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COOK STOVE TESTING AND DEVELOPMENT AT THE LESOTHO RET PROJECT

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TABLE OF CONTENTS

Section		Page
I.	Introduction	1
II.	Metal Paolas	2
III.	Stone Paolas	4
IV.	Metal and Mud Stoves	6
V.	Other Issues	8

I. INTRODUCTION

This report presents the scope of work and activities undertaken by Mr. Howard S. Geller at the Lesotho Renewable Energy Technology (RET) project from April 15 through April 22, 1983. Mr. Geller is a stove specialist, who was consulting for Associates in Rural Development, Inc. (ARD), the contractor implementing the Lesotho RET project for the U. S. Agency for International Development (AID). The scope of work for his week-long consultancy on the project's cook stove testing and development program is given below.

1. Standardize testing procedures for cook stoves, based on revised VITA protocols, developed at the December, 1982 conference, in three areas:

   - laboratory, and research and development,
   - cooking under controlled conditions in the field, and
   - uncontrolled, but monitored, field conditions.

2. Conduct training for Appropriate Technology Section (ATS)/RET staff in new testing protocols.

3. Suggest further activities or improvements in cook stove development.

4. Work with ATS/RET staff to decide on best portable paola models.

5. Produce written reports on VITA's revised standard protocol system and stove/paola design changes.

II. METAL PAOLAS

The water boiling test procedure being used and data collected to date were reviewed with Mr. Gary Klein, ARD's laboratory supervisor for the RET project, and Mr. Nkare Thelejane. The procedure differs from the proposed international standard in a number of ways:

- duration for different periods of the test,
- measurements taken, and
- method of accounting for remaining useful energy after the simulation task.

From the measurements, an overall efficiency or "percentage of heat utilized" is calculated in the conventional manner. The procedure being used by the RET project is based on local cooking practices and is appropriate for internal comparisons of different stove models, design features, etc.

However, it was agreed that it would be useful to conduct a few water boiling tests using the provisional international standard, if possible. This would permit comparisons with stoves outside the project and also indicate how the RET models will perform at longer tasks, such as cooking beans. Mr. Klein and Mr. Thelejane were concerned that the recommended international testing procedure could not be used with dung fuels, but the test was carried out without difficulty once a sieve was constructed to separate dung char and ash. Mr. Klein and Mr. Thelejane are now prepared to carry out a small number of water boiling tests (five to 10) on the better paola models using the international procedure.

Additional design features and operating techniques which could further improve the performance of metal paolas were also discussed. In particular, an analysis of different grate-to-pot distances (15, 20, 25 and 30 centimeters) was considered important to optimize the design(s). Mr. Thelejane also indicated that feeding a fire regularly with smaller amounts of dung is more efficient and uses less fuel than the usual technique of building a fire using a large initial charge. Periodic stoking methods were discussed and formal water boiling tests to compare operating techniques agreed upon.

In terms of analyzing the metal paola test data, the methods suggested in the provisional international standards were explained and an example worked out. In addition, further statistical analysis involving ANOVA was discussed together with Dr. John Gay. The metal paola test data are well suited to this analytical technique, and Mr. Klein and Mr. Thelejane are now prepared to carry out such an analysis after reviewing the procedure.

Based on the tests completed, the improved metal paolas are approximately 35 percent more efficient than traditional models (12.0 versus 9.2 percent overall average efficiencies, respectively). The best improved paola design--cylindrical with a grate--yielded an average efficiency of 14.6 percent. Preliminary analysis shows that differences in efficiency between traditional and improved paolas, and some of the different design features are statistically significant.

As previously mentioned, further testing of grate-to-pot distances is advisable because these increases in efficiency are reasonable, though not overwhelming. Once this analysis is completed, it is suggested that a final phase one metal paola be specified. This design and a typical traditional paola should then be subjected to a limited round of controlled cooking tests, i.e., preparation of set meals by village women, which need not be nearly so laborious as the original stone paola cooking test plan. It is recommended that no more than two types of meals and two fuels be tested. If reasonable fuel savings (20 percent or greater) are found and no other problems encountered, field tests should be conducted. This will require kitchen performance monitoring (which is now being called user tests) in at least five households.

III. STONE PAOLAS

Ms. Margaret Thomas, another ARD stove consultant, drew up a lengthy plan of controlled cooking tests for stone paolas and the traditional alternative (a leifo). Less than 50 percent of the tests called for have been completed, and none have been done since her consultancy ended. Mr. Geller, Mr, Klein, Mr. David Palasits and others agreed that the original testing plan should be streamlined because:

- the tests proposed are too extensive and laborious, and
- dissemination of stone paolas has already begun.

It was further agreed that the project would attempt to complete four of the 10 proposed stone paola versus leifo test series, which includes redoing one steamed bread (bohobe ba metsi) comparison using the traditional cooking method. If the controlled cooking tests in this revised plan are completed, the project will still gain a good indication of how much fuel the stone paola saves when used for common cooking tasks.

The revised plan for controlled cooking tests includes rounds of cooking papa and moroho with a leifo and on stone, traditional and improved metal paolas. This will provide the basis for an overall comparison of fuel use by all the stoves the project is working on, as tests have already been completed for the five metal and mud stove models. A total of about 30 additional controlled cooking tests are being proposed, approximately half of what was originally planned. It is advisable to discuss this revised plan with Ms. Thomas in the United States.

Mr. Geller, Mr. Klein and the field staff agreed that a series of stone paola user tests (kitchen performance monitoring) is needed to determine how much, if any, fuel is saved when a household has a stone paola. These tests should be conducted in a minimum of five homes. Mr. Klein suggested monitoring at three times of the year--winter, summer and spring/fall--to assess seasonal variation in stove use and fuel savings. This is desirable, if time and manpower permit, and could be incorporated into follow-up activities.

One woman in Khutlo-peli has built a stone paola without assistance from RET or trained paola builders. This stove does not have a grate and has only one set of air holes. It would be useful to test this paola to see how it performs, with the expectation that these simplifications reduce fuel savings. Mr. Klein and others agreed that first, a round of controlled cooking tests should be conducted with the woman doing the cooking since she knows the stove best. Three tests on the paola and three with the traditional alternative should be adequate. If significant fuel savings (20 percent or more) are observed, the

project should then construct a duplicate at one of the testing centers for further study.

The optimal grate-to-pot distance for the stone paola has not been rigorously analyzed. Based on his experience, Mr. Klein claims that 27 to 32 centimeters between the grate and pot supports is best. This variable could be carefully evaluated by conducting water boiling tests with one particular stove, and the procedure for doing so was discussed. Although this analysis would be useful, the stone paola effort is well beyond the design stage. At this point, accumulated experience may be a reasonable guide for setting the grate-to-pot distance.

IV. METAL AND MUD STOVES

The metal stove developed by Mr. Glenn Burket, another ARD stove consultant, and a two-pot Lorena mud stove with chimney are being user-tested. There is a fundamental difference in the way the RET project is conducting kitchen performance monitoring and the procedure recommended in the proposed international standards. For the week of monitoring when the stove is in use, the project is instructing people to use it for all their cooking, water and space heating tasks. If this is not done on a particular day, the measurements for that day are considered invalid and not included in the results. On the other hand, the recommended procedure allows people to use whichever device they prefer. While people should be fully instructed in the stove's operation and encouraged to use it during the week of monitoring, they should be allowed to use the device of their choice, if an accurate determination is to be made of how much fuel is saved when a household has a new stove available. The information recorded daily should include which device is used for every fuel-consuming activity.

This issue was thoroughly discussed, and all concerned agreed that the procedure from the proposed international standards is preferable. Kitchen performance monitoring with the mud stove has only begun in one household, so the recommended method can be used with the remaining four households. However, for the metal stove, user tests have already begun or been completed in all five households. It is suggested that the week of monitoring be repeated when the stove is available in two or three of these homes. (The week without the stove need not be repeated.)

A few of the daily kitchen performance monitoring visits were observed and then discussed with the staff conducting them. In addition, many completed data forms were examined. There have been some minor difficulties in completing them properly, including recording which cooking/heating devices are being used. In a number of cases, all of the pre-weighed fuel is used up during the day. If at all possible, this should not be allowed to occur. All these problems were discussed with the staff.

Another area where the user tests could be improved is in noting observations and subjective information provided by the user. The comments written on the forms are very brief and general in nature. From the few visits to households with stoves and discussions with staff members, it is clear that much useful verbal and visual feedback is being offered, but not recorded. Some women are devising innovative ways to use the stoves, while others are having problems or are not using them to their best advantage.

This type of information should be carefully documented for use in evaluation, training and dissemination activities. One

idea is to maintain large charts with good and bad uses of the stove, problems, etc. Some questions for the follow-up interview could be derived from this information. Also, an analysis of the monitoring forms might provide some important interview queries. For example, in one household where kitchen performance monitoring has been completed, only shrubs were burned, unlike the normal combination of shrubs and dung. The interviewer should try to find out the reason(s) for this anomaly.

During this consultancy, a methodology for evaluating the data collected during kitchen performance monitoring was worked out. The first step involves figuring total daily fuel use. It was agreed that this should be computed in terms of equivalent kilograms of dung (EKD), whereby different fuels are weighted according to their calorific value relative to dung. Weighting factors were determined, based primarily on fuel tests done in South Africa.

The second issue concerned which parameter to use for comparative purposes. Based on the information collected, data can be analyzed in terms of EKD per day, EKD per person per day or EKD per person per meal. The latter two figures are better than the first because they permit comparisons between households of different size. However, computations per meal are complicated by the fact that some meals are cooked for an entire day, while others merely involve reheating the food. Therefore, EKD per person per day is the preferred measure. It also showed the lowest degree of variability across days in the data from one household that were carefully examined.

To assess household size, the proposed international standards include a simple table that weights different members of the household according to their approximate food intake. Use of this table was recommended. Project staff agreed with this recommendation and will "recount" people in the households where kitchen performance monitoring has already been completed.

The simple statistical evaluation procedure suggested in the international testing standards was reviewed with Mr. Palasits and Mr. Koranta Matete, the two field staff members who are conducting the user tests. Also, an example was worked out using kitchen performance monitoring fuel use data for one metal stove. These staff members are now prepared to carry out this analysis for all the controlled cooking test and kitchen performance monitoring data.

V. OTHER ISSUES

One smoke monitoring test was conducted while a traditional paola was being used to cook an evening meal in a rondavel near Malefiloane. The smoke level in the house was definitely high, although quantitative results will not be available until the smoke filter is analyzed in the United States. The smoke monitoring equipment was left with the field staff, so that five tests could be completed in homes using traditional paolas and five with either a mud or metal stove with chimney. Mr. Klein agreed to return the equipment to the United States.

Tests show that the radiant heat from the body of a traditional or improved paola represents only a small fraction (one to two percent) of the heat released by these stoves. Observations of a paola in use confirmed that radiant heating per se is not very important in terms of space heating. Rather, convective heating from hot gases is the major source of space heat from a paola. Furthermore, if a chimney is used to remove smoke from the house, the ability to close the door and tighten the structure play a much greater role in increasing indoor comfort than radiant heating. In fact, it may be useful to monitor indoor temperature in a house(s) where a stove with chimney and traditional paola are used alternately.