack of basic information required for an economic analysis. Essentially none of the requisite economic information specified in the Project Paper (1, pp. 53-54) had been gathered, so when the economist arrived on the scene there was little for him to do. The lesson here is that an economic analysis without basic economic data is impossible.

D. About Project Papers

The project paper prepared by Burrill and Steedman was detailed and thorough. It provided technical, social and economic guidelines with sufficient flexibility to accommodate unexpected developments in the course of the project. However, much of the project paper was never followed and the most recent project director had never even seen it. One vital component, a sociological study, was scheduled for June,

1981. Instead, it was conducted so late as to have no value whatsoever to the project (the study has not yet been submitted). Had all the work been done as planned, there is little question that the result would have been at least positive. The lesson here is that a good project paper should be consulted frequently for direction by all personnel involved.

VI. FUTURE DIRECTIONS

At this point there are three steps through which this project may be followed up:

A. Re-examine the specific needs to be addressed. Is the spoilage of fish really a major problem? Is there a demand for a better quality fish product? Is there a need to raise the economic condition of fish processors?

B. Next, evaluate the range of solutions to identified problems. If spoilage is the problem, could it be resolved by better preservation methods or better storage, or perhaps even by faster transportation to final markets? If poor economic conditions are the issue, would it help to assist in the formation of stronger workers' associations?

C. Finally, it should be possible to design a new series of projects on the basis of these analyses.

DOCUMENTS REVIEWED

GENERAL DOCUMENTS

1. "Senegal Renewable Energy Project." Project paper prepared for USAID by George Burrill and Charles Steedman, October, 1979.

2. "Etude de projets d'énergies renouvelables au Sénégal: rapport sociologique," prepared for USAID by the Société Africaine d'Etudes Techniques (ORGATEC), November, 1981.

3. "Etude de projets d'énergies renouvelables au Sénégal: rapport économique," prepared for USAID by the Société Africaine d'Etudes Techniques (ORGATEC), November, 1981.

4. "Etude de projets d'énergies renouvelables au Sénégal: rapport technique," prepared for USAID by the Société Africaine d'Etudes Techniques (ORGATEC), November, 1981.

5. Memo by USAID Energy Evaluation Team (George Burrill, Clarence Kooi, Wallace Tyner and Weston Fisher) on renewable energy projects in Senegal, November 3, 1982.

6. "Briefing Paper for REI Joint Review," USAID/Dakar, January 12, 1983.

7. "Six-month Project Implementation Report: Renewable Energy AIP, 685-0937.7," for period ending June 30, 1983, USAID/Dakar.

8. Various memos, implementation reports, correspondence, budget planning and financial reports from project files, USAID/Dakar.

COOKSTOVE DOCUMENTS

9. "Improved Cookstoves for Rural Senegal," report of a mission by Ianto Evans, Elisabeth Gern and Lawrence Jacobs (Aprovecho Institute), April, 1980.

10. "Programme des cuisinières 'Ban ak Suuf', compte rendu de la réunion du 5 mai 1980," by Eric Lagandre (ENDA) and Gerard Madon (IPM-CERER).

11. "Les cuisinières 'Ban ak Suuf,'" information booklet perpared at CERER, June, 1980.

12. "Rapport d'activité no. 1/juillet 1980," by Gerard Madon, Project Director at CERER.

13. "Rapport d'activité no. 2/novembre 1980," by Gerard Madon, Project Director at CERER.

14. "Ban ak Suuf Cookstoves in Senegal," a report of the second mission by Elisabeth Gern, Gina Amalfitano and Ianto Evans (Aprovecho Institute), submitted to USAID, March 1981.

15. "Rapport d'activité no. 3/juillet 1981," by Gerard Madon, Project Director at CERER.

16. "Senegal's Ban ak Suuf Cookstoves," a paper presented by Carol Ulinski (USAID) to the Conference on Energy, Forestry and Environment at Nairobi, Kenya, December 6-11, 1981.

17. "Rapport d'activité no. 4/avril 1982," by Gerard Madon and Massaer Gueye, CERER.

18. "Qualification en laboratoire des cuisinières Ban ak Suuf," by Jean Claude Tantardini, CERER, August, 1982.

19. "Note sur le programme 'BAS' (Oct. 30)," an apparently internal 12-page document from CERER with no author cited.

20. "Les consommations de combustibles domestiques au Sénégal sur foyers traditionnels et sur foyers améliorés." CERER, March, 1982.

21. "Reflexions de synthèse sur la formation-sensibilisation au CERER (mars-avril 1982)" by Bernadette de Mesmay, training consultant, CERER.

22. "Final Report," by Karen Nelson, Peace Corps volunteer serving as national coordinator to the cookstove project, July 8, 1982.

23. "Tabaxe sa toggu kaya ban ak suuf," ("Construire sa propre cuisinière ban ak suuf"), information booklet prepared at CERER, July, 1982.

24. "Principaux résultats de l'évaluation du taux d'utilisation des cuisinières améliorées ban ak suuf construites en zone rurale," by Gerard Madon, Project Director, CERER, July, 1982.

25. "Senegal's Urban Cookstove Program: a Plan of Action," prepared for USAID and CERER by Stephen Dwyre, July 29, 1982.

26. Memo by USAID Energy Evaluation Team (George Burrill, Clarence Kooi, Wallace Tyner and Weston Fisher) on renewable energy projects in Senegal, November 3, 1982.

27. "Rapport de mission de la délégation sénégalaise," presented at the CILSS/FISTD Regional Session on Improved Cookstoves at Bamako, December 1-8, 1982.

28. "Appui au programme de diffusion des cuisinières améliorées Ban ak Suuf," by Therese Deneve-Steverlynck (FAO), December, 1982.

29. "Briefing Paper for REI Joint Review," USAID/Dakar, January 12, 1983.

30. "Summary Report for the Improved Cookstove Project for August, 1982-February, 1983," by Cheryl Fattibene, Northern Coordinator, Peace Corps.

31. "Report to Peace Corps/Senegal on the Cookstoves Project," by Gene Ellis and Bruce Hanson (University of Denver), March 10, 1983.

32. "Six Month Project Implementation Report: Renewable Energy AIP, 685-0937.7" for period ending June 30, 1983, USAID/Dakar.

33. "Energy-efficient Cookstoves," an internal document from USAID/Dakar.

34. "Technical Notes for the Senegalese Ban ak Suuf (Improved Stove) Program," confidential draft document by Sam Baldwin (CILSS/VITA), July 1, 1983.

35. Miscellaneous memos, implementation reports, correspondence, budget planning and financial reports from project files, USAID/Dakar.

CHARCOAL PRODUCTION DOCUMENTS

36. "Senegal Fuelwood Production Project No. 685-0219," Appendix C., USAID project paper, 1979.

37. "Carbonization: Final Technical Report of Forest Energy Specialist," by G.E. Karch, U.S. Peace Corps, Senegal, FAO Document SEN/78/002, July 1980.

38. "Rapport sur la première session de recyclage des charbonniers traditionnels," submitted to USAID/Dakar by the Direction des Eaux, Forêts et Chasses, June, 1981.

39. "Rapport sur la deuxième session de recyclage des charbonniers traditionnels qui s'est déroulée du 11 mai au 14 juin 1981 à Tobor (Casamance). Submitted to USAID/Dakar by Bassirou Diedhiou and Ibrahima Ndiaye, Direction des Eaux, Forêts et Chasses, Senegal, September 19, 1981.

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41. "Informations sur la meule casmançaise," Direction des Eaux, Forêts et Chasses, Senegal, September, 1981. (Also in English translation as "Data on the Casamance Kiln.")

42. "Rapport sur la troisième session de recyclage des charbonniers traditionnels," November 9 - 19 December, 1981, by Ibrahima Ndiaye and El Hadji Ndiaye, Direction des Eaux, Forêts et Chasses, Senegal, July, 1982.

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45. "Rapport de suivi du projet d'énergies renouvelables--volet carbonisation, submitted to John Balis by Daby Diallo, USAID/Dakar, July, 1983.

46. "Rapport introductif (Réunion annuelle sur l'exploitation forestière)," Direction des Eaux, Forêts et Chasses, Senegal, August, 1983.

SOLAR FISH DRYER DOCUMENTS

47. "Phase I - Conservation du poisson par énergie solaire," project report by Niokhor Diouf and Mamadou Sarr, October, 1981.

48. "Rapport sur l'évaluation des sechoirs solaires pour poissons au point par l'ITA," by Ron Alward, October 30 - November 2, 1981.

49. "Rapport technique: sechage solaire du poisson," submitted to USAID/Dakar by Niokhor Diouf and Boubacar Diakiti (ITA), for the period March-December, 1982.

50. "Solar Fish Dryers: A Report," submitted to USAID/Dakar by Gene Ellis, University of Denver, March 8, 1983.

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52. "Projet sechage solaire du poisson," a four-page project evaluation without reference to either author or date, found in USAID/Dakar project files.