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DOMESTIC ENERGY USE IN TWO VILLAGES:

ADDENDUM TO BOTSWANA VILLAGE ENERGY SURVEY

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PREFACE

The Botswana Renewable Energy Technology (BRET) project (number 633-0209) is jointly funded by the government of Botswana and U. S. Agency for International Development (AID). Technical assistance and project management are being provided by Associates in Rural Development, Inc. (ARD) of Burlington, Vermont, under AID contract number 633-0209-C-00-1024-00. This report describes a portion of the work undertaken by Ms. Judith A. Oki, ARD's extension support supervisor for the BRET project.

I. SUMMARY

A. Background

In 1982, the BRET project conducted a village energy use survey in the two villages of Shoshong and Ditshegwane to determine overall energy use patterns and guide the project in its technology selection and development process. While that survey did not include quantitative measurements of fuel use, it did gather data on the frequency with which different fuels were used for various domestic activities. This report describes an intensive fuel measurement study undertaken in 1983 with a much smaller number of households to quantitatively assess energy use in those two villages. The methodology employed as well as detailed results and conclusions are presented in subsequent sections of this report.

B. Purpose of the Study

The objectives of this intensive fuel measurement study were to:

- verify earlier findings about the use of various fuels for different household activities;
- determine the quantities and kinds of fuels used for domestic activities during a single week;
- identify seasonal variations in fuel consumption patterns; and
- detect differences in fuel consumption related to economic level.

C. General Findings

The study's results reaffirm the village energy survey's finding that firewood is the primary fuel used in rural areas for a number of domestic purposes and paraffin (kerosene) is the main fuel used for lighting. In both villages, weekly household wood consumption in the winter is at least twice as high as in the summer. Ditshegwane households use two-thirds as much fuel in summer as Shoshong families do in winter. In Shoshong, where it was possible to distinguish between various income levels, it appears that there is a noticeable increase in fuelwood and paraffin consumption with economic status.

II. METHODOLOGY

A. Evaluation Criteria

To fulfill the study's purposes (discussed above in the summary), the following evaluation criteria were formulated for this survey:

- total weekly quantities of each domestic fuel per household for summer and winter;
- stated end-uses of each fuel;
- kinds and quantities of fuels used for various domestic activities by income level; and
- extrapolated annual firewood use.

B. Study Design

For seven consecutive days during both the hot and cold seasons (summer and winter), visits were made to the study households at about the same time of day to weigh or measure the fuels to be used and determine their specific end-uses. Survey visits were made during either mid-morning or mid-afternoon to ensure that approximately equal numbers of fires were included in each day's measurement. Households were asked to only use wood from a specific, pre-weighed pile, refill paraffin appliances when an enumerator was present and report when either batteries were purchased or gas bottles refilled. Enumerators were selected from the two villages and were accompanied by BRET staff until the staff members were satisfied that the enumerators' use of measuring devices and data recording were accurate. Wood and gas bottles were weighed using 50-kilogram spring balance scales, and paraffin was measured in graduated, two-liter jugs.

C. Sample Selection

To do a detailed, quantitative fuel measurement study, it was necessary to limit the number of households included in the survey, yet still maintain a reasonable cross section of the two villages' income levels. Using past experience and information from the village energy survey conducted in 1982, 34 households in Shoshong were selected from a rough grouping organized according to income level. Descriptions of these income-level household distributions can be found in an earlier ARD report, BOTSWANA VILLAGE ENERGY SURVEY REPORT (Judith Oki and Julia Majaha-Jartby, September, 1983). For the first part of the study, conducted in July, 1983, 12 households were chosen for the

lowest economic level from the groupings for Shoshong, 11 from the middle group and seven from the highest. By the time the summer measurements were made in February, 1984, there were only 10 low-income households, nine in the middle group and seven at the high level.

In Ditshegwane, the study was conducted in the 15 households where women volunteered to participate in the metal stove user tests. Because so little income is generated in this village, the economic level of these households was impossible to determine. In Ditshegwane, it was also necessary to include some additional households for the second set of measurements to obtain 10 useful cases for each season.

D. Data Analysis

For every household, a weekly consumption total and average were determined for each fuel. A weighted daily per capita consumption figure was figured using the total amount of wood consumed per week and average number of persons present in the household for meals. Use of the two major fuels (wood and paraffin) was examined by economic level for Shoshong. For reasons discussed above, this analysis was not possible in Ditshegwane.

While the data collected included several pieces of information that may be interesting and useful for further work on renewable energy technologies, they are not directly relevant to the purposes of this survey. These findings can be gathered from the original questionnaires, if desired. The following sections present only those results and conclusions that are pertinent to the stated goals of the fuel measurement study.

III. RESULTS

A. Shoshong

Fuel Use by Household Activity

One of the stated purposes of the fuel measurement study was to confirm the village energy survey's earlier findings regarding the use of various fuels for different household activities. Table 1 presents the number of Shoshong households in the sample using specific fuels for various domestic activities. The sample size was 26 households for the summer (S) measurements and 30 for the winter (W). The blank cells in this table indicate that no use of a particular fuel was reported for that activity.

Table 1. Fuel Use by Household Activity for Shoshong

Activity	Wood		Paraffin		Candles		Batteries		Gas		Dung	
	S	W	S	W	S	W	S	W	S	W	S	W
cooking	26	30										
water heating	22	30										
baking	2	7										
space heating	1	30										
lighting	9	5	16	24	11	6						
brewing beer	1											
other							8	7				

These results differ from those of the original village energy survey by five to eight percent, but they do confirm that firewood and paraffin are the major fuels used in Shoshong, with wood being the primary cooking fuel and paraffin, the main lighting fuel. In addition, the original survey found that in a sample of 165 households, five percent used gas for cooking. However, in the fuel measurement study, only one household (three percent of the sample) had an empty gas cylinder, and it was not used during either measurement period. Because wood and paraffin are the major fuels used in Shoshong, the next two subsections present further, in-depth, quantitative results regarding their consumption.

Seasonal Wood and Paraffin Consumption

Table 2 shows the quantities of wood and paraffin used by the Shoshong households for the two seasons considered in the fuel measurement study, summer and winter.

Table 2. Seasonal Consumption of Wood and Paraffin in Shoshong

	wood (kilograms) summer	wood (kilograms) winter	paraffin (milliliters) summer	paraffin (milliliters) winter
weekly household average	18.56	36.5	145.9	403.5
standard deviation	11.6	19.9	143.5	387.0
per capita daily consumption	.98	.99	4.4	8.48

For wood, the seasonal differences at the household level appear large, although the per capita difference in fuelwood consumption is negligible. There are three readily apparent reasons for this result:

- in the summer, the average number of meals cooked per week was 12, compared to an average of 16.4 for winter;
- the use of wood for space heating during the winter implies that fires are kept burning for a longer period of time in the evening; and
- the number of people present in a household increased during the winter, when household members return from cattle posts in lands areas--the average number of people present during the winter was 6.8, compared to 4.7 for the summer.

Given this information, and assuming 34 weeks of fuel consumption at the summer rate and 18 at the winter rate, an annual per capita figure for fuelwood consumption can be determined for Shoshong--357.98 kilograms (kg). This statistic will have greater significance when the rural energy study is completed, as it can then take into account a national sampling of villages, the existing supply of firewood and projected rate of depletion.

Paraffin use increases significantly during the winter due to the increased amount of time when lighting is required. In summer, the average weekly total number of lamp-hours was 12.9, compared to 20.4 for the winter. Annual household consumption of paraffin is 12.22 liters, which was determined using the summer and winter durations noted above.

Fuel Use by Economic Level

Table 3 presents the results for fuel use by economic level in Shoshong.

Table 3. Fuel Use by Economic Level in Shoshong

Income Group	Weekly Household Consumption of Wood (kg)		Number of Meals Cooked		Weekly Household Consumption of Paraffin (ml)	
	summer	winter	summer	winter	summer	winter
low	15.1	28.4	10	14	173.1	276.0
middle	19.9	34.51	12.5	17.6	133.9	314.8
high	18.6	54.7	14.8	17.2	145.9	760.7

These results show that households with higher incomes consume more firewood than low-income families during both seasons. The data on paraffin use are less clear for summer, where the low-income group appears to actually consume slightly more paraffin. However, in general, lighting requirements are minimal in summer, and during the long winter nights, households use lighting in relationship to the amount of fuel that they can afford.

B. Ditshegwane

Fuel Use by Household Activity

The results for fuel use by domestic activity for the 10 households in Ditshegwane are presented in Table 4 on the next page. As before, blank cells indicate that no household reported using a particular fuel for that activity.

Table 4. Fuel Use by Household Activity for Ditshegwane

Activity	Wood S	Wood W	Paraffin S	Paraffin W	Candles S	Candles W	Batteries S	Batteries W	Gas S	Gas W	Dung S	Dung W
cooking	10	10										
water heating	10	10										
baking	9	8										
space heating	10	10										
lighting			9	5	1	4						
brewing beer												
other								6				

As expected, these data correspond almost exactly with the initial village energy survey results, which found that 98 percent of Ditshegwane housholds cook with firewood and 51 percent use paraffin for lighting. However, the frequency of paraffin use in the summer is much higher and cannot easily be explained. Nonetheless, the results of this study confirm that wood and paraffin are the primary fuels used in Ditshegwane. Thus, it is appropriate to provide a more detailed, quantitative examination of seasonal variations in the consumption of these fuels.

Seasonal Wood and Paraffin Consumption

Table 5 shows the amount of wood and paraffin used by Ditshegwane households for the two seasons considered in this fuel measurement study, summer and winter.

Table 5. Seasonal Consumption of Wood and Paraffin in Ditshegwane

	wood (kilograms) summer	wood (kilograms) winter	paraffin (milliliters) summer	paraffin (milliliters) winter
weekly household average	27.9	65.6	270.4	320.1
standard deviation	11.1	26.52	163.5	360.6
per capita daily consumption	1.4	2.14	4.15	4.31

As was true for Shoshong, the difference between summer and winter fuelwood consumption at the household level is

considerable, with the winter total more than double the summer figure. This difference is especially noticeable in Ditshegwane because there is virtually no seasonal difference in the weekly average number of meals cooked per household--12.4 for summer and 12.5 in winter. However, observations indicated that during the winter, fires are frequently kept going all day and into the night, while in summer, there is no need for a fire during the day. There are two reasons for keeping a fire going all day in winter:

- firewood is relatively easy to obtain--it is only an average distance of three to five kilometers to gather wood; and

- activity outside the household is minimal, so most household members who are not schoolchildren are at home all day.

Using the same procedure as for Shoshong, the annual per capita wood consumption can be determined for Ditshegwane. This figure is 602.84 kilograms, twice as much as for Shoshong, which reflects the difference in the availability of wood for the two villages.

In terms of paraffin, the seasonal difference in use is relatively small and difficult to account for. Ditshegwane's annual household consumption figure for paraffin is 1.5 liters.

As noted earlied, an analysis of the Ditshegwane data by economic level was not possible because the income generated in this village is minimal. A review of the raw data indicated that differences in consumption were not related to perceived income levels and, in fact, seemed to be random.

IV. CONCLUSIONS AND RECOMMENDATIONS

The original intent of this fuel measurement study was accomplished. The findings verify earlier conclusions concerning the types of fuels used for domestic activities in Botswana and confirm that fuelwood is the predominant fuel used in rural areas. Firewood continues to play a role in all household activities, especially cooking, water heating and space heating. The weekly winter rate of fuelwood consumption per household in the two villages studied was found to be at least twice the summer rate. It can also be stated that in areas where firewood is relatively abundant, it is consumed in greater quantities, as shown in Table 6.

Table 6. Comparison of Wood Use in the Two Villages

	Shoshong	Ditshegwane
Weekly Household Average		
summer	18.56 kg	27.90 kg
winter	36.50 kg	65.60 kg
Per Capita Daily Consumption		
summer	.98 kg	1.40 kg
winter	.99 kg	2.14 kg
Annual Per Capita Consumption	357.98 kg	602.84 kg

Where it was possible to gather data on households' economic level, the rate of consumption of the two major fuels (wood and paraffin) is higher for households with higher incomes. Winter consumption of fuelwood in high-income households is almost double that for low-income families. Batteries, candles and bottled gas are in use, but their rate of consumption is difficult to measure on a weekly basis.

Two recommendations can be made on the basis of the results of this fuel measurement study. First, the information gathered could be used in combination with a large national sample and a firewood supply study to predict the rate at which existing wood supplies are being depleted in different areas of Botswana. Such data may be readily available from the upcoming rural energy study.

Second, conservation campaigns should be targeted at groups that appear to consume the most fuelwood--people living in areas that do not currently have either a wood shortage or severe inconveniences in terms of gathering firewood as well as those with higher incomes. Any appeal to the groups that use the most firewood will have to be futuristic and focus on their responsibility to the nation to conserve its energy resources. With regard to the high-income group, the BRET project's wood-conserving cooking devices are especially appropriate, since these households are most likely to be able to afford such technologies. This recommendation is not intended to imply that energy conservation is not an issue for consumers that use small amounts of fuelwood--this group is likely to be most clearly aware of the problems involved and thus, perhaps more receptive to the adoption of conservation strategies.

Although much research has been done on fuelwood consumption in Botswana, most studies also indicate significant and widespread use of batteries. An investigation of battery use might also be warranted at some future time.