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An Evaluation of RCUP's Improved Cookstove Program with Special Emphasis on Indoor Air Pollution Sampling

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Holly F. Reid
Technical Assistant to the
Resource Conservation and Utilization Project, Nepal
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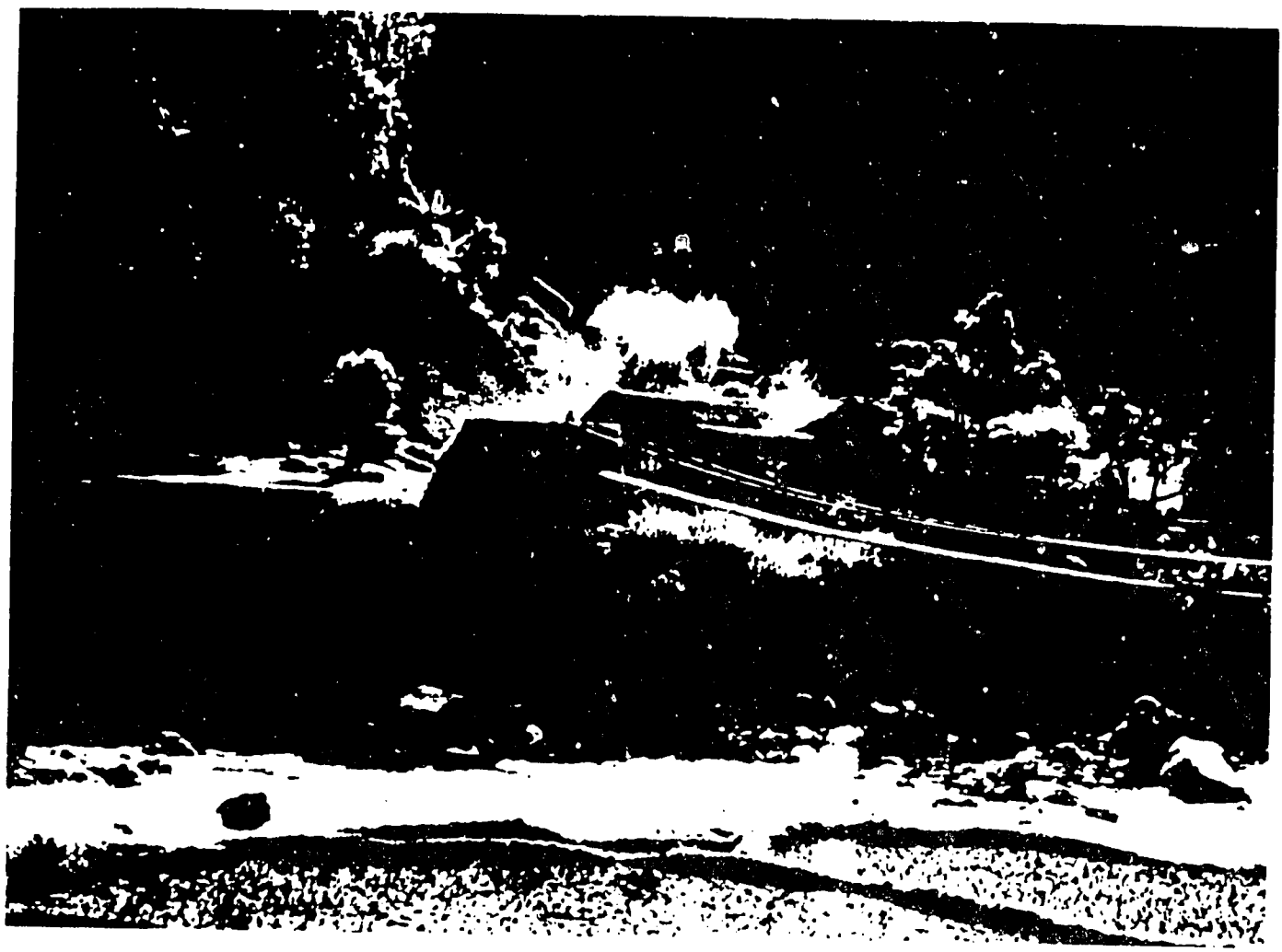

Smoke Haze from Domestic
Cooking Fires Hangs Above
a Nepali Village

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I want to express my deepest appreciation to my closest companion, and cultural, lingual and social interpreter, Bageshwari Sherchand, for her unending energy, commitment to seeking truth, and ability to provide comic relief when most needed. I would also like to recognize RCUP's stove and energy technicians, Dina Nath Koirala, Bal Bahadur Pun, and Prem Tulachan, without whom this field evaluation would have taken twice as long and been twice as difficult. Gerry Richards, Bill Hart, Ann Lewis, Shanta Pandey, Prajwol Pradhan, and Yam Malla were also invaluable as my very practical and experienced advisors during the many uncertain hours of certain confusion.

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Most impcrtantly, my work companions and I offer a respectful greeting "Namaskar" to all the cooks and families who generously welcomed us into their mountain homes to learn a little bit about their lives.

INTRODUCTION

This is an evaluation of the Resource Conservation and Utilization Project's (RCUP) improved cookstove program. The purpose of the study is to provide a more complete report of the improved cookstove's performance, user acceptance, and preference, along with data on women's exposure to indoor air pollution from cookstoves with and without flues. The original objective of the evaluation was to visit at least sixty households in the three RCUP districts (thirty households with traditional, no-flue cookstoves and thirty households with improved cookstoves) to compare old and new stoves by subjective and objective criteria.

The study combined a qualitative survey (a sixty-six item questionnaire) with quantitative measurements of cookstove fuel efficiency and cooks' exposures to domestic air pollution. However, due to time limitations, previous field work completed on cookstove efficiency, and the absence of any data collected in Nepal on womens' exposures to smoke, the quantitative portion of this study was exclusively focused on indoor air pollutant measurements. Section I describes a brief history of the cookstove program and the parameters and limitations of this Fall 1984 evaluation. Sections II and III explain the methods and results of the quantitative smoke sampling and the qualitative questionnaire sampling, respectively. Section IV addresses cookstove program obstacles in the climatically and socially divergent district of Mustang. Section V offers cookstove program conclusions and recommendations, and finishes with the relevance of this study as a Women in Development project.

SUMMARY OF FINDINGS

* Indoor air pollution measurements of smoke from domestic cooking fires have revealed alarmingly high concentrations of harmful gases and other substances, including carbon monoxide, formaldehyde, nitrogen dioxide, suspended particulates, and a carcinogenic hydrocarbon known as benzo[a]pyrene.

* Comparisons of pollutant measurements between households with improved cookstoves and those with traditional cookstoves clearly demonstrate that the use of a flue significantly reduces the cook's exposure to harmful pollution by venting an otherwise confined cooking environment.

* Emissions data, from both traditional (flue-less) and improved (flue) cookstoves, collected for this study are conservative es-

timates of annual exposure rates, because 1) measurements were conducted during the driest part of the year, and 2) sampling sites were concentrated in more populated bazaar areas where "modern" architecture (more windows and high ceilings) influenced the ventilation of the cooking areas. Bazaar homes were considered unrepresentative of the traditional, rural Nepali lifestyles.

* Domestic indoor air pollution is likely to be an important contributor to the high prevalence of chronic obstructive lung disease in rural Nepali adults, particularly women, and an important risk factor for the high mortality and morbidity from acute respiratory infections in rural infants and children. The flue is presently the most effective method of decreasing domestic indoor air pollution, and therefore is likely the most effective means of reducing lung and eye disorders in Nepal.

* Health benefits of flues should be a greater consideration in the justification of cookstove programs, even for development organizations that do not actively work in the field of public health.

* Decreased exposure to smoke was the cooks most often stated first priority for wanting or using the improved cookstove.

* Although the improved cookstove generally took a longer time to cook meals than the traditional mud chulo (but less time than the one-pot agena), the majority of cooks responded that the improved stove decreased their overall workload, or work time.

* A "Kitchen Behavior Test" indicated that Nepali cooks spend about 93 percent of the cooking period at or within six feet of the cookstove. Both improved and traditional stove users spend approximately five hours per day cooking meals and snacks (this includes approximately two hours in morning and evening, and approximately one hour in the afternoon).

* This Women in Development (WID) sponsored project did improve communications between RCUP personnel and the district villagers, and did specifically solicit the native wisdom of the rural women to identify and address sex-segregated issues. This study employed a woman interpreter and a woman Technical Assitant which resulted in uninhibited rapport and dialogue with predominantly female, household cooks. This procedure was a reflection of: 1) sensitive policy changes introduced by USAID/WID to respect and work within traditional Nepali customs and beliefs on sex segregation, and 2) practical recommendations made by other field projects finding that their male personnel had great difficulty in soliciting the open opinions of rural women. Women talking with women made a very practical difference in the quantity and quality of information exchange.

I. COOKSTOVE BACKGROUND AND EVALUATION CRITERIA

"We had a land named after the dense forest that grew there called 'salyani gairo' (pine tree gorge). Now, it is called 'rato gairo' (red gorge) because it is naked and all you see is the red soil sliding down the mountain."

Yoga Nanda Regmi, Bansbot, Myagdi

"In mother's day, there used to be forests. Now we have all eaten them up."

Lal Kumari Malla, Rakhu Piple, Myagdi

A. RCUP Cookstove History

The RCUP improved cookstove program was initiated in 1980 as a basic means of decreasing household fuelwood consumption and, subsequently, the rate of wholescale forest destruction within two watershed catchments in Nepal. Since the first cookstove installations in the Gorkha district in 1981, RCUP's energy division has experimented with at least five different designs, including: double wall, terri, insert, mud, in situ-built, and single wall magan. Most improved cookstove designs consist of a pre-fabricated ceramic frame which includes a fuel-efficient feature, such as a baffle in the firebox, and a flue (1) of either ceramic or tin. Improved cookstoves are intended to replace or significantly reduce the use of the traditional Nepali one-pot, open flame "agenas", and two-pot, enclosed flame "mud chulas" (referred to as the "old stoves" - see Figures D and E). Table I shows the types, location, and number of improved stoves that RCUP has installed since 1981, while Maps I and II (Figures A and B) show their distribution. Beginning in January of 1984, the UNICEF single wall magan chulo (referred to as the "new stove" - see Figures F and G) was introduced to the Gorkha and Myagdi districts. Satisfactory user-assessment and ease of installation have encouraged the promulgation of this UNICEF model as RCUP's long-term choice of design.

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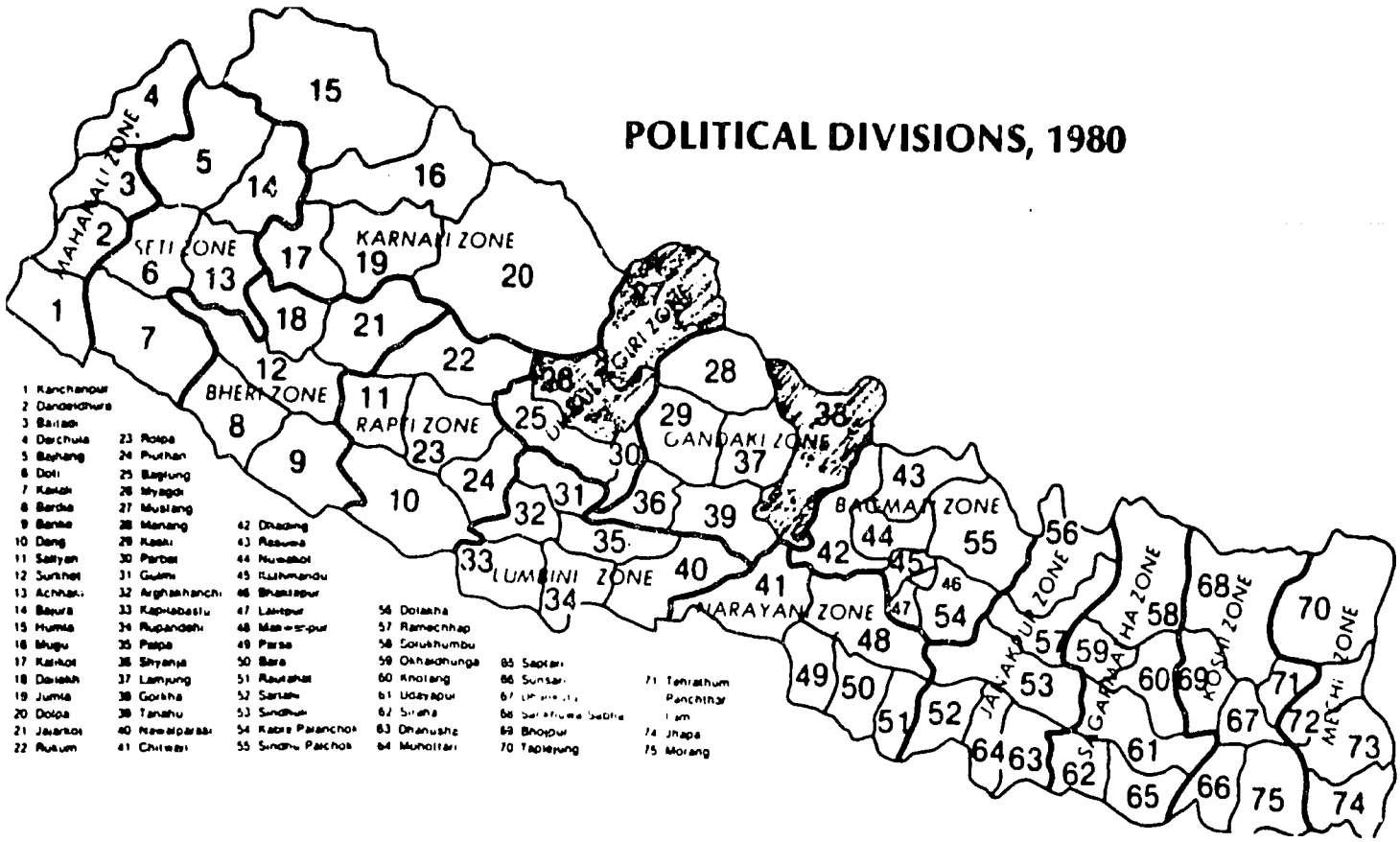
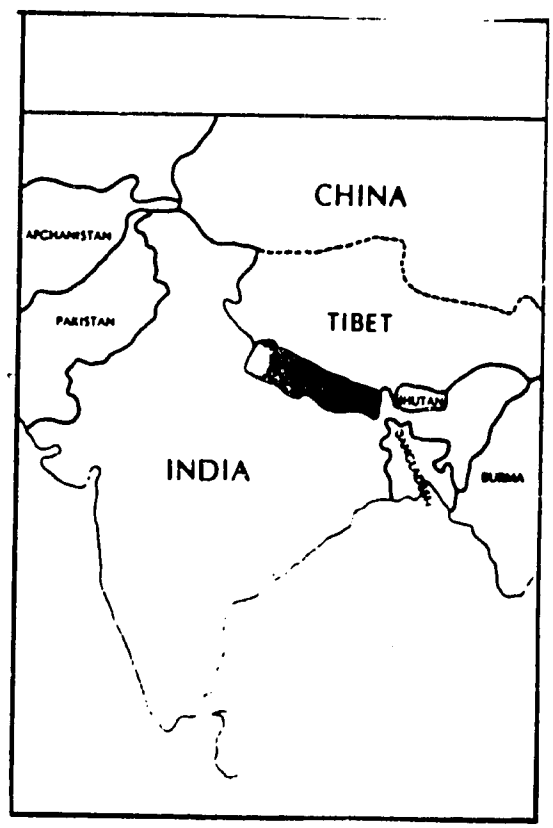
(1) "Flue" is used in this analysis in place of the more common, though less accurate, term "chimney". Chimney refers to a vertical pipe that is not directly connected to the combustion chamber, as in a fireplace. A flue is connected directly to the combustion chamber, and is not necessarily straight or vertical.



NEPAL

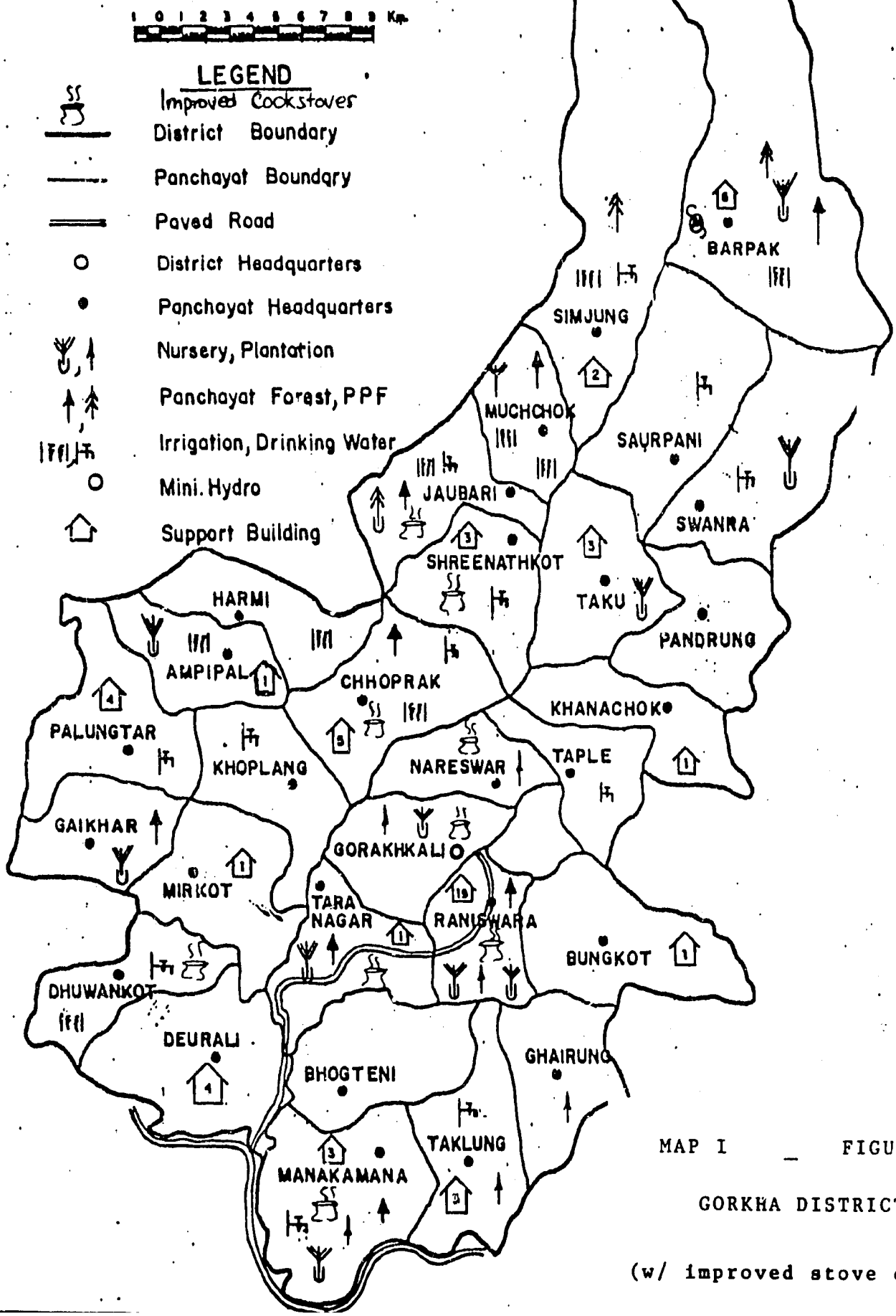
26 - Myagdi District
27 - Mustang District
38 - Gorkha District

(Karan et al., 1983)



GORKHA DISTRICT

SOUTH EAST CONSORTIUM FOR INTERNATIONAL DEVELOPMENT
RESOURCE CONSERVATION & UTILIZATION PROJECT



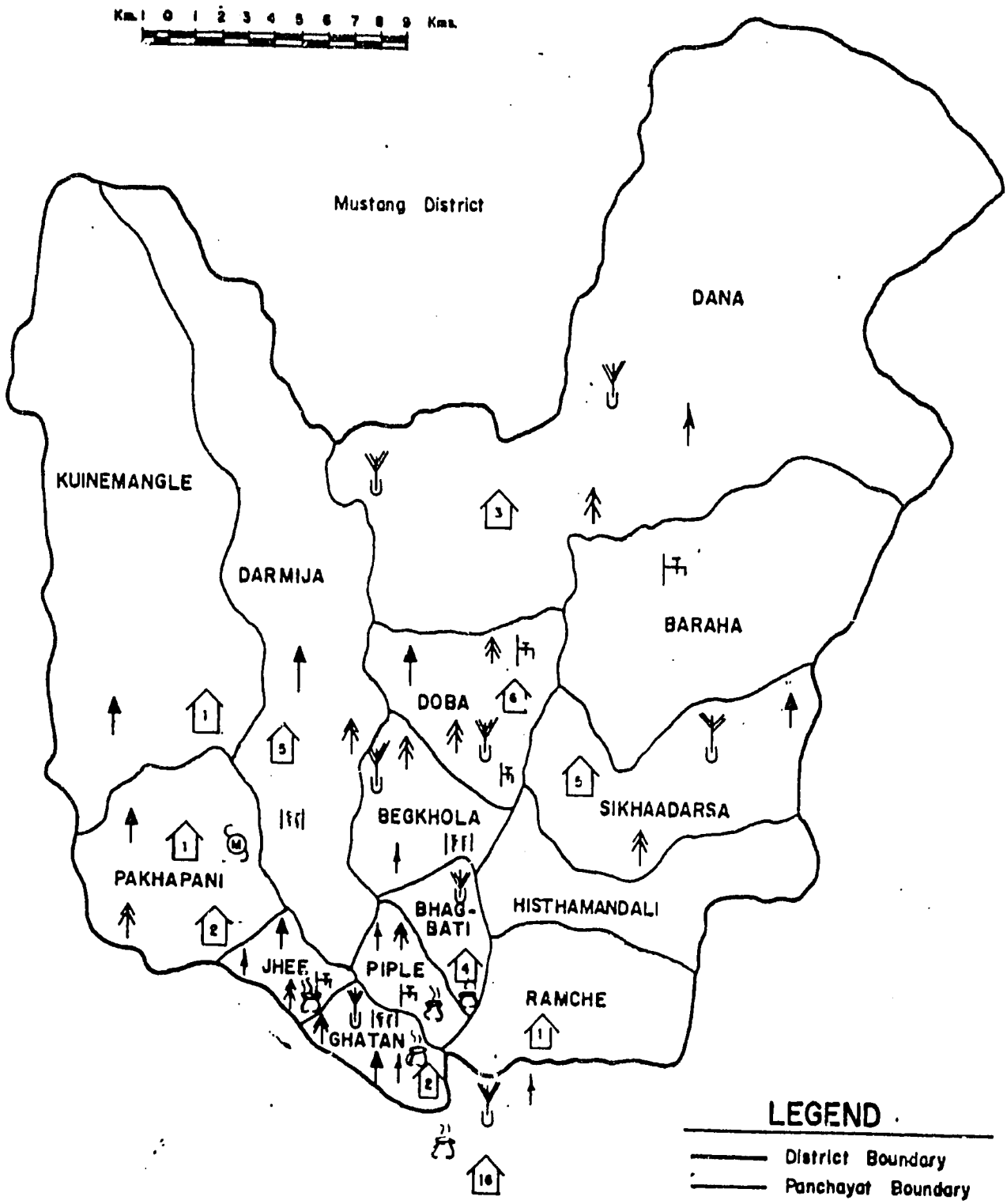
MAP I — FIGURE A

GORKHA DISTRICT

(w/ improved stove distril

MYAGDI DISTRICT

SOUTH EAST CONSORTIUM FOR INTERNATIONAL DEVELOPMENT
RESOURCE CONSERVATION & UTILIZATION PROJECT



LEGEND

- District Boundary
- Panchayat Boundary
- District Headquarters
- Nursery, Plantation
- Panchayat Forest, PPF
- Irrigation, Drinking Water
- Mini. Hydro
- Support Building
- " Improved Cookstoves

MAP II _ FIGURE B

MYAGDI DISTRICT

(w/ improved stove distrib)

MUSTANG DISTRICT

SOUTH EAST CONSORTIUM FOR INTERNATIONAL DEVELOPMENT.

RESOURCE CONSERVATION & UTILIZATION PROJECT.

MAP III _ FIGURE C

MUSTANG DISTRICT

(w/ improved stove distrib)

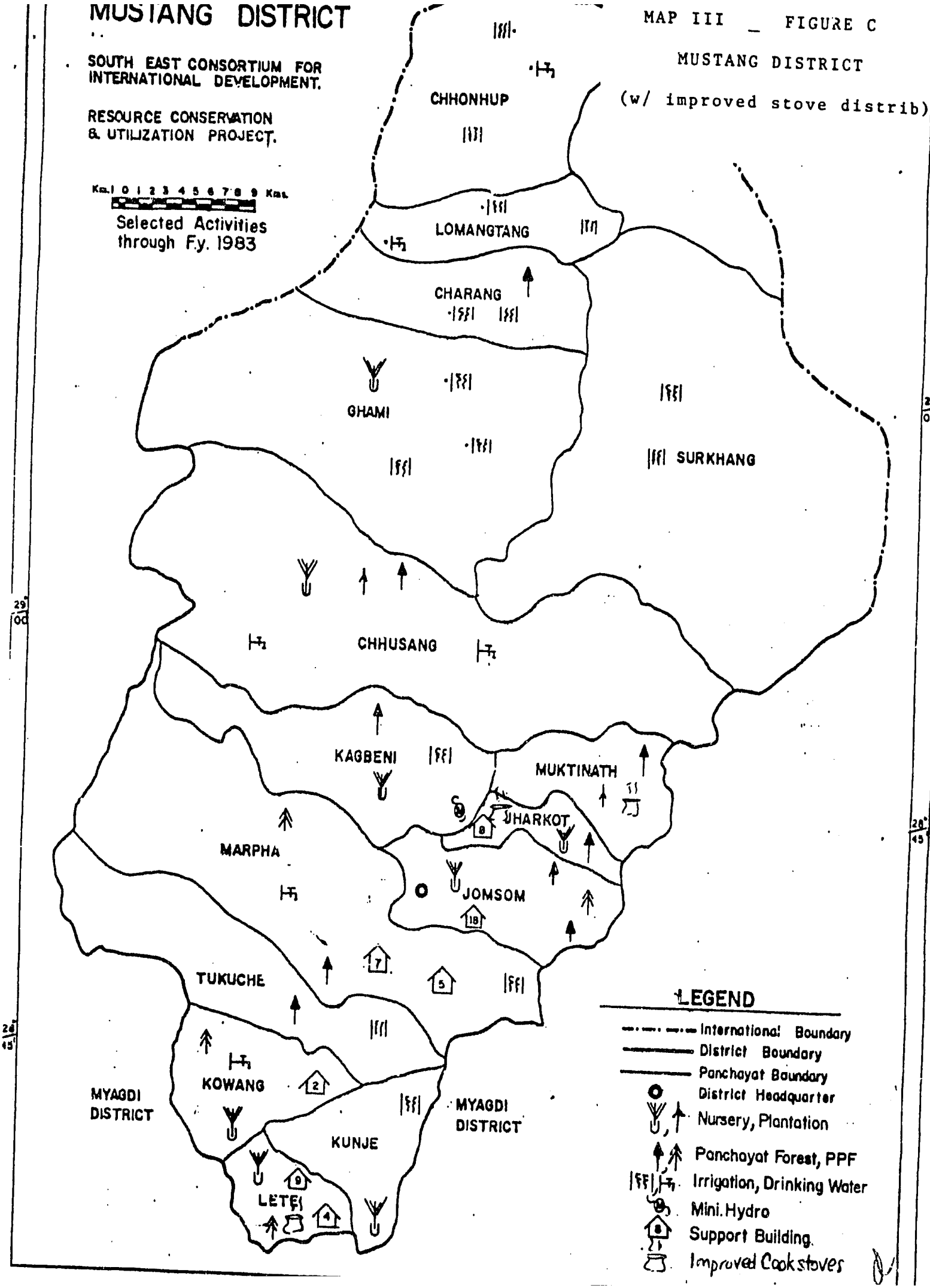


FIGURE D

Traditional No-flue
Tripod Agena

Photo by Don Messerschmidt

FIGURE E

Traditional No-flue
Mud Chulo

Photo by Gyani Shakya
Gorkha District

FIGURE F

Improved Magan Chulo
with a Flue

Myagdi District
Photo by H. Reid

FIGURE G

Improved Magan Chulo
with a Flue

Gorkha District
Photo by G. Shakya

Table I

Distribution of RCUP Improved Stoves

	Installations (as of)					
	FY 81	FY 82	FY 83	FY 84		
				6/84	9/84	Target
Stove Type	In-situ Built	Double-wall	Double-wall	UNICEF Magan Single-wall		
District						
Gorkha	140	74	130	98	150	300
Myagdi	7	20	68	74	74	74
Mustang	7	3	9	--	--	26
TOTAL	154	97	207	174	224	400

(Byers, 1981)

RCUP's third district, Mustang, demands an entirely different cookstove design due to its Tibetan cultural influence and cooler climate. The UNICEF cookstove does not radiate the heat that is needed by households in this region. For this reason, the RCUP cookstove program is neither well defined nor active in Mustang. Stove installers have found little success with the pre-fabricated ceramic frames, (designed to fit the needs of their warmer, southern neighbors), and are currently experimenting with new materials. For example, cast iron rings permit the use of different sized pots and corrigated tin sheets allow more radiation of heat from the firebox and flue during the cooking period (see Map III - Figure C).

To minimize variability, this project evaluates only one type of improved cookstove: the UNICEF single wall magan chulo. Therefore, sampling sites were restricted to the Gorkha and Myagdi districts. The fledgling Mustang cookstove program is evaluated only briefly due to the few observations conducted during an abbreviated field visit to this region (see Section IV).

Three evaluations of RCUP's cookstove program were conducted prior to introducing the magan chulo to the Gorkha district: July, 1983 by K. Roesing (60 households); February, 1983 by H.M. Shrestha (50 households); and December, 1982 by D.N. Koirala (60 households). All evaluations employed a portion, or all, of a 46-item questionnaire developed by the Community Forestry Afforestation Division (CFAD), FAO. Only one quantitative sampling, a fuel-efficiency test, was attempted in the field by S.K. Acharya in 1983. Unfortunately, the equipment employed for the Water Boiling Test (a standard test of fuel efficiency established by the Volunteers in Technical Assistance (VITA)) proved

inaccurate. Although systematic field testing of the actual fuel efficiency of many designs of improved stoves have been completed by development organizations other than RCUP, the UNICEF magan chulo has been omitted (Campbell, 1984b). In order to prove this design's efficiency compatibility with other improved stoves, cookstove reseachers argue that the UNICEF model is still in need of field testing. This study did not conduct fuel efficiency measurements of the UNICEF magan in the field, and therefore, assumes that its efficiency relates closely with cookstoves of similar design, (see Table II). Advocates of improved stoves say they can achieve an overall efficiency of between 20 and 30 percent (Islam, et al., 1984).

Table II

Field Tests of Cookstove Efficiences

Stove Type	To Boil 2 Liters H2O	Efficiency
Double Wall	12 - 17 min.	25 - 29 %
Insert	14 - 18	18 - 26
Traditional	13 - 25	15 - 22

(RECAST, 1982) and (Bhattarai, 1983)

RCUP's method for distributing the single wall magan began with RCUP's Energy Specialist identifying the panchayats with the greatest fuel scarcity. The two district headquarters presented prime targets because of high population density, taxed forests, and ease of access. At first, the improved stoves did not meet with great consumer demand. In Gorkha stove installers had to recruit recipients with slide shows and exhibitions. Later, advertising by word-of-mouth caught on until today, the stove installation cannot keep up with the demand. In Gorkha and Myagdi there is an applicant waiting list. Households apply for the stove at RCUP headquarters, and are later interviewed in their homes to match the compatability of their family size and the intended uses of the new stove with new stove limitations. This screening process directly influences stove acceptance rates by encouraging stove distribution to more appropriate households.

RCUP stove recipients are not required to pay for stove materials. They are, however, responsible for transporting stove materials to their homes and for assisting RCUP's stove technician with mud, bricks, and labor during installation.

For Gorkha District, the magan chulo is pre-fabricated by potters in the Kathmandu Valley and transported by truck to Gorkha district headquarters in Gorkha Bazaar. Gorkha's energy specialist and stove technician report that 10 percent of ceramic

stove parts are broken upon arrival due to poor packing (Shrestha, H.M., 1984).

For the Myagdi District, the magan ceramic set is made by potters in the same District, and are transported by porter to district headquarters in Beni for distribution (see Figure H).

B. Sampling Conditions

Household visits for this evaluation were conducted during the month of September in Gorkha, October in Mustang, and November in Myagdi. Because Nepal has distinctly separate and characteristic seasons, it is necessary to point out how the time of sampling affected results. The summer monsoon season runs approximately from May to August; the winter monsoon, December to January; and the spring windy season, February to April. All of these field tests were conducted during the autumn when conditions were said to be the driest and least windy of the year. This means that wood moisture content, and the associated smoke production, were at their lowest annual levels. With the improved cookstoves, lower wind conditions contribute to good ventilation as smoke is not forced back down flues, a reportedly common occurrence during the strong winds of spring. On the other hand, very low wind conditions can cause higher pollution levels when stagnant non-circulating does not draw smoke out from windows and doors to ventilate the cooking area. In the opinion of most participant cooks, this study's indoor air pollution measurements should reflect the best (or least suffocating) cooking environments that Nepali women experience during the year.

Due to RCUP's relatively recent introduction of the magan chulo (January, 1984), this study's choice of household participation was limited to two central locations. Until September 1984, RCUP installed most of its stoves in the two district headquarters of Gorkha and Beni. Both are large bazaars on major trading/trekking routes, affording RCUP an opportunity to monitor the status of many new stoves within easy access. Both bazaars have been influenced by the influx of modern conveniences, including a less traditional architectural style. Selection of households without prior reconnaisance sometimes resulted in the sampling of more "modern" homes with very high ceilings, large windows and tin roofs. Most Nepalese live in traditional rural homes, that are characterized by very small windows and doors, thatched roofs and low ceilings. For air pollution monitoring, the height of ceilings directly affected ventilation and the amount of smoke in the cook's breathing zone. Exposure to traditional, flue-less stoves in a "modern" house would likely be lower than a cook's normal exposure to smoke from the same stove in a traditional low-ceiling, almost window-less rural village home. In the opinion of the surveyors, monitoring these non-traditional homes, therefore, placed a conservative bias on traditional stove exposure results.

FIGURE H

Potter Making an
Improved Cookstove's Flue

Myagdi District
Photo by G. Shakya

C. Household Selection

Household selection was not based on random sampling due to the recent date of stove installations, access inconveniences, and the influence of recent changes in home design. Critics of past cookstove evaluations have noted the short period of cookstove use between installation and evaluation. To avoid examining the performance of very young stoves, this study limited household selection to those homes with the earliest installations, i.e. before June of 1984. The average age of improved stoves sampled was 5.7 months. In Gorkha this criterion decreased the potential number of participants to 98 (see Table I). A few households were rejected because of distance, or non-traditional home design. (Home design became a more important factor in household selection as more household visits revealed the difference between "modern" and traditional architecture. Hence, both types of architecture are included in the study, although the non-traditional influence was discouraged as selection progressed).

The primary consideration for household selection was to establish an equal representation of households of high, medium, and low economic status. Caste status was originally planned to be an indicator of economic status, however, it was soon recognized that one did not necessarily reflect the other. In order to include a wide cross-section of participants, RCUP stove installers instead helped to cross-identify households by both criteria. Using the technician's unwritten definitions: "high economic" status indicated households with surplus food, surplus land, and many livestock; "medium" meant just sufficient food, land to produce the food, and one or several water buffalo; "low" meant insufficient food, no land, and usually no livestock. "High caste" status included Brahman, Chetri, and Thakuri; "medium" included Newari, Thakali, and Magar; "low" included the Untouchables and/or all those of occupational employment such as blacksmiths, tailors, and musicians. Once designated, households were distributed into a three by three matrix of caste and economic distinction (see Table III). Actual selection of households from these matrices occurred one day prior to sampling. The same methodology was also used for households with traditional stoves.

Table III

Household Selection
Matrix of Equal Representation

		Economic Status			
		High	Medium	Low	Total
Caste Status	High	3	1 or 2	-----	5
	Medium	1	3	1	5
	Low	-----	1 or 2	3	5
		Total no. of households randomly selected from the matrix to represent one stove type			15

As of September 1984, many improved stoves in Gorkha had been distributed, but not installed. These homes, that had been given stoves parts but awaited installation, were ideal candidates for traditional stove tests because they were already participants in the RCUP cookstove program, and were, therefore, approachable. In Myagdi, on the other hand, all improved stoves distributed were also installed, which necessitated the participation of old stove households not already affiliated with RCUP.

Nepali women cook two main meals each day, at approximately 9 am and 6 pm. For this reason, two 1 1/2- to 2-hour sampling sessions were planned for each day. Households were selected randomly from the caste/status matrices, and visited one day prior to testing. The RCUP stove installer, interpreter, and Technical Assistant visited the cooks to gain their trust, to determine their desire to participate, and to set up the next day's time of return. In the two cases where a household declined to participate, for religious reasons or inconvenience, another household on the matrix was chosen and visited in turn. In this manner 35 households, 20 with new stoves and 15 with old stoves, were sampled in Gorkha. Thirty-one households were sampled in Myagdi, 15 with new stoves and 16 with old stoves. Only four stoves, those of caste iron ring and metal construction, were sampled in Mustang.

D. Selection Limitation

The greatest difficulty during selection was finding enough low economic and caste status households with improved stoves to sample. In Gorkha, only three households of low economic status had improved stoves installed by RCUP as of September 1984. Initially, there was concern that RCUP was showing a serious lack of consciousness for the needs of the most destitute. RCUP stove technicians, however, have described specific reasons for the improved stoves' failure to fit into the traditional low-income lifestyle. They explained that the poorest of Nepal scavenge for firewood. They do not buy firewood at the bazaar as do the other castes and, therefore, do not have an incentive to save cash by decreasing their fuel consumption. On the other hand, fuel efficiency is the highest stated priority of the poor who did want the new stove (see Section III). These few respondents wanted to change their long-held tradition of old stove-use in order to save time; the time that is lost scavenging for fuel at greater and greater distances each year. Based on these considerations, then, new stove dissemination among lower income groups may be partially hampered because overall improved stove promotion emphasizes monetary savings from fewer fuel purchases, more than time savings from less frequent fuel collections. Futhermore, critics argue that some improved stoves are not necessarily fuel efficient with scavenged fuel (small twigs, dung, and crop residues), the fuel of the poor. They are usually designed for wood combustion (Tinker, 1985).

The majority of Nepal's poor use the least efficient of cookstoves, the tripod pot support, or agena. Introducing a mud-enclosed firebox and flue into their lives demands that the women learn a completely new way of cooking. In addition, the poor usually have large families, while the improved stoves are specifically designed for limited family size. Large pots and large quantities of food are inefficiently heated and allow smoke to escape between the pots and pot mouths.

Although there are impediments for improved stove promotion with poorer Nepalese, RCUP has achieved progress in the adoption of the new stove in their ranks. Poor Nepalese who have dared to try an improved stove (a sometimes large deviation from a dictated low caste lifestyle) first note the large reducton in their fuel needs. In the case of one low-income home, the change from an open to an enclosed fire decreased fuel use, and therefore, scavenging time, by 80 percent (Shrestha, D. M., 1984).

Of secondary importance, new stoves symbolize a higher standard of living and a cleaner, more attractive living environment for those of low income and low castes. Regardless, a change in cooking style seems to affect most profoundly those who can afford the least experimentation in their lives.

II. QUANTITATIVE SAMPLING

"When too windy outside with wet wood and smoke inside, would like to stay hungry rather than cook."

Shariya Prakash Baniya, Beni, Myagdi
(Owner of a traditional stove)

"In developing nations, exposure to smoke from biomass fuels is probably the single most important occupational health hazard of women."

(De Koning, Smith, and Last, 1984)

A. Domestic Air Pollution

Air pollution sampling took a giant leap forward with the introduction of personal air monitoring equipment. Air sampling is "personal" when the subject wears the equipment. Portability means that measurements reflect a person's exposure to a pollutant much more accurately than measurements from a stationary, middle-of-the-room air sampler. Therefore, personal air monitors sample the air in the subjects ever-changing breathing zone. This enables analysts to quantify the harmful particulates suspended at the nose and mouth of the respiratory system, rather than waiting to examine the lungs of the victims of respiratory disease.

Indoor pollution measurements are just beginning to gain popularity in more developed countries (MDCs), where gas/wood stove, furniture, and insulation emissions often exceed allowable standards set by government health protection agencies. Unfortunately, very little attention has been directed towards much greater pollutant levels in rural village homes in lesser developed countries (LDCs), where one-half of the world's households are cooking two to three times daily with biomass fuels: wood, crop residues, or dung (Smith, 1986).

This is the first study in Nepal in which personal air monitoring equipment was used. The purpose of the air monitoring was to document Nepali women's exposure to pollutants produced from the combustion of biomass fuels. More specifically, the data were used to compare the difference in pollutant levels between indoor cooking environments with traditional, no-flue cookstoves and those with improved cookstoves with flues.

In Nepal, it is suspected that womens' exposures to smoke are exceptionally high because they cook in confined kitchen environments, under low ceilings, with few windows, and at high altitudes.

B. Sampling Procedure

Smoke consists of the products of incomplete fuel combustion in the form of suspended particulates, droplets, and gases. In wood smoke, for example, several hundred compounds have been identified, several dozen of which are known to be toxic in one way or another. In this study, five types of sampling tests were performed to monitor some of the more harmful constituents of smoke which are produced during the combustion of biomass fuels, including suspended particulates, carbon monoxide, nitrogen dioxide, formaldehyde, and benzo[a]pyrene. All equipment (see Equipment List, Appendix A) and training for smoke sampling was provided by Dr. Kirk R. Smith, coordinator of the Biomass Fuels and Development Project of the East-West Center in Hawaii and his associates. The following paragraphs briefly describe the method used for each of the separate smoke sampling tests.

As mentioned earlier, personal air sampling measures the cook's exposure to Total Suspended Particulates (TSP) in the breathing zone because it is portable (see Figure I). The battery pack/air pump is clipped to the hip and a plastic tube runs from the pump to the shoulder where the cassette containing the filter is located. The pump simply draws in air through the filter and collects particles down to 0.1 microns. (TSP includes particulates as large as 15 microns in diameter. However, it is the smallest particle sizes that pass the nose and mouth and cause respiratory problems. Because nearly all material in wood smoke is less than three microns in diameter (Smith and Apte, et al. 1984), then essentially all may be considered to be RSP (Respirable Suspended Particulates), or able to penetrate to the deep lung.) The pump indicates the rate of air flow in liters per minute, which is multiplied by minutes sampled and particulate weight to yield quantity per volume. To insure consistency of flow rate, the air pump was periodically calibrated with a bubble meter and timer.

The second type of data collection employed a carbon monoxide (CO) continuous diffusion monitor. This CO monitor was originally intended for use in industrial, occupational settings where it was attached to the worker's hip belt. The monitor has an electrochemical cell that senses the presence of carbon monoxide, and instantaneously displays the amount, in parts per million, on a small digital panel display. The monitor has a built-in alarm, usually set at 50 ppm, which sounds when the worker is in an area of high concentration. For our purposes, the alarm (a beeping signal) was set at the highest possible limit, 197 ppm, and the second signal (continuous alarm) at 500 ppm, because very high CO levels were expected.

The CO monitor was designed to be worn at hip height on a belt. However, both because nose and mouth height was the correct sampling zone for this study and because the cooks were already inconvenienced by the particulate air sampler, the CO

FIGURE I

Myagdi Woman Wears a
Personal Air Sampler
While Preparing the
Evening Meal

Photo by Gerry Richards

FIGURE J

Sampling a Cook's Exposure
to Particulates and
Carbon Monoxide

Gorkha District
Photo by G. Shakya

monitor was placed in a stationary spot on a box or shelf at the cook's head height at the cookstove (see Figure J). Most cooks squatted on the floor in front of their cookstove, so the monitor was positioned between two and three feet from the floor and within a three-foot horizontal distance from the cook's most common squatting position at the stove.

Because instantaneous concentrations in such conditions vary dramatically from one minute to the next, the CO monitor was modified to permit an averaging of the instantaneous readings over the total sampling period. The monitor held a gold memory cell that periodically recorded instantaneous readings during the hour of testing. After sampling was completed, an accessory instrument, called a dosimeter, read what was stored on the cell, and calculated the time weighted average in ppm's-hrs. A small tank of carbon monoxide, in the form of certified 190 ppm span gas, was carried to the field in order to calibrate the monitor on a weekly basis.

The nitrogen dioxide (NO2) and formaldehyde (HCHO) monitors consisted of chemically impregnated filters designed to be passively exposed to the air. Unlike the particulate and CO monitors discussed above, these passive monitors require no pumps, batteries, or electronics. These passive monitors were kindly supplied by Air Quality Research Labs in California and were designed principally for NO2 and HCHO detection in MDC homes where principal sources would be gas stoves and insulation respectively. They had not been previously used to sample smoke from cooking fires in rural LDC homes. With the previous active monitors, only one hour of the cooking period was sampled. The passive NO2 and HCHO monitors, however, were placed in homes for a one- or two-week duration to measure a family's total exposure. Thus, these monitors average cooking and non-cooking periods together.

The filters, located at the bottom of small glass test tubes, were hung from wood beam rafters at standing height in both cooking and sleeping areas. Although the sample size was small (n=36, total; n=18, NO2; n=18, HCHO; plus further subdivisions), the results gave a useful indication of differences in NO2 and HCHO exposures between old and new cookstoves, and between cooking and sleeping areas.

The fifth and final test involved a chemical analysis of the air sampling filters for quantification of a polycyclic aromatic hydrocarbon called benzo[a]pyrene (BaP). BaP is a cancer-causing substance found in the tar of cigarette tobacco, and is also a product of the combustion of other biomass fuels. The analysis (gas chromatography) was conducted by Prema Menom, a doctoral student at the Biomass Fuels and Development Project at the East-West Center in Honolulu, Hawaii.

C. Sampling Results

Table IV compares sampling results of the improved stove with those of two types of traditional stoves (the mud chulo and agena) as compared to different national exposure standards. The TSP and CO results are compared to one-hour public safety standards because the sampling time was for only one hour of cooking period. The one-hour standard is logically higher than longer-term standards, because it reflects a human's capacity for safe exposure to a higher concentration for a very short period of time.

This comparison is misleading, however, because Nepali women are not exposed to these pollutants for only one hour, but an average of 5 hours every day. One could argue that the preparation of food consumes so many hours each day that a Nepali woman nearly spends an entire "work day" by the stove. This reasoning suggests that it makes more sense to compare TSP and CO exposures to 8-hour occupational safety standards (which are much higher than one hour public, or ambient, exposures because higher risks are known to be part of the job). For example, the United States Environmental Protection Agency's air quality standard for exposure to particulate matter during an 8-hour work day is 5,000 ug/m3. This study's results would then indicate that a Nepali cook's exposure to improved stove emissions are 4.4 times less than these occupational standards prescribed for workers exposed to TSP in MDCs. Exposure to traditional stove emissions, however, would bear a dangerously close resemblance to this high occupational limit of only 1.6 times less.

On the other hand, the NO2 and HCHO results are compared to longer term standards because the sampling time was longer (one or two weeks). Long-term standards are lower because they reflect a person's total exposure averaged over all cooking and non-cooking hours. To demonstrate the spatial differences and possible exposure of other family members to pollutants, NO2 and HCHO results are also subdivided between cooking (k) and sleeping (b) area exposures.

The BaP results are only compared to a proposed USSR standard here because no other countries have even suggested allowable exposures to this carcinogen.

Table IV

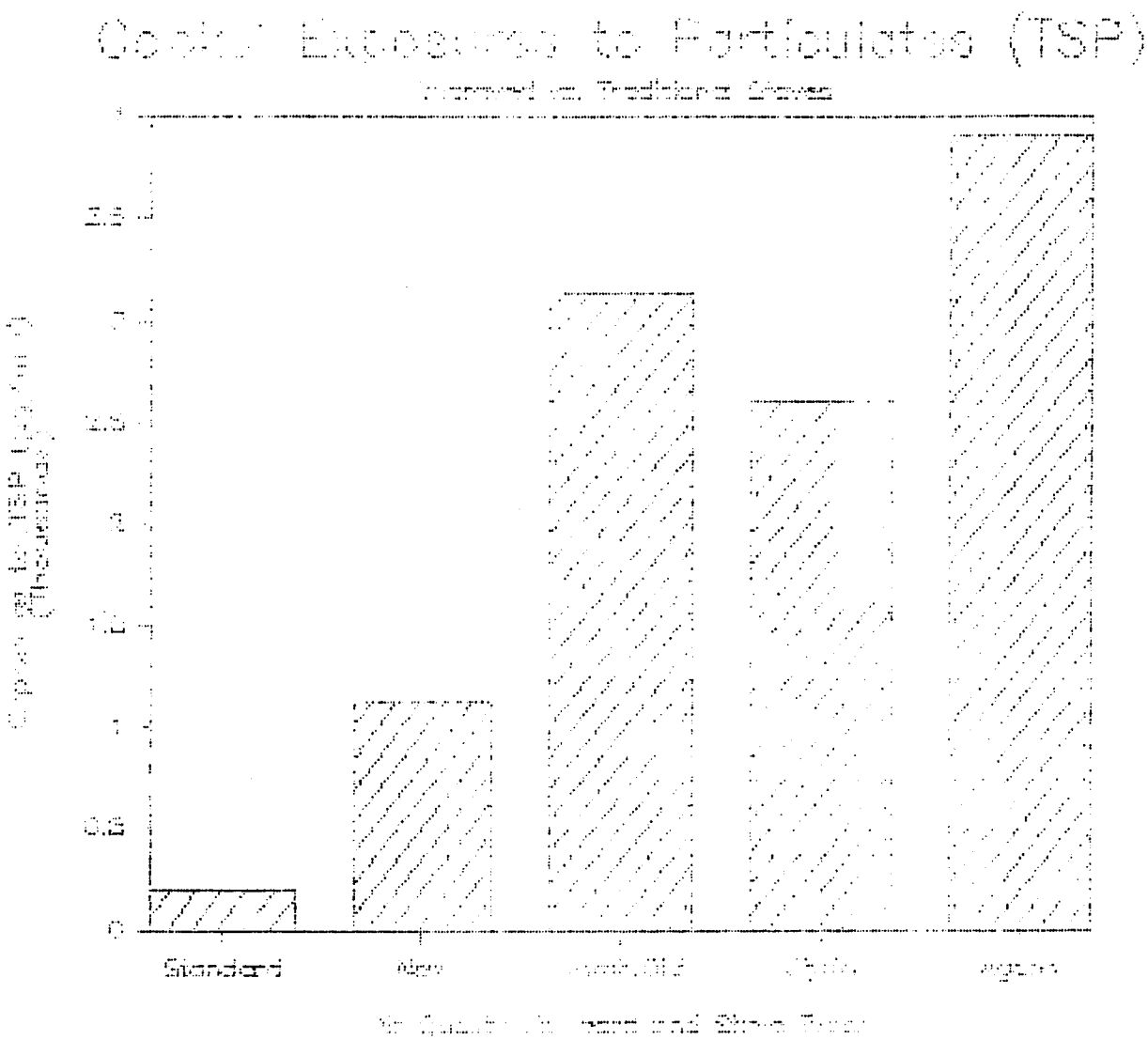
Pollutant Exposures of Nepali Women Using Improved versus Traditional Cookstoves

P = P-test for comparison of the means (improved versus combined cookstoves)
n = sample size
x = mean
s = standard deviation
cov = covariance
k = kitchen (cooking area)
b = bedroom (sleeping area)

POLLUTANT	STANDARD (country, averaging time)	IMPROVED	TRADITIONAL MUD CHULO	TRADITIONAL AGENA	COMB.TRAD	P
TSP (ug/m3)						
n		27	13	9	22	
x	200	1130	2610	3915	3140	<0.5%
s	(Japanese-	690	2930	1930	2650	
cov	one hour)	0.61	1.12	0.49	0.84	
CO (ppm)						
n		26	15	12	27	
x	35	65	240	375	300	<0.5%
s	(USEPA-	111	193	179	199	
cov	one hour)	1.7	0.81	0.48	0.67	
NO2 (ppm)						
		Improved (k)	Improved (b)	Combined (k)	Trad. (b)	(k)
n		5	4	5	4	
x	0.05	0.04	0.04	0.26	0.02	<2.5%
s	(USEPA-	0.03	0.03	0.13	0.01	
cov	one year)	0.75	0.75	0.50	0.50	
HCHO (ppm)						
n		5	4	5	4	
x	0.1	0.20	0.13	0.33	0.03	>20%
s	(Canada-	0.17	0.16	0.16	0.03	
cov	one week)	0.85	1.23	0.48	1.00	
BaP (ng/m3)						
n		4		5		
x	0.1	454		393		>50%
s	(USSR-	466		171		
cov	proposed annual)	1.0		0.4		

GRAPH - FIGURE K

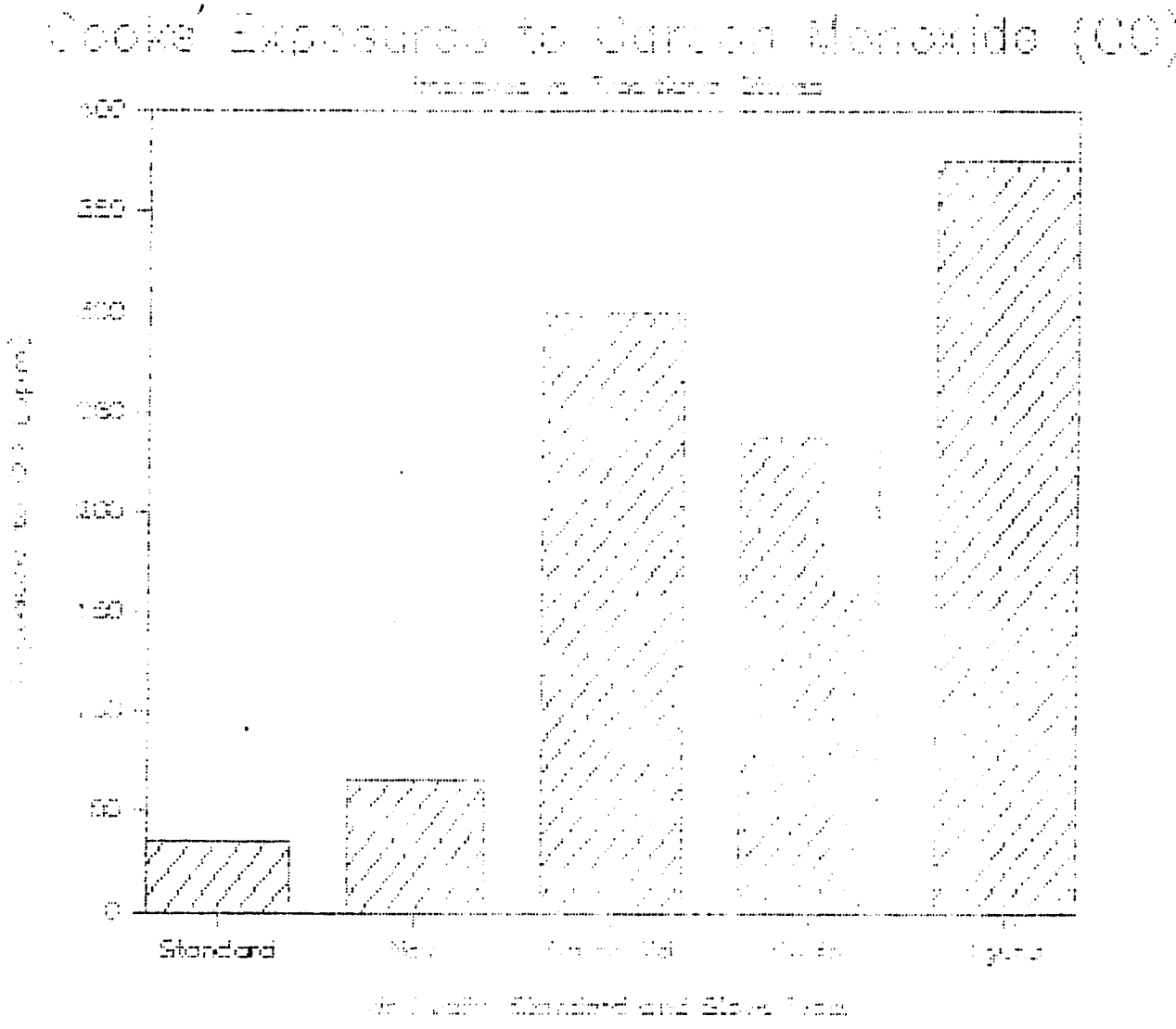
Nepali Cooks' Exposures
to Particulates
compared to an
Air Quality Standard



Best Available Document

GRAPH - FIGURE L

Nepali Cooks' Exposures to Carbon Monoxide compared to an Air Quality Standard



Best Available Document

The total suspended particulate (TSP) results demonstrate the large difference between the smoke emitted indoors from improved and old stoves (see Figure K). In this case a flue is effective in eliminating approximately two-thirds of the smoke from the indoor environment, from a particulate concentration of 3,140 ug/m3 to 1,130 ug/m3. Using a Japanese safety standard for acceptable exposure to TSP for a one hour period of 200 ug/m3, we see that even the improved stove results are 5.6 times greater than this allowable level. However, the old stove results exceed the improved stove emissions by a factor of three, or 16 times greater than the allowable levels.

It is important to differentiate between two types of traditional stoves, the mud chulo and the tripod agena. Because of their designs, TSP measurements are significantly different between them. Mud chulo TSP quantities averaged 2,600 ug/m3. The tripod agena produced the highest monitoring of TSP in all sampled households, averaging 3,900 ug/m3, or almost 20 times higher than the Japanese one-hour standard. The tripod agena proved itself as the most inefficient method of burning fuel in Nepal, ie. emitting the most amount of uncombusted particulate matter into the cooking environment.

Carbon monoxide results were hampered somewhat at exceptionally high concentrations of smoke. At lower concentrations of 0 to 200 ppm, occasional observations of the instantaneous display coincided well with the average readout from the dosimeter. However, at high levels when the alarm was sounding, observations of the displayed readings during the test were considerably lower (approximately 500 ppm) than the dosimeter's post-average (up to 7,500 ppm). Interference of other gases has been dismissed as a possible reason for the high averages because the gases that are known to affect the CO's electrochemical cell's plating of the memory cell cannot be not present when biomass fuels are combusted (Islam, 1985). To adjust for this occurrence, all dosimeter readings over 500 ppm were decreased to that amount. The adjustment only affects old stove measurements and is a very conservative procedure designed to take into account the inconsistent readings above 500 ppm. The result is that the reported CO concentrations for old stoves are lower than the true values.

Improved cookstove flues performed well in venting carbon monoxide (see Figure L). Exposures averged at 65 ppm, or only 2 times more than WHO's standard for one hour, and 7.5 times their standard for 8 hours. Even after adjustment, old stove CO readings <u>still</u> averaged at 300 ppm, or 8.5 times and 33 times the one and eight hour WHO standards respectively. Distinguishing between traditional stove types, CO measurements resulting from exposure to cooking with the tripod agena were higher than the mud chulo. The agena exposure levels averaged at a dangerously high

level of 375 ppm, and the mud chulo, slightly lower but still of great concern, at 240 ppm. The open fire, tripod style of cooking maintains its distinction as the most inefficient burning and efficient polluting style of cooking with the highest concentrations of carbon monoxide and particulate matter emitted into the cook's breathing zone.

Nitrogen dioxide and formaldehyde tests also indicated a difference in exposures to traditional and improved cookstove use. Overall, a statistical comparison of the means demonstrates that the difference between the cooks' mean exposures to NO2 produced from new and old stoves is greater (probability (P) of less than 2.5%) than their mean exposure differences to HCHO between the two stove types ($P > 20.0\%$). In other words, there is greater statistical confidence that cooks are exposed to higher levels of NO2 rather than higher levels of HCHO when comparing the use of traditional stoves to that of improved stoves. Nevertheless, both tests show significant improvements in exposure reduction with the new stove.

As mentioned previously, NO2 and HCHO sampling was conducted for longer periods (one or two weeks) than that of CO or TSP (one hour during meal preparation). For this reason, results reflect the cooks' overall exposure to these pollutants, including periods of zero pollution production when cookstoves were not in use (assuming there were no other sources of the pollutants). These data are compared to long-term standards which are set for public, not occupational, settings. For example, NO2 results are compared to an annual USEPA standard of 0.05 ppm. Cooks' exposures to the NO2 produced by traditional cookstoves exceeded these standards, whereas results with the improved stove did not. HCHO results, in turn, were compared to a Canadian standard of 0.1 ppm. In this case, both new and old stove results exceeded this standard, the old stove by a greater factor (3X) than the new (2X).

In addition to sampling in the cooking area, NO2 and HCHO tests were also conducted in sleeping areas. A hypothesis is that smoke rises through stairwells and gets trapped on the second floor to add a second area of exposure for Nepalese retiring soon after their evening meals. As expected the cooking area exposures,

0.04 ppm	(new stove, NO2 exposure)
0.26	(old,NO2)
0.20	(new, HCHO)
0.33	(old,HCHO)

exceeded sleeping area exposures,

0.04	(new stove, NO2 exposure)
0.02	(old, NO2)
0.13	(new, HCHO)
0.03	(old, HCHO).

However, none of the tests of sleeping areas exceeded the long-term standards set for safe exposure. Sleeping areas of homes with old stoves averaged lower quantities of the two gases than the same areas in new stove homes. This may mean that smoke is effectively vented from the first floor indoor cooking area by the flues, but is re-entering in second floor windows to contaminate the bedroom area. This observation was noted by a few cooks whose second floor had open windows at both ends to encourage a cross-draft. In general, Nepalese family members sleep on both ground and upper floors. It is, therefore, important to consider the impact of pollutants on the not only the cook, but on other family members as well.

Benzo[a]pyrene (BaP) analysis of the TSP filters was only completed with nine households. The four homes with the new stoves averaged slightly higher (454 ng/m3) than the five homes with the old stoves (393 ng/m3). New stove results are unreliable: a high standard deviation (466 ppm) includes two data points of zero and two high readings of 760 and 1,056 (the highest of which can be attributed to the smallest (4 m3) cooking area sampled). Overall, however, it is important to recognize that all of the results are high, about 4,000 times the proposed annual standard set by the USSR of 0.1 ng/m3. These indications call for more data collection in this area. Fortunately, the recent introduction of BaP personal monitors, in the form of badges easily worn on the cook's shirt, will make information gathering more exact.

D. Flue and Pot Fit Micro-experiments

In two tests with improved stoves, sampling was repeated during a second cooking period because ventilation performance of the flue seemed exceptionally poor. This presented a perfect opportunity to a do a micro-experiment with two "before and after" tests.

In the first case, a woman in the town of Bansbot, Myagdi complained that we had come at the wrong time, harvest time, when she had to feed more than her own family members. For the month of November she was compelled to use extra large rice containers which were not the pots for which the stove was designed. This situation resulted in much smoke escaping between the large pot and the smaller, supportive pot-mouths.

Limited pot use is a commonly heard complaint of the improved stoves. It is a limitation that must be well advertised before stove dissemination. In this case the cook did not mind the inconvenience during one part of the year, because the greatly improved ventilation for most of the year was well worth the trade-off. We tested while she used the ill-fitting pots: TSP = 4,908 ug/m3 and CO = 500 ppm. The next morning we repeated

the test, asking the cook to use her normal pots (the same used to mold pot-mouth size during installation) and the difference in the amount of smoke in the cooking area was remarkable: TSP = 1,100 ug/m3 and CO = 30.6 ppm. Poor pot fit accounted for 4.4 times the amount of particulates and 16 times the carbon monoxide trapped indoors.

A second opportunity for before and after sampling occurred in Gorkha where a woman and her daughter admitted to never having cleaned the flue of their improved stove since its installation six months previously. During the first evening that we tested, the smoke noticeably backed down the flue and we recorded a TSP measurement of 1,740 ug/m3 and a CO measurement of 500 ppm. On the following day the RCUP Energy Specialist, Gyani Shakya, helped the cooks remove 1.5 liters of soot from their flue. That evening we returned to do an after test, but unfortunately, our air pump's battery discharged and a follow-up TSP measurement was not completed. The after test for CO, however, showed a nine times reduction of the household's exposure to the harmful gas, at 56.1 ppm.

This second example demonstrates the importance of the responsibility for maintenance of the improved stove's flue. Flue cleaning is another voiced disadvantage of the new stove. This is in part due to the new stove flue being a completely alien technology for rural Nepali homes, and therefore, a completely alien responsibility. Understandably, flue disassembling takes a little practice. In this case the mother and daughter were still convinced of the new stove's advantages, even when the flue was clogged. They well represented a majority of cooks who claimed that they had forgotten, did not understand, or were never taught how to clear soot from the flue. Because the stoves are installed by technicians, RCUP's social scientist postulates that the cooks also expect the technicians to return to maintain the stove by periodically cleaning the flue (Pandey, 1985).

E. Two Smoke Sources Micro-Experiment

During six smoke sampling tests, the cook employed a second cookstove. In every case a tripod agena was the second type of stove brought into use, either for making alcohol, tea, livestock feed, or to help ignite the main cookstove fire. The second fires were in use for approximately 30 minutes, or half of the sampling period. The use of both an improved and traditional tripod cookstove (n = 3) resulted in TSP measurements of 1,510 ug/m3 and CO measurements of 183 ppm. The use of two types of traditional stoves (n = 3), a mud chulo and a tripod agena, produced the expected higher results of TSP of 3,910 ug/m3 and CO of 447 ppm.

As was mentioned earlier, two-source exposure is not an unusual situation in Nepali homes. Many households with domesti-

cated livestock and/or alcohol producing practices regularly use a second stove because improved stoves cannot support or heat the larger pots needed for cooking large quantities of feed, food, or brue. In fact second sources of smoke, especially from large fires for large duties, may contribute more emissions to the cooking area than worse-case agena cookstoves. More attention must be directed toward distinguishing between cookstove emissions depending upon the number of sources, such as the auxillary use of agenas for warmth as a major and continuous source of smoke during colder, winter months.

F. AM/PM Cooking Period Distinctions

Pollutant measurements for TSP and CO were subdivided into morning and evening cooking periods in order to determine possible influence of outside conditions. The following table displays the obvious differences between the two times of day. All mean evening exposures exceed mean morning exposures.

Table V

Differences in AM/PM Exposures

	MORNING			EVENING		
TSP (ug/m3)	mean	std. dev.	sample	mean	std. dev.	sample
new	1,110	580	14	1,410	1,190	15
old	1,580	1,680	15	3,490	3,190	13
all stoves	1,470	1,400	35	2,380	2,430	32
CO (ppm)						
new	36	22	14	168	203	13
old	286	212	14	313	183	13
all stoves	173	193	34	230	209	31

A discrepancy between morning and evening particulate exposures was also reported in a 1981 study in India by Smith, Aggarwal, and Dave (1983). This study concluded that ground-level inversions and calm air affect Indian villages in the evening and probably caused decreased air flow through homes. The same reasoning is also likely behind the consistently higher exposure levels found in the evenings for this study. Knowing that Nepalese cooks use the same fuel and same food for morning and evening meals, then local valley inversions (rapidly cooling, evening air trapping ground level firesmoke and preventing it from rising) would be the most logical contributors to this consistently recorded occurrance.

G. Health Implications

"I believe the smoke is really bad for my health. It is the root of all my sickness."

R.K. Shahi, Rakhu Piple, Myagdi

"The most prevalent disease I've seen among the cooking people are asthma, coughing, eye pains, eye weakness, and sight diminishing early. And many complain of severe headaches."

B.P. Regmi, Beni Bazaar, Myagdi

"Links between wood burning and respiratory and eye diseases are clear to any rural cook, but have not been scientifically established."

(Cecelski, 1984)

Few studies have been conducted in LDCs on health problems associated with heavy exposures to indoor air pollutants. Particulates, carbon monoxide, formaldehyde, nitrogen dioxide, and benzo[a]pyrene have been examined from the perspective of MDCs: urban outdoor exposure and exposures of men in occupational settings. These latter studies have been used to set national standards for allowable exposure to air pollutants in MDCs. Ironically, there are no air pollution standards to protect the health of half of the world's households who cook with biomass fuels, and are, therefore, chronically exposed to high levels of indoor air pollutants.

This study provides information about Nepali cooks' exposures to air pollutants along with their perceptions of the health problems associated with that exposure. Unfortunately, lung and eye disorders were not diagnosed during this study for want of a qualified rural health doctor. Although a direct correlation between health problems and smoke exposure cannot yet be established quantitatively, interviewee perceptions of smoke-related ailments are a useful contribution. Table VI describes the symptoms commonly cited by the cooks during this study as being attributable to daily exposure to the smoke produced from their cookstoves.

Table VI

Symptoms of Smoke Exposure

Respiratory Problems	Eye Problems
-chest pains	-constant tearing
-coughing up black mucous	-headaches from eye pains
-difficulty breathing	-mucous formation on eye lids
-asthma	-eyes itch
-general lethargy	-squinting/reddening of eyes
-prone to catch colds and sore throats	-poor eyesight
-exhaustion	-drying of eyeball lubrication
-excessive expectoration	-blindness
-heat suffocation	

These observations may be compared with the known health impacts of some of the individual constituents of biomass smoke shown in Table VII below.

Table VII

Health Problems Associated with Exposure to Specific Air Pollutants

Respirable Suspended Particulates (RSP)
- bronchial hypersecretion
- air flow obstruction

Carbon Monoxide
- headache
- nausea
- vomiting
- dizziness
- drowziness
- collapse

Formaldehyde
- asthma attacks
- fatigue
- insomnia
- diarrhea
- chest pains
- eye, nose, and throat irritation
- nausea and dizziness
- rashes

Nitrogen Dioxide
- reduced resistance to respiratory infection
- eye irritation
- pulmonary edema

Benzo[a]pyrene
- lung cancer
- skin cancer

The exact health implications of chronic exposures to wood smoke have not yet been addressed systematically. Although few, the studies in LDCs are fairly consistent in their suggestion of the causative agent of high prevalences of respiratory diseases: cooking indoors on open fires in unventilated homes (Cleary and Blackburn, 1968) and (Kossov, 1982). Full comprehension of the specific health impairments caused by specific constituents of smoke requires extensive, systematic medical research of household health in collaboration with air pollution monitoring of household exposure (EWC, 1985).

In 1984 the World Health Organization declared that the leading cause of death in lesser developed countries was respiratory disease (WHO, 1984). Among the most commonly occuring respiratory diseases in LDCs are acute respiratory infections (ARI) in children, and chronic obstructive lung disease (COLD) in adults.

It is estimated that 666,000 infants die each year from ARI (Chretien, et al., 1984). Table VIII identifies the causative agents most associated with ARI morbidity (incidence of disease) and mortality (number of deaths). In Nepal Dr. Mrigendra Raj Pandey of Bir Hospital found an alarming 330 ARI deaths per 1000 births in the high-altitude village of Jumla (Pandey, et al., 1983) and (Pandey, et al., 1984).

Table VIII

Causative Factors of ARI Morbidity and Mortality

Morbidity	Mortality
1. Air Pollution (including tobacco smoke)	1. Malnutrition
2. Crowding	2. Previous Morbidity of Moderate or Severe ARI
3. Lack of Immunization	3. Lack of Access to Curative Health Services
4. Lack of Personal Hygiene	
5. Presence of Causative Organisms	

(Smith and Kunstader, 1985)

Dr. Pandey has also done extensive work in the Kathmandu valley region on the prevalence of chronic bronchitis (CB) in men and women tobacco smokers and non-smokers has lead him to the conclusion that time spent near the fire is statistically correlated with CB (Pandey, 1984). Both male and female smokers were shown to have a similar prevalence of CB of about 18 percent. However, male non-smokers only had a 3 percent chance of having CB, whereas female non-smokers had a 17 percent chance. This

verified the fact that women were being exposed to another source of air pollutant that the men were not-- domestic cooking fires. Dr. Pandey also demonstrated that as hours spent near a fire increased, so did the prevalence of chronic bronchitis (Pandey, 1984).

Recognizing that Dr. Pandey has demonstrated the relationship between exposure to cooking fires and a respiratory disease, then it is only reasonable to suggest that improved cookstove flues can, in fact, decrease the prevalence of chronic bronchitis and other smoke related respiratory diseases in Nepal.

III. QUALITATIVE SAMPLING

"My life is so difficult I would do anything to make it easier, like have a new stove."

Balmati Biswakarma, Beni, Myagdi
Traditional Stove Owner of the
Untouchable Caste

"...rural Nepalese respondents think, talk and behave in terms of their own social organization, beliefs, fears, values, and ways of categorizing and interpreting the world, which the research designers do not necessarily even know about (let alone control for) beforehand."

(Campbell, et al., 1983)

A. Questionnaire

Sixty-six questions constituted the interview format for this study (see Sample Questionnaire, Appendix B). This questionnaire was a compilation of several improved stove surveys from the Indoor Air Pollution, Biomass Fuels and Health Project of the East-West Center in Hawaii and other resource management development organizations in Kathmandu. The first three pages of the questionnaire were taken directly from the Community Forestry and Afforestation Division's (CFAD) Survey of New Stoves which included queries about household characteristics, stove use, installation, and users perceptions of fuel use. The fourth through sixth pages asked questions about perceptions of smoke exposure, women's workload changes, the advantages and disadvantages of the improved stove, followed by surveyor's observations. The seventh page made room for sketches of the stove, room, window and door, and general household dimensions. The last page was a Kitchen Behavior Test of the cook's usual location and activity during the sampling period.

Most important to the question-preparation process was an understanding of the question-presentation process. Experienced social scientists warned that formal questions would produce formal answers, long and complex questions would lead to misunderstandings and frustration, and the interviewer's attitude and interest would dictate sincerity of response. Several advisors, including J. Gabriel Campbell (1984b) of CFAD and Shanta Pandey of RCUP, specifically noted the importance of making the interview simulate an informal conversation to increase dialogue and gain the trust of the interviewee. Indispensible advice, such as this, helped both the interpreter and the Technical Assistant to be sensitive and effectual during questionnaire sessions.

The next eight sections of this chapter present, in part, the results of the 66-item questionnaire. Some results are abbreviated or not discussed if they were thought to present no new information.

B. Household Information

All tests were conducted between the altitudes of 855 and 1,530 meters (2,800-5,000 feet) with the exception of four tests in Mustang at 2,560 meters (8,400 feet). Most stoves were located on the ground floor and had been installed about one-half year previously. The sampling sessions were divided evenly between morning and evening cooking periods. Of the seven ethnic groups represented in the study, the most common households were Newari (40%), Brahmin (17%), and Magar (15%). More importantly, the three economic groups were evenly represented (see Table X). Within the old stove category, more tripod stove owners were characterized as poor (61%) than those with mud chulas (20%). Few households of high economic status had an old stove that was a tripod agena (8%); most had mud chulas (40%).

All homes averaged about six household members with between one and two children under the age of 10 years. Most cooks started cooking "on a regular basis" at 16, although this age ranged from 4 to 56. Men (or women) beginning to cook at a much older age did so because their spouse had died, daughter had married, or servant had been dismissed. The average age of all cooks at the time of sampling was 34 years, and ranged between 10 and 75 years. Only those cooks using a tripod agena were, at an average of 43 years, older than most cooks in the survey.

Seventy households were sampled in the three districts. The breakdown of the sampled stove types are in Table IX:

Table IX

Sampled Stove Types

Sample Size	Cookstove Name
n = 28	Improved UNICEF "New"
n = 28	Traditional Stoves "Old"
n = 15	Mud Chulas
n = 12	Tripod Agenas
n = 1	3 Stone Support
n = 4	Mustang District
n = 6	Two Sources of Smoke
n = 4	Experimental
n = 70	TOTAL

When the improved stove was installed, it most often (89%) took the place of a mud chulo, rather than a tripod agena (11%). Most replaced stoves were actually removed or broken (78%), although 15 percent were kept to be used "sometimes". All mud chulas that were sampled were employed for all cooking, except livestock feed. A majority (61%) of the sampled tripod agenas were used to cook everything (meals, feed, alcohol, etc.). These differences in stove uses are expected because agenas can support and heat any sized container, whereas, mud chulas are usually built too close to the wall to accommodate an animal feed pot, or alcohol container.

Many Nepalese believe that a fire used to cook rice, corn, or cereals is contaminated and needs to be red-washed with clay after use. Likewise, Nepalese of higher caste groups forbid using the same fire for human and animal food preparation (Pandey, S., 1985). For these reasons, the improved stove was exclusively used for meal and tea making in most cases (77%), and least frequently (7%) for all cooking. Recipients of improved stoves usually (59%) kept an agena present to supplement their cooking options, although a significant portion (41%) maintained no other stove. Most households with mud chulas also kept agenas as second cookstoves (80%), while most agena households did not have a second cookstove (54%). No homes employed two mud chulas as their primary and secondary cookstoves, though a few homes maintained a pair of agenas of different sizes. In all cases, secondary cookstoves were limited to specific functions for alcohol, livestock feed, or tea making. These observations all support a conclusion that stove type and number is an indicator of economic status. In general, Nepalese of higher economic status will own both a mud chulo and an agena. The poorest Nepalese usually have only one simple agena. Table X shows the percentages and types of households sampled in the two districts of Gorkha and Myagdi, according to ethnic group and economic status.

Table X

Percents of Households Sampled

		Improved (n = 27)	Combined Trad (n = 28)	Mud Chulo (n = 15)	Agena (n = 13)
ETHNIC GROUP	Brahmin	22%	11%	13%	8%
	Thakuri	4	14	0	31
	Chetri	15	4	6.5	0
	Magar	11	18	13	23
	Thakali	0	0	0	0
	Newari	44	39	60	15
	Occupational*	4	14	6.5	23

(Lowest Hindu caste grouped by occupation such as tailors, blacksmiths, and leather goods makers.)

ECONOMIC STATUS	High	37%	25%	40%	8%
	Medium	33	36	40	31
	Low	30	39	20	61

C. Improved Stove Inspection

At the start of sampling sessions, the accompanying RCUP stove technician performed a systematic inspection of the condition of the stove. When the technician was not available, the Technical Assistant followed the same procedure. A flashlight and probe were the only equipment necessary to perform inspections. The only difficult point of the inspection was determining the ash content collected inside the flue, because the answer had to be induced by stated flue performance instead of observed build-up of soot and ash.

Stove parts were very infrequently broken and only occasionally cracked. This is easily attributed to the young age of the stoves and that most cooks handled the stove carefully, sometimes for fear of its fragility and the unavailability of replacement parts.

The "damper" feature noticeably went totally unused (36%), or frequently unused (55%). Dampers are used to regulate the airflow through the stove in order to control the speed of combustion and unwanted backdrafts during windy days. Very few cooks responded that they understood the function of the damper after complaining of smoke backing down the pipe.

Seventy-two percent of the cooks with new stoves had attempted to clean the flue since installation. The median number of times that soot and ash were removed (requiring some diaman-

tling of the pipes) was three times, or once every two months. Tea shop and hotel owners cleaned most frequently, between once or twice a week. Flue cleaning was probably the most unpopular responsibility associated with the new stove, which was demonstrated in the number of times that ash was found in the connecting pipe (59%), and soot or ash reported to clog the flue (83%).

About 44 percent of the cooks indicated that their pots fit the molded pot mouths "good" or "fair". This result does not seem to be a fair description of pot fit because cooks commonly complained of smoke escaping from between pots and pot mouths. Poor pot-fit concerns stove technicians because it so easily defeats flue ventilation advantages. RCUP technicians consciously try to accommodate several pot sizes by 1) placing extra mud in a funnel-shape at the pot mouth, and 2) encouraging the use of tin plates with an inner section removed to support, for example, very small tea pots.

D. Fuel Savings

Improved stove users perceived that they saved approximately 38 percent of the fuel over their replaced, traditional stove. Cooks were asked how many big "bharis" of fuel that they consume per month (a "bhari" is a headload of collected, stacked wood; small bhari's weigh from 15 to 35 kilograms and big bhari's vary from 35 to 60 kilograms). Perceptions obviously differ on fuel use and bhari size and recall questions have proven to yield quite inaccurate guesses, though consistently on the side of over exaggeration (Fox, 1982). Nonetheless, average perceived fuel use for improved stove users was 3.9 bharis per month. This is 1.7 times or 42% less than the reported use with their original stove of 6.7, which differs some from perceived fuel use by old stove owners of 8.0. Within old stoves, fuel use per month was 7.8 bharis for mud chulas and 8.4 bharis for agenas. This reflects the greater fuel use by the open fire agenas.

At the time of the survey, one bhari cost about 28.5 rupees in bazaar areas; (range = 20 to 40 rupees.) Although these results are only perceived savings, not measured fuel savings, one could conjecture that new stove owners could save about 80 rupees per month (28.5 x 6.7 - 28.5 x 3.9 = 79.8) due to the improved stove fuel efficiency characteristic.

E. Smoke Exposure

All but one improved stove owner (96%) were delighted with the new stove's ability to reduce the smoke in the cooking area. An important consideration for both smoke exposure and workload information is the average time the cook spends near the fire. This question was asked from two perspectives to check the consistency of responses: 1)cooking hours per day and 2) hours

spent near any fire. Answers from the first question revealed that new stove owners spend about 5.2 hours per day "cooking", versus 5.1 spent by old stove owners. By the second method, new stove owners spent 1.9 hours per meal by a fire and another 1.3 per tea/tiffen/alcohol/livestock feed heating, for a total of 5.3 hours per day (when multiplied by 2 meals/day plus tea/etc.) Old stove owners spent 2.1 hours per meal and 1.1 for tea/etc., for a total of 5.4 hours per day. According to both perspectives, then, the time spent around either stove is a little over 5 hours per day. However, within the old stove category, there is a differentiation. Mud chulas cook faster than agenas because two pots can be heated simultaneously and the mud enclosure acts to re-radiate the heat. Cooks spend between 4.8 and 5.1 hours around mud chulas, and between 5.3 and 5.6 hours with the tripod agena. Therefore, differences in exposures to smoke between mud chulas and agenas is related to time (ie. hours spent by the fire), whereas differences between new and old stoves, in general, is related to exposure control (ie. the flue).

The percentage of health problems associated with smoke exposure to the different stoves was very significant. Cooks using the improved stove stated that 1) they had no eye problems in the last month (65%), 2) they had no cough in the last month (63%), and 3) it was easy to breathe when they cooked (89%). In contrast, most cooks using the old stoves stated that 1) they had eye problems in the last month (74%), 2) they had a cough in the last month (71%), and 3) it was not easy to breath when they cooked (67%). Both new and old cookstove owners stated that their eyes teared when they cooked (85 to 8[illegible]%). New stove owners probably experienced eye tearing because the flue did not rid the indoor environment of all smoke (see Section II).

More old stoves owners smoked cigarettes (11 of 28) than new stove owners (5 of 25). All except one of the old stove owners who smoked used an agena. These 10 agena cooks smoked an average 10.2 cigarettes per day, whereas the one mud chulo cook of low income status smoked 30 cigarettes in a day. Six of the 10 agena cooks were in the lowest economic status, (possibly suggesting that more poor Nepalese smoke cigarettes than those of medium or high economic status.) The average number of other family members complaining of breathing or eye problems was 2.2 for old stoves, and 1.2 for new stoves.

Overall, cooks' consciousness of health problems associated with breathing excessive quantities of smoke varied widely. The survey did note, however, that new stove owners mentioned ills and hazards of smoke inhalation more frequently than did old stove owners. When asked about breathing or eye problems, old stove owners did not necessarily equate health problems directly with smoke.

In general, greater health awareness, better education, and higher economic statue characterize owners of new stoves more than old stoves. On the other hand, this conjecture is limited to observing cooks and families living in two large villages, rather than an even representation of rural households to which the stove program is presently expanding.

F. Women's Workload

"At subsistence levels, women are the major providers and consumers of energy."

(Irene Tinker, 1980)

This portion of the questionnaire was appended to bring a more obvious Women-in-Development perspective to the study. Originally, the questions were centered around a family history of time spent collecting firewood. First of all, however, the younger generation of cooks sampled rarely collect fuelwood themselves. For those of high and medium economic status, bazaar life means buying fuelwood in the marketplace. Seventy-two percent of new stove owners buy their own fuel versus 46 percent of old stove owners. Within old stoves, however, most mud chulo stove owners (73%) buy their wood, whereas most agena owners (85%) collect their own. Those who do scavenge for fuel collect brush or crop residues in a government protected forest (by permit), on their own land, or claim driftwood. On the days they collected fuelwood, approximately 20% of new stove owners and 50% of old stove owners spend between 2 and 12 hours away from their household chores.

Secondly, few cooks could recall the hours spent by grandparents in the collection of fuelwood. Therefore, the focus of the questions were redirected towards work-time related to cooking. Most cooks (79%) declared that they spend less time working with the improved stove than they had with their old stove. Also, despite most preconceptions of the new stove's slowness in cooking, there was no clear concensus. New stove owners were clearly divided over the change in time spent cooking with the new as compared to the old stove: decreased (35%), same (27%), and increased (38%). These responses coincide with reported hours spent near the fire, averaging approximately 5 hours for both new (5.2) and old stoves (4.8 - mud chulo, and 5.3 - agena). Every new stove owner agreed that the improved stove was more convenient than their old one. This further indicates that although cooktime does not decrease with the new stove, worktime does.

Nineteen of 27 (70%) new stove owners stated that they are able to perform other activities while they cook with the new stove. Some of these activities include: other household

"work," visiting other people, knitting or weaving (loom), preparing other food, relaxing, fetching water, reading, or selling medicine (response of a local doctor). In general, these cooks had to learn to shift the pots between pot holes, but otherwise the improved stove required less tending of the fire, less attention to cooking, and, therefore, less work. Outside of the cooking period, new stove owners also felt their work time was greatly decreased by the flue venting dirty soot that used to require daily washing of stove walls, pots, clothes, and body. This is explained more thoroughly below.

G. Stove Advantages and Disadvantages

Findings of this evaluation coincide with other studies done in Nepal (Bajracharya, 1984) concerning the cook's highest priority for wanting an improved stove. Decreased domestic air pollution is the major selling point of the improved stove for potential recipents, and the most appreciated attribute for present owners. These results have a greater impact when considered together with the third most stated priority: cleaner homes. "Less smoke" as a first priortiy is associated with increased comfort and better health. A "cleaner home" is also a direct benefit of less smoke: for example, less particulate fallout on clothes and hair, and less charring of walls adjacent to the stove and pot bottoms. Priorities #1 and #3 combine to emphasize the dominating influence of smoke in a Nepali cook's life, and the great significance a flue por ends in improving that lifestyle.

Tables XIA to D list priorities for (a why new stove owners liked or disliked their new stove, (b)why old stove owners wanted a new stove, and (c)why old stove owners liked or disliked their old stove.

Table XI-A

NEW STOVE OWNERS
REASONS FOR LIKING NEW STOVE: PRIORITIZED

Priority	Reason	
1	Less Smoke - better health - less discomfort	
2	Less fuel consumed	
3	Cleaner homes (Better Control of Soot) - less red-washing walls and stove - less pot washing - less clothes washing - less hair and body washing	(LESS WORK

Other advantages most often offered (in order of frequency of response):

- Less tending/blowing of fire
- Less heat emanated directly on body
  associated with better health
  (especially in summer heat)
- Stove stays warmer longer
  - -keeps food heated, or also able to make tea
- Fewer pains and aches
  - -fewer or no eyepains, headaches, nausea, dizziness, tearing
- More safety
  - -children safe from falling in fire
  - -hands safe from open flame when cooking
- More attractive stove
  - -higher standard of living, cleaner home
- Easier to patch/repair/maintain stove
  - -no chipping
- No ashes fly when blow in stove mouth
- Able to use second floor
  - -no complaints from children, guests, or lodgers
- Less chance of burning food
- Rice tastes better
- Stove leaves more coal
  - -less ash (a possible disadvantage because villages need ash for laundry and dish washing)
- Covered and controlled flame - less time needed to tend fire

Table XI-B

NEW STOVE OWNERS
REASONS FOR DISLIKING NEW STOVE: PRIORITIZED

Priority	Reason
1	Longer cooking time
2	Difficult to clean flue
3	More wood splitting Wood must be straight & dry

Other disadvantages enumerated:

Pots don't fit well
- -cannot interchange pots
- -not good for cooking for many people (limits guests)
- -need tin overlay or extra mud to adjust for pot size

Smoke backs down flue when outlet pipe faces into strong winds

Frame too fragile

No warmth in winter
- -ceramic pipes vent heat, rather than radiate heat
- -cold high altitude climates (Mustang) need warmth

Hard to ignite

Small mouth for feeding in wood

No regulation of flame

The first priority for why new stove owners disliked their stove, "longer cooking time", is misleading. Most new stove owners replaced a mud chulo with the new stove. Mud chulas take less time to cook because there is a hot flame under both pot holes. Agena owners, however, compliment the new stove's quickness because they are used to one pot cooking at a time. Recognizably, then, the improved stove takes longer to cook for those of higher economic status who traditionally use the mud chulas. Lower income Nepalese (not as well represented here) see the new stove as adding a second pot to the burner, and less overall cooking time. Ironically, longer cooking hours were also viewed as an advantage: more "free" time for other activities or work.

The next portion describes the expectations of the new stove by those about to receive one:

Table XI-C

OLD STOVE OWNERS
REASONS FOR WANTING NEW STOVE: PRIORITIZED

Priority	Reason
1	Less Smoke
2	Less Fuel
3	Cleaner Home

Other expectation of the new stove included:
- Less work
- Greater attractiveness of stove
- Time to do other work
- Less chipping
- Less pains and aches
- Free from illnesses
- Safe from burns
- Food keeps warm longer

Old stove owners, in general, also selected "less smoke" as their first priority for wanting the new stove. However, with further examination of old stove responses, tripod agena owners more frequently chose fuel efficiency as their most important desire. Agenas are the most inefficient Nepali cookstoves. It makes sense that the poor, who use them exclusively, would feel the pressure of fuel collection (to cook food-- their immediate necessity) more than the "inconveniences" of poor health and increased cleaning time.

Finally, the last portion lists old stove characteristics that their owners liked or diliked:

Table XI-D

OLD STOVE OWNERS
REASONS FOR LIKING OR DISLIKING OLD STOVES

LIKED	DISLIKED
-cooks for many	-always dirty
-no wood splitting	-high fuel use
-warmth in winter	-much work to clean
	-no free time
	-frequent repair
	-always feel sick
	-cooks "late" or slowly
	-always bending over
	-great discomfort

Two final notes include: 1) the disadvantage of the new stove not providing warmth in the winter would likely have been a more frequent response if the survey were conducted during that season, and 2) the tradition of squatting and cooking on the ground may be a common adaptation to domestic smoke pollution based on the observation that many old stove owners noted the inconvenience of "always having to bend" to keep their heads out of the smoke. Several young women stated their preference for a higher improved stove. To them, a flue meant that they would be able to sit or stand (instead of squatting) while cooking, because the smoke would no longer fill the upper portion of the room.

H. Surveyer's Observations

The following observations were noted by the Technical Assistant during sampling sessions:

* The average number of people eating meals in new stove homes was 6, compared to 7 in old stove homes.

* Only one or two other members were usually present in cooking area during cooking periods.

* Three quarters of all the cooks agreed that the fuelwood was "dry"; usual only for autumn and spring.

* Except a few homes in remote areas that burned with corn husks, all cooks used wood for fuel.

* Most new stove owners (75%) used "small" sized fuel, whereas all of the old stove owners (100%) used "large" wood pieces.

* The relative "smokiness," "blackness," and ventilation of cooking areas (see Table XII below) was determined exclusively by the Technical Assistant's opinion of comparison:

Table XII

Perceptions of Smoke

		New Stove		Mud Chulo		Agena	
Smokiness of Cooking Area	None	68%	(n=28)	27%	(n=15)	23%	(n=13)
	Little	29		60		15	
	Much	3		13		62	
Blackness of Cooking Area	None	36	(n=28)	23	(n=13)	0	(n=13)
	Little	39		31		8	
	Much	25		46		92	
Ventilation	Good	83	(n=28)	40	(n=15)	23	(n=13)
	Fair	14		53		23	
	Poor	3		7		54	

The three indicators on the left clearly show the impacts of decreased exposure control; most new stove owners reported good ventilation and no smokiness in the cooking area. The agena stove not only demonstrated the most smoky and black indoor conditions, but also the poorest ventilation. This observation about agenas was also noted by Joseph et al. (1984) in "A Preliminary Investigation Into Impact on Pollution Levels in Nepali Households by the Introduction of Stoves" where poor ventilation and poor installation are also associated with low economic status.

In general, rural Nepalese architecture is not characterized by windows; concerns over warmth, thievery and demons discourage any open spaces in walls. Poorer homes are usually smaller, crowded next to other homes, and not well ventilated. In these homes, all family members live in one room that also serves as the cooking area. Higher income homes, especially in bazaars, have larger rooms, higher ceilings, and a separate area for cooking.

* Roof material on the all homes surveyed was most often wood beam and occasionally thatch or tin. Room volumes ranged between 4 and 150 cubic meters and averaged 24 cubic meters for all households.

* Cooking areas usually had only one window, and one or two doors. Estimated free wall space (ventilation from windows and doors) did slightly differ between new stove households (14%) and old stove households (11%).

* Daily weather conditions were graded visually according to wind, wetness, and temperature. In general, most sampling sessions were conducted in sunny, warm, and calm or breezy conditions, soon after sunrise or during sunset.

I. Kitchen Behavior Test

To supplement this study's questionnaire, J. Gabriel Campbell (1984b) of the Community Forestry Afforestation Division, FAO, suggested a behavior test to monitor the cooks' location and activities during the cooking period. The behavior test, also known as the "monkey test" because it was first used to monitor the behavior of monkeys, checks the subject's activity every five minutes during the hour. The percentage of totaled observations (represented by a tally mark by different activities and locations) are averaged and multiplied by 60 minutes to estimate the average portion of the hour the cook spends in a specific position, and the portion of the hour she spends doing a specific task. The difficulty encountered during the test was adjusting for the influence of the investigators' presence on the cook. The cook was always asked to follow her normal pattern of cooking, however, dialogue sometimes required her to be in close proximity to the surveyors who were usually seated in the cooking area.

The following results combine the behaviors of cooks using both new and old stoves:

Table XIII-A

ESTIMATED TIME SPENT BY COOKS IN A SPECIFIED LOCATION
(minutes per hour)

At Stove	<6ft.	Other Pt Rm	Another Rm	Outside
47	8	2	2	1

Table XIII-B

ESTIMATED TIME SPENT BY COOK DOING A SPECIFIED ACTIVITY
(minutes per hour)

Cooking	Preparing	Feeding Fire	Sitting/Talking (by fire)
21	8	12	13
		Arranging Pots	Fetching Water
		3	3

Assuming that the hour sampling session represented a normal cooking hour, this behavior test indicates fairly well the approximate number of minutes in each hour that the cook actually spends by the cookstove. Looking at the behavior of both new and old stove owners, the cooks spend about 55 minutes of each hour within 6 feet of the cookstove. Multiplied by the average 5.3 hour cooking period for new stove owners (see Women's Workloads), this suggests that the new stove users spend 292 minutes or over 4 3/4 hours every day in very close proximity to the cookstove. For mud chulo owners (average 4.8 hours cooking period), this translates to just less than 4 1/2 hours, and nearly 5 hours for agena owners (average 5.3 hour cooking period). This, of course, does not include time spent near the fire when space heating. As Bhattarai (1983) reported percentages of overall fire use as:

- 72% for cooking and tea,
- 17% for livestock feed/alcohol/other, and
- 11% for space heating,

another 30 minutes (11% of 5 hours) of daily exposure may be added for extra exposure during winter months.

IV. MUSTANG

"One of my great uncles brought the first tin stove to the Thak Khola region from India a generation ago. Tin flues and stoves are not a new introduction to Mustang."

(B. Sherchand, 1984)

A. Background

Within its mandate to work on natural resource management in the two major watershed of Nepal, RCUP took on a very diversified project. Briefly, Myagdi and Gorkha can be described as having predominately Hindu ethnic groups. Although they are located in two separate river basins, these two districts have similar social and cultural conditions, and therefore, similar applications for RCUP. On the other hand, the Mustang District, containing an upper portion of the Kali Gandaki River, possesses a distinctly different character than its lower, warmer neighbors. Bordering Tibet, Mustang has a Tibetan-Buddhist influence from years of exchange along this busy trade route through the Himalayan range. A particular ethnic group, known for its business savy, established itself in this northern region. Their merchant skills have brought foreign goods and modern influence to communities along the trade route. As a result, the area has been characterized as more commercially advanced than most districts of Nepal.

As to climate, most of Mustang is located in the rain shadow of the great Dhaulagiri and Annapurna ranges (26,000 ft.). Therefore, the region is known for being a cold, high-altitude desert for a majority of the year. As would be expected, Mustang's social and climatic differences prescribe an entirely separate subset of resource management investigations and solutions for RCUP.

RCUP reassessed its Mustang program in order to match cookstove design with this region's cooking habits. Mustang women and men are known for building very sophisticated and attractive stoves. When surveyed, Myagdi cooks often remarked about the perfect, angular shapes of Mustang stoves that are frequently constructed at standing height instead of on the floor (see Figure M). Whereas the pre-fabricated ceramic mud chulo and flue seemed to address the Myagdi and Gorkha situations fairly well, the same cookstove in the Mustang District was an understandable failure.

Between 1981 and 1983 RCUP energy specialists tried introducing 10 experimental double wall and insert chulas with ceramic flues in the villages of Jharkot and Muktinath in Mustang. In brief, Mustang's energy technician later assessed the trial

FIGURE M

Improved Cookstove
Similar to those in the
Mustang District
(note: missing tin flue,
and cast-iron rings)

stoves as "useless." Because mud was used as the construction material, it completely eliminated that improved design as a viable option for the cold climate of Mustang; a ceramic flue cannot radiate heat to provide warmth.

Our discussion with one double wall stove owner (the would-be reigning queen of the ex-Tibetan Kingdom of Jharkot) verified some of the energy technician's observations. She complained of the small mouth which prevented her from stuffing large pieces of wood into the stove. She also disliked the insufficient amount of heat that emitted from the flue, causing her to limit her stove use to the few warmer summer months when no heat was needed. On the other hand, she praised the stove because it did ventilate the smoke, it was very fuel efficient, and the enclosed fire prevented her small children from getting burned.

RCUP had not intended that the improved cookstove only be used for a few summer months. This modified use was encouraging and informative, however, it was also clear that the Mustang cookstove program needed to experiment with a dual function stove for cooking and heating during the majority of cold months. Fortunately, RCUP recognized this concern and proceeded very cautiously.

Energy personnel also understood that this <u>was not</u> a new problem for Mustang households. Industrious Thak Khalis imported the first tin into Mustang from India at least a generation ago to make tin heaters (S. Sherchand, 1984). Although the tin comprised both the firebox and flue to radiate maximum heat, the stove consumed much fuelwood. Today, many Thak Khalis have tin flues on both heaters and <u>tin stoves</u>. RCUP's Mustang Energy Technician, is profitting from these advanced ideas by experimenting with a combination heater and stove, and adding cast-iron rings to accommodate different sized pots. The combination stove has a baffle to increase fuel efficiency and large cast iron rings built into the stove mouth for structural support. A household in Larjung has volunteered to try the new stove during winter 1984-85.

In 1984 Kalopani, Mustang received enough galvanized iron sheets and cast iron rings for 27 stoves. As of November 1984 only two had been installed because potential recipients were fully occupied by the busy harvest season. The Energy Technician wanted to determine acceptance rates before encouraging more dissemination.

Some cookstove practices hamper the promotion of new cookstoves. Villagers of Kalopani, Mustang are traditionally concerned with wood beam preservation because the Valley's wetter climate contributes to wood rot. Eliminating smoke via a flue, for those who have not used them, means losing beam preservation benefits. The Energy Technician understands that he must con-

vince cookstove recipients that a tin flue does not limit their smoking practices because the cookstove pot mouths can be left uncovered for fumigation purposes.

On the other hand, the tin flue and cast iron rings are easily promoted because of perceived advantages. The unpopular task of required soot removal and flue cleaning is simply performed by periodic knocking on the pipe to loosen soot or ash build-up on the inside walls. The concentric rings are placed one inside the other in order to fit different sized pot mouths for a variety of cooking containers. The rings are very popular. In fact, guesthouse and teashop owners in the southern Myagdi District are asking about ring availabilty. Unfortunately, the rings are both heavy and expensive.

Stove technicians advocate the use of tin-plate overlays (hole in middle for pot) to place over mud pot mouths as an inexpensive substitution for the cast iron rings. Many households, teashops, and lodges are willing to use the cast iron rings even without the improved cookstove body or flue.

B. Quantitative and Qualitative Sampling

Only four households were sampled for indoor air pollutants in Mustang. Monitoring results from this region were not included with other district data because the stoves were not pre-fabricated, or of same design. Despite the small sample size (n=2), there again appears to be a noteworthy difference in TSP and CO readings between the "new stoves" with 920 ug/m3 and 41 ppm, respectively, and the "old stoves" with 1,750 ug/m3 and 64 ppm. In these cases the "new stove" was defined as the traditional mud chulo of Mustang retrofitted with: 1) a hand-made baffle, 2) cast iron rings, and 3) a tin flue. The "old stoves" did not have baffles or tin flues, but did have cast iron rings in anticipation of subsequent baffle and flue installation.

It is important to note that these Mustang homes were, overall, much better ventilated than Myagdi and Gorkha homes. The average volume of cooking rooms in Mustang was 43 cubic meters, versus 25 cubic meters for the other districts. Architecture also differed very noticeably within this region. Homes of the middle and high economic status were characterized by their large rooms, and large windows (with and without glass panes). They also have high ceilings with a four-foot square hole above old stoves without flues. These ceiling "sky lights" provide light, and effective ventilation when high winds do not prevent the smoke from escaping. No homes of the lower economic status were visited. A resident stated that fewer poor people live in Mustang and, therefore, do not represent the living conditions of a large majority as in the other districts (Tulachan, 1984).

The two "new stove" owners also claimed fuel savings over their "old stoves" of 20 and 50 percent. Fuel use and cook time were much greater (20 to 40 bhari's per month and 9 hours per day) in these few examples because three of the four households offered lodgings and meals to tourists and traders.

The two "old stove" owners' first priority for wanting a "new stove" was for smoke reduction. The same priority was voiced by the two "new stove" owners as the primary advantage of their "new stove". Health impairments most associated with heavy smoke exposure included susceptibility to sore throats and colds, headaches, and "weak" eyes.

C. Recommendations for Mustang's Cookstove Program

RCUP's cookstove program in Mustang is proceeding at a deliberately slow pace. It has the chance to develop carefully and with great sensitivity to tradition and new ideas. The Energy Technician is experimenting with new designs using iron and tin. Once these experimentations are perfected, the stoves will likely find rapid acceptance because the largest user group of the region is known for its general adaptability and ingenuity in marketing. The market potential for the tin stoves appears to be large even with expense of imported metal stove parts.

Little evaluation can be made about Mustang's cookstove program when there have been few installations. However, a few suggestions may be offered on expansion. RCUP will want to examine the participation of lower economic status households. Are the poorer offered the same opportunity for improved stove ownership? RCUP is realizing difficulty in Mustang, as it is in its other two districts, of matching this "advanced" stove with the simple needs of its most needy beneficiaries. New design experimentation must be sensitive to the most user groups and the most practical uses.

RCUP may be especially interested in assessing the impact of cookstove fuel efficiency in this dry, cold region of slow vegetative growth and exacerbated fuelwood scarcity. People of Jomosom, Mustang stated that their required distance to travel to collect fuel has lengthened in one generation to a two-day walk each way. Logically, the effects of decreased fuelwood consumption would be the greatest concern of Mustang residents. Nonetheless, it is remarkable that smoke reduction was selected by all four respondents as the first priority for cookstove acquisition, over fuelwood savings.

RCUP may want to experiment with other development organization cookstove ideas that have succeeded in high altitude, cold environments. A suggestion for combined heating and cooking technology for Mustang has been tried in eastern Nepal, in Nepmache Bazaar (Coburn, 1984). "Backboilers" or cookstoves

equipped with water tanks near the flue pipe provide heated water during cooking hours. Guesthouses with high water demands found the backboilers particularly simple and useful.

Finally, RCUP may want to sponsor a health impact study of the peculiar effects of altitude on cooks and chronic smoke exposure. High altitudes with their lower oxygen levels compound respiration and cardiovascular illnesses. For example, carbon monoxide (CO) from fuel combustion is known to bind with hemoglobin (the oxygen carrier in the blood) and tie up sites on hemoglobin protein normally held by oxygen . Cooking at high altitudes with biomass fuels puts much CO into the indoor air environment where already "thin air" exists. Mustang cooks may have better ventilated kitchens, but their village elevations put them at greater risk for CO poisoning than their lower altitude neighbors. In addition, women have a greater susceptibility to CO poisoning than men, due to: 1) naturally lower reserves of hemoglobin, 2) malnutrition and anemia, meaning lower iron levels, or less heme to bind with oxygen, and 3) pregnancy which naturally causes increased CO levels produced by the body (Smith, 1986). These effects result in a twenty to thirty percent decrease in oxygen carrying capacity of hemoglobin levels in women, and lowered birthweight in children.

Slow distribution of new cookstoves and careful monitoring of experimental designs is the most important prescription for Mustang's cookstove program. If the expense of metal cookstove materials decidedly exceeds the investment made by RCUP for ceramic stove components in Gorkha and Myagdi, then selling metal parts should be heavily considered before abandonment of the program. The great interest shown in cast iron rings and metal flues suggests that RCUP could provide a popular service, generate revenues to sustain that service, all the while encouraging the use of more fuel efficient, less smoky cookstoves.

V. CONCLUSION AND RECOMMENDATIONS

"Our old stove left no time but to cook. Now we can read newspapers, books, and talk while cooking, besides cutting vegetables and bringing water. This is more relaxing and very good for small families. Also, since the new stove consumes less fuel, the forests will be saved. So the same wood can be used to increase industries like paper and furniture making, thereby providing employment to our people."

B. P. Regmi, Beni, Myagdi

"We do need to remind ourselves to look at the bigger picture. Any improved stove that can help to reduce fuelwood dependency and, even better, to also alleviate at least some of the hardship of living and working in a smoky home will make a very large difference in a rural cook's life."

Gyani Shakya, RCUP Energy Specialist

A. Resources and/or Health

A natural resource management project does not have health or human resource management as one of its mandates. Energy conservation does not seem to relate directly to preventative medicine, and logically, the Resource Conservation and Utilization Project does not have any responsibilities in the health field. The fact that the Project promotes a particular cookstove which is most importantly resource efficient, and secondarily, protective of health is clearly understandable.

With no knowledge available on the comparative health impacts between traditional and improved cookstove emissions, little accusation can be made of projects that decide to discontinue funding of improved stove flues when fuel efficiency is their primary concern. In contrast, however, most projects have supported the often expensive and problematic flue, despite the lack of evidence on their specific health benefits. Before dissemination of RCUP cookstoves, preliminary surveys (Bajracharya, 1984) demonstrated the overwhelming preference of Nepali cooks in several villages to have a cookstove which included a way to ventilate their cooking environments in addition to the basic fuel efficient feature. User preference and common sense lead most cookstove programs to encourage the promulgation of improved cookstoves with flues. Ridding the indoor air environment of at least some unquantifiable, though recognizable, portion of smoke had to be worthwhile.

B. Flue Versus Flueless

A critic of improved stoves with flues focuses on a resource conservation project's larger objective of easing rates of forest consumption. French (1983) measures an improved stove's success by its actual, miniscule fuel savings on a national scale, while a proponent (Manibog, 1983) emphasizes the population actually served and the translation of small national fuelwood savings into thousands of hectares of plantations and millions of retrieved donor-agency investments in reforestation efforts.

In Nepal, Darrow (1984) of the Resource Centre of Applied Science and Technology (RECAST) specifically targets the inclusion of the flue in all stove programs as a serious threat in keeping overall stove adoption, and slowed deforestation rates, at a relatively insignificant level. His argument underlines the high costs to manufacture, transport, install, and maintain the flues, and less-than-expected reductions in total household smoke exposure due to: 1) non-cooking sources, 2) reduced smoke exposure from increased fuel efficiency, and 3) the use of traditional stoves in addition to improved stoves. Darrow also reiterates that household smoke is only one of several factors contributing to health problems associated with smoke inhalation.

When, once again, considering RCUP's main objective of decreasing natural resource degradation, Darrow's (1984) ideas on an alternate strategy for more rapid and easier dissemination of fuel efficient cookstoves (without flues) are very important. Especially in remote regions of Nepal, where distribution, installation and maintenance of cookstoves with flues would be prohibitive, the simple one-piece, flueless cookstove becomes a practical alternative. (Although at high altitudes, where the loss of forests are the greatest and where the supposed highest levels of respiratory and eye diseases are found, the flueless stove offers no greater benefits than stoves with ceramic flues.)

Campbell (1984a) disagrees with Darrow's promotion of a flueless stoves, arguing that none have proven socially acceptable in Nepal. He notes that a flue reduces: 1) smoke pollution from 40-60 percent over reductions already received from improved efficiency, and 2) smoke inhalation from the equivalent of 16 cigarette packs a day to 6 or 8 packs a day. Campbell believes there is merit in exploring the possibility of introducing flueless stoves, but that improved stoves should aim to provide the maximum benefits per household.

The RCUP stove program ought to heed Darrow's and Campbell's arguments, perhaps to consider offering both flue and flueless stoves in the future. The program will need to address access difficulties and transportation costs as it expands towards more remote areas. However, RCUP's present program has evolved properly, with a slow and steady growth in interest, acceptance, and use. Its ceramic and tin stove parts are popular, in most

part, due to the benefits of the flue. In essense, many Nepali cooks in the RCUP districts are finally recognizing that their kitchens do not have to be "suffocating chambers of pungent smoke" (Raju, 1953) twice daily, and that a simple flue can indeed alleviate significant hardship from their traditional responsibility of cooking.

This study shows that the inclusion of the flue as part of RCUP's fuel efficient cookstove program is providing benefits of greater significance than the RCUP Energy Sector had hoped or expected. It is the cooks in the RCUP districts who have received and properly maintained their improved cookstoves with flues that will consistently verify the far-reaching importance that decreased indoor air pollution has had on their lives. The responses of seventy cooks in the three RCUP districts of Myagdi, Gorkha, and Mustang in fall 1984 along with clear results of indoor air pollution monitoring supports the conscious dissemination of improved cookstoves with flues in the future by the host of development organizations concerned with resource management and/or health in Nepal.

Recommendation: the success of RCUP's stove program is in large part due to the benefits of flue, which needs to be a greater consideration in the evaluation and promotion of all improved cookstove programs.

C. Pollutant and Health Monitoring

Fortunately, attention has been recently directed toward cooking and its hazardous health effects which are understood to affect many households in lesser developed countries. The harmful levels of toxic air pollutants are a health problem of much worse proportions than common sense anticipated. The scant research conducted in LDCs which have identified and quantified these pollutants demonstrate that the levels are frequently of magnitudes higher than any measurements performed in MDCs (Smith and Ramakrishna, 1984). The only episodes of comparison in MDCs are situations of infrequent, emergency, acute exposures. Half of the world's households are chronically exposed, every day and at least twice a day, to airborne gases and particulate matter which are seemingly significant factors in the development of respiratory diseases as the leading cause of death in LDCs. Domestic air pollution is and long has had a great effect on the health of LDC households.

The conclusions of this study must be used as a pilot study for future research that employs both air pollution monitors and rural health workers that can diagnose respiratory, eye and cardiovascular diseases (EWC, 1985). Clearly, the greatest significance of smoke sampling is its direct relation with health impairments. The extensive research of Dr. Mrigendra Raj Pandey on chronic bronchitis and acute respiratory infection of

thousands of Kathmandu Valley residents must be supplemented with exact measurements of smoke exposures, specifically differentiating between tobacco smoking, heating and cooking. This invaluable information would enable researchers to correlate specific exposure levels and durations to specific ill-health. In this fashion the inclusion of flues on fuel efficient stoves, represented by lower measured exposures and improved health, may be included as part of the documented benefits in the justification of energy program expenditures.

Recommendation: future research combine the expertise of pulmonary physicians and environmental scientists to establish the exact relationship between changes in pollutant exposures with changes in health.

D. Making Cookstoves a Concern of HMG

For RCUP's interest in particular, it has been strongly suggested that the improved cookstove program should be "institutionalized" into one of His Majesty's Government (HMG) ministries (Malla, 1984). At present, RCUP administrates the cookstove program without an improved cookstove counterpart within HMG. The obvious importance of this suggestion centers around the concern over the eventual cessation of the RCUP project after its grant date completion. Without institutionalization of the cookstove program into a department of the government, proper continuation and follow-up of the program after RCUP departs will not be possible.

Recommendation: an HMG ministry adopt the oversight/development of RCUP's improved stove program, and help to coordinate information flow and collaboration between all donor agencies with improved stove interests.

E. Expansion

The RCUP cookstove program is successful. It is enjoying much popularity in the villages that it has serviced so far. After four years the improved stoves are proving to promote themselves and installation cannot keep up with distribution. The needs of the specific user groups and their environments seem to be well met by the different cookstove designs (with the possible exception of households of low economic or caste status). With interests in expansion, RCUP's Energy Sector must be careful to continue its dissemination with much respect to selection of needy and responsible recipients. RCUP stove technicians are very aware of the reasons why their programs are working. Potential recipients of the cookstoves must continue to satisfy specific criteria before installation. Cookstove distribution should always depend on household size, pot size and user intention. Very large families which need large pots for meal preparation will be dissatified with cookstove performance. On

the other hand, cooks with smaller families who have a clear understanding of the maintenance responsibilities attached to the improved stove should be encouraged to participate. Screening interviews such as these are extremely important for maintaining very satisfactory user rates.

On another point, the Gorkha stove technician was very concerned with rapid expansion of the successful program that might inhibit the installer's personal contact with the many households who need frequent instructions on the use of this "appropriate", but nevertheless, new technology. He specifically feared that the numbers of installations would become more important than maintenance review in homes already with the new stove. The technician argued for very conscious expansion because he personally did not want to install more stoves without making sure that previously installed stoves were properly functioning. Otherwise, abandonment rates might eventually equal installment rates, (Koirala, 1984). Both the Myagdi and Gorkha district installers hoped that if expansion were to occur, that it would, at most, double in size and include the hiring of one other trained installer. Screening recipients and advertising the limitations of the improved stove, such as maintenance responsibilities, are integral to the continued success of the program.

A related recommendation from RCUP Energy field personnel included the establishment of a Maintenance and Repair program. Neglect or misunderstanding of soot removal from the flue or mud enforcement responsibilities, for example, can cause abandonment and poor relations with RCUP.

A suggestion for inclusion in a Maintenance and Repair program is the advertisement of fuel-saving practices. Some literature states that the management of cooking fires, utensil and food preparation can save more fuel than the improved stove itself (Cecelski, 1984). Ideas such as putting out embers, reclaiming charcoal and careful tending can supplement techniques already employed by fire-conscious cooks. The use of round-bottom and/or aluminum pots and tight fitting lids increase fuel efficiency. Placing rocks on top of pot covers can increase pressure and reduce cooking times. Food preparations, such as soaking beans, parboiling rice, finely chopping meat and vegetables and cracking wheat are traditional methods of fuel conservation in many countries. All these techniques would be practical to advocate as part of the Maintenance program for a more holistic perspective on saving fuel.

Recommendation: RCUP continue to stress acceptance of improved stoves before accelerating distribution, and toward these ends, establish a Maintenance and Repair program to aid recipient households to maximize their fuel efficiency and minimize their smoke exposure.

F. Women in Development

"With old stove, it used to be very smoky. So husband never used to come in the kitchen. He would come home late or stay out until the smoke had settled. So now, with the new stove, we have more family life."

Heem Kumari Shrestha, Beni, Myagdi

"To accumulate data about household energy, it is necessary to reach women themselves."

(Tinker, 1980)

Most development organizations now fully understand that directing attention towards women in development activities brings more attention to the entire family. Women's roles in community dynamics defines the essence of participation. Women are already the organizers, managers, and unifiers of a micro-community: the home and family. In fact, involving women in making appropriate changes and acceptable improvements in village life can be argued as more effective than involving men. However, the exclusion of either women or men is obviously wrong for building any community or development activity. Community development, after all, is principally defined by all-inclusive participation.

This evaluation of RCUP's cookstove program depends upon user assessment: those users are necessarily cooks; those cooks are inevitably women. Common sense dictates that assessing a person once-removed from the activity of cooking, such as men or children, would have offered erroneous or at least incomplete information on the success or failure of the program.

An essential component of soliciting useful, and accurate, first-hand information is the presentation and approach of the surveyors during the questionnaire process. In an effort to prevent biasing of participant responses and to decrease the formality of the survey, we as investigators (myself, the Technical Assistant, and Bageshwari Sherchand, my interpeter/Research Assistant) underemphasized ourselves as RCUP representatives or official program evaluators, and specifically allowed time for informal discussion (ie. "small talk"). The fact that we were two females, one of which Nepali, most emphatically aided in accessing homes, promoting discussion, and increasing information flow. Rapport was greatly facilitated because women were communicating with women about cooking, a very sex-seggregated issue in Nepali society.

Two Nepali women-surveyors would be the best combination for an evaluation team. Hoskins (1982) suggests that at least 30

percent of all RCUP energy personnel be women to ensure their participation in the modification of energy technologies, and strengthen their leadership positions. As the success of any program depends upon participation and representation, Nepali women must also be continually encouraged to voice their experiences in Panchayat Committee Meetings, as well as in field and administrative posts. The support and training of Nepali women in resource management issues will only enhance communication, and help all HMG ministries/donor agencies make more representative decisions about issues of greatest priority for the future of Nepal.

Women-in-Development (WID) projects are necessary to bring more attention to the wealth of information, or "native wisdom", that Nepali women share. The data that this WID-sponsored project has gathered, alone, signifies the importance of actively soliciting Nepali women's views.

Recommendation: assign Nepali women to more field positions (such as stove installation, energy-technology assessment, and program monitoring) to improve rapport with a neglected portion of Nepal's great resource base, rural Nepali women; encourage frequent and informal dialogue between expatriot WID assistants and Nepali WID representatives.

Hopefully, future WID issues will not have to be treated separately or as separate entities within certain ministries, but eventually be absorbed as an obvious and necessary component of all donor-agency and HMG work in natural resource management, as well as all other fields. Afterall, a common thread in all development work is the fact that humans cause development. Leaving out half the cause leaves out half the potential.

APPENDIX A

Equipment List
Indoor Air Pollution Sampling

	Manufacturer
TSP (Total Suspended Particulates)	
- personal air sampler - aerosol filter pump with 3 batteries (6 volt)	Gilian Corp. Wayne, NJ
- teflon-coated glass-fiber filters	Pallflex CT
- cassettes, tubing, boss filters	
- inverted burette, detergent, stop watch	
- solar cells, invertor, charger	
- polybags, labels, tape	
Carbon Monoxide	
- continuous CO diffusion monitor with flow adapter and batteries (1.5 v)	Gastech Inc. Newark, CA
- gold-plated memory cells	Dupont Corp. Wilm., DE
- audio read-out dosimeter with batteries (9 v)	Dupont Corp. Wilm., DE
- CO pure span gas, nozzle, regulator	
Formaldehyde and Nitrogen Dioxide	
- HCHO passive monitors	AQRI, Inc.
- NO2 passive monitors	AQRI, Inc. Berkeley, CA
- ribbon, thumb tacks	

RESOURCE CONSERVATION AND UTILISATION PROJECT

ENERGY SUB-PROJECT

DHOBIGHAT

APPENDIX

PATAN

Entire Key and Responses to Questionnaire are available through:
H. Reid
c/o SECID, Suite 207
400 Eastowne Drive
Chapel Hill, NC 2751

Sixty-six Item Questionnaire

HOUSEHOLD CHARACTERISTICS:

		CODE V.#	Name	Value
1.	District: _____	01		
2.	Panchayat: _____ Village: _____	02		
3	Household name: _____ S.No: _____ Surveyor: _____ Date (Roman): _____ / _____ /1983 Main Cook's name: _____	03	HH#	___
4	New stove type: 1 Insert 2 Double wall 3 Modified Hagan Chulo	04	NSTO	___
5	Months installed: _____	05	AGE	___
6	Floor installed: 1 Ground 2 1st Floor 3 2nd Floor 4 3rd Floor	06	FLOR	___
7	Installer: _____ # _____	07	INST	___
8	Ethnic group / caste (see code): _____	08	ETH	___
9	Regular number of household members: _____	09	HPOR	___
10	Number less than 10 years old: _____	10	CPOP	___
11	Previous traditional mud stove type 1 There was no traditional mud stove 0	11	STO1	___
12	Present use of traditional mud stove: Removed 0 Still have but not used 1 Have and used 2	12	ST_1U	___
13	Traditional Tripod stove type 2	13	STO2	___
14	Present use of traditional Tripod stove Removed 0 Still have but not used 1	14	ST_2U	___

Stove Use:

		V.#	CODE: Name:	Value
15.	Stove temperature: warm: 0 Cold: 1	15	TEMP	☐
16.	New stove use: (see code)	16	NUSE	☐
17.	Old stove use: (see code:-	17	OUSE	☐

Condition of New Stove:

18.	Firebox: 0: not cracked / 1: cracked/2 broken	18	FIRE	☐
19.	~~Front Arch~~ Mouth Piece: 0:not cracked/ 1: cracked/2 broken	19	ARCH	☐
20.	Baffle: 0: not cracked / 1 cracked / 2 broken and Damper	20	BAF	☐
21.	Chimney: 0:not cracked / 1:cracked / 2 broken	21	CHIM	☐
22.	Repaired: 0: not required 1: not repaired 2: partially 3: completely	22	REP	
23.	Inside chimney: 0: clean/ 1: soot accumulated 2: Ash accumulated / 3: both ash and soot accumulated	23	ASHC	☐
24.	Is there ash in firebox or back connecting pipe 0: no / 1 Yes	24	ASHP	☐
25.	Number of times chimney cleaned	25	CLEN	☐

Stove Installation:

26.	Measurements: 0: Within tolerance limits 1: Slightly exceeds limits 2: Greatly exceeds limits	26	MEAS	☐
27.	Chimney installation: 0: Good 1: Minor problems / 2: major problems (note separately)	27	CHIM	☐
28.	Pot hole spacing: 0: good / 1: Bad	28	POTS	☐
29.	Stove and chimney location: 0: Good / 1: Bad	29	LOCA	☐
30.	Frequently used pots fit holes: 0: Good 1: Fair / 2: Poor	30	PFIT	☐

28a) 2 = sufficient

Users Perceptions and Fuel Use:

31. Estimated percentage fuelwood saving:

32. Amount of fuelwood used before new stove:

33. Amount of fuelwood used at present:

34. Present price of fuelwood per kg:

35. Average amount purchased:

36. Straw/Agricultural residue used before - in kg:

37. Straw/Agricultural residue used at present:

38. Dung burnt before:

39. Dung burnt at present:

40. Meal cooking time: 0: Decreased 1: Same 2; Increased

41. Comparative convenience: 0: Better 1: Same/Mixed 2: Worse

Smoke and Health · Perceptions of Exposure

42. Change in amount of smoke with new stove:

43. Average time per meal spent near a fire:

44. Have you had any eye problems in the last month:

45. Have you had a cough in the last month:

46. Do your eyes tear when you cook:

47. It is easy to breath when you cook:

48. Do you smoke cigarettes:

49. How many in a day:

50. Does any one else (in family) complain of breathing or eye problems:

Name	Age	Smoker	Problem

Women's Workload · Perceptions of Change

51. How long does it take to collect firewood/day & distance:

    How long did it take your monther:

    How long did it take your grandmother:

52. Does the new stove make more or less work:
    Does it change the schedule of your day:

53. Does the new stove take more or less time to cook:

54. Did the new stove change your way of cooking, or what you cooked:

    How:

55. What do you like and dislike about the new stove:

Like	Dislike
Less smoke Less wood to burn Preserves forests Cleaner house Move attractive stove	Longer to cook More wood splitting Less light (children to study by) (lose fire spirit) (lose warmth) Hard to clean

56. Do you think the new stove improves life in your village:

Sampling Session

57. Who usually does cooking:

58. At what age did she begin cooking:

59. How many hours/day spent cooking:

space heating:

60. Do you use the same cooking space all year:

61. Whats being cooked:

62. For how many people:

63. Is this a typical meal:

64. What type of fuel is being used:

65. Where is it stored and for how long:

66. Who else is in the room when you cook:

Measurements

Fuel Type:

Last Calibration:

Weight of Fuel Before:

After:

Weight of food before:

After:

Moisture content of wood:

Size of wood used:

During cooking - Filter #:

Pump #:

Time - Start cooking (lighting fire):

end of cooking (extinguishing fire):

Time - Begin air sampling:

end air sampling:

Readings - Rotometer - begin:

end

- CO begin:

end:

- Dosimeter - average:

Surveyor's Observations

Location of sampler and movement:

Time near stove:

Location of monitor and movement:

Time near stove:

Who else was in the vicinity of stove:

How smokey was the room:

How black was the kitchen:

Nearby rooms:

Ventilation - where did smoke go:

What is roof made of:

Other sources of smoke:

Conditions outside:

Comments:

Sketches

a) Stove including Dimensions (also agena if present)

b) Location within "Kitchen"

c) General house plan

d) No. of windows & doors and c/o. of "Kitchen"

KITCHEN BEHAVIOR DURING MEAL

WHERE COOK IS LOCATED:

	AT STOVE	CLOSE VICINITY	OTHER PART OF ROOM	ANOTHER ROOM	OUTSIDE		OTHER
:05							
:10							
:15							
:20							
:25							
:30							
:35							
:40							
:45							
:50							
:55							
:60							

WHAT COOK IS DOING:

	COOKING	PREPARING	FEEDING FIRE	TALKING	ARRANGING POTS		OTHER
:05							
:10							
:15							
:20							
:25							
:30							
:35							
:40							
:45							
:50							
:55							
:60							

REFERENCES

Bajracharya, D. (1984) Organizing for energy needs assessment and innovation: action research in Nepal. In Islam, M. N., Morse, R., and Soesastro, M. H. (eds.). Rural Energy to Meet Village Needs: Asian Village Approaches. Westview Press, Boulder, CO, p. 42.

Bhattarai, T. N. (1983) A preliminary evaluation of the stove improvement programme in Nepal. Community Forestry and Afforestation Division, FAO, Kathmandu, Nepal.

Byers, A. (1981) Energy development sub-project implementation plan. Resource Conservation and Utilization Project (RCUP). Jawalakhel, Nepal. Sept., 1981.

Campbell, J. G. (1984a) Comments on paper by Ken Darrow. Community Forestry Project, FAO, Kathmandu, Nepal. May 29, 1984.

Campbell, J. G. (1984b) Director of Community and Forestry Afforestation Division (CFAD), FAO, Kathmandu, Nepal. Personal Communication, September 5, 1984.

Campbell, J. G., et al. (1983) The use and misuse of social research in Nepal. CFAD, FAO, Nepal.

Cecelski, E. (1984) The rural energy crisis, women's work and family welfare: perspectives and approaches to action. World Employment Programme Research Working Paper, International Labour Office, Geneva.

Chretien, T., W. Holland, P. Macklem, T. Murray, and A. Woolcock. (1984) Acute respiratory infections in children: a global public health problem. New England J. Med., 310(15):982-984.

Cleary, G. J. and C. R. B. Blackburn. (1968) Air pollution in native huts in the highlands of New Guinea. Arch. Environ. Health, 17:785-794.

Coburn, B. (1983) The development of alternate energy sources and the implementation of a micro-hydroelectric facility in Sagarmatha National Park, Nepal. UNESCO.

Darrow, K. (1984) Some heretical thoughts about stove promotion in Nepal: re-evaluating the costs and benefits of chimneys, and an alternative strategy for rapid dissemination of fuel-conserving cookstoves. Resource Centre for Applied Science and Technology, Kirtipur, Nepal. May 26, 1984.

De Koning, H. W., K. R. Smith, and J. M. Last. (1984) Biomass fuel combustion and health. EFP/84.64. Geneva: World Health Organization.

East-West Center (EWC) Workshop on Health Correlates of Domestic Smoke. (1985) Communique to medical and public health communities, East-West Resource Systems Institute, Honolulu, HI.

Fox, J. (1982) Firewood consumption of a Nepali village. Environ. Management, 8(3):243-250.

French, D. (1983) Letter to Gerald Foley, Earthscan, England, with draft comments on his draft publication, "Improved Cooking Stoves in Developing Countries." Dept. of Forestry and Energy Studies Unit, Malawi. June 27, 1983.

Hoskins, M. (1982) Strategies for involving women in RCUP activities and benefits. Department of Sociology, Virginia Polytechnical Institute, Blacksburg, VA.

Islam, M. N., R. Morse, and M. H. Soesastro, (eds.). (1984) Rural Energy to Meet Village Needs: Asian Village Approaches., Westview Press, Boulder, CO.

Islam, N. (1985) Doctoral Candidate. Biomass Fuels and Development Project, East-West Center, Honolulu, Hawaii. Personal Communication, May 21, 1985.

Joseph, S., et al. (1984) A preliminary investigation into the impact on pollution levels in Nepali households by the intro duction of chimney stoves. Community Forestry Afforestation Division, Nepal.

Karan, P., G. Pauer, and S. Iijima. (1983) Map of Kingdom of Nepal. Monumenta Serindica no. 11. Institute for Study of Languages and Cultures of Asia and Africa, Tokyo, Japan.

Koirala, D. N. (1984) Stove Technician for the Resource Conservation and Utilization Project, Gorkha, Nepal. Personal Communication, Dec. 9, 1984.

Kossov, D. (1982) Smoke-filled rooms and respiratory disease in infants. South African Med. J., 61:622-624.

Malla, Y. B. (1984) Extension Specialist for the Resource Conservation and Utilization Project, Kathmandu, Nepal. Personal Communication, Dec. 4, 1984.

Manibog, F. (1983) Letter to David French on his comments on G. Foley's draft publication, "Improved Cooking Stoves in Developing Countries." New and Renewable Energy Unit, World Bank, Wash. DC. August 4, 1983.

Pandey, M. R. (1984) Domestic smoke pollution and respiratory function in rural Nepal. In Berglund, et al., (eds.), 4:413-429.

Pandey, M. R., S. Dhungel, K. D. Upadhyaya, et al. (1983) Acute respiratory infection in infants and children in remote rural hill Jumla, Nepal. J. Inst. Med. 4(1):1-12.

Pandey, M. R. and R. P. Neupane. (1984) Acute respiratory infections (ARI) in infants and children in Nepal. Souvenir Nepas J., 3(1):47-52.

Pandey, S. (1985) Social Scientist for the Resource Conservation and Utilization Project, Kathmandu, Nepal. Personal Communication, July 17. Washington, DC.

Research Centre for Applied Science and Technology, (RECAST). (1982) A Report on Different Models of Stoves in Field and Laboratory. Kirtipur, Nepal.

Roesing, K. (1983) Early progress of the new stove program in Gorkha: report to the Resource Conservation and Utilization Project. Center for Women in Development, Southeast Consortium for International Development, Wash., DC.

Shakya, G. R. (1984) Energy Specialist for the Resource Conservation and Utilization Project, Jawalakhel, Nepal. Personal Communication, Aug. 30, 1984.

Sherchand, B. (1984) Research Assistant and Interpreter, Thamel, Kathmandu, Nepal. Personal Communication, Nov. 6, 1984.

Sherchand, S. (1984) Thakali Clan Head. Thamel, Kathmandu, Nepal. Personal Communication, Dec. 15, 1984.

Shrestha, D. M. (1984) Nepali cook of low income economic status using an improved RCUP stove. Personal Communication, Sept. 19, 1984.

Shrestha, H. M. (1984) Energy Technician for the Resource Conservation and Utilization Project, Gorkha, Nepal. Personal Communication, Sept. 11, 1984.

Smith, K. R., A. L. Aggarwal, and R. M. Dave. (1983) Air pollution and rural biomass fuels in developing countries: a pilot village study in India and implications for research and policy. Atmospheric Environment, 17(11).

Smith, K. R. (1984a) Biomass combustion and indoor air pollution: the bright and dark sides of small is beautiful. Resource Systems Institute Working Paper WP-84-16, East West Center, Hawaii, p. 24.

Smith, K. R. (1984b) PAH and the household cook in developing countries: the lung cancer anomaly. (Presented at the Symposium on Polynuclear Aromatic Hydrocarbons in the Workplace, International Chemical Congress of Pacific Basin Societies, Honolulu, Hawaii, December, 1984). Resource Systems Institute, East West Center, Honolulu, Hawaii.

Smith, K. R. (1986) Biomass Fuels, Air Pollution and Health: A Global Review. Forthcoming in Plenum Publishing, NY.

Smith, K. R., M. Apte, P. Menon, and M. Shrestha. (1984) Carbon monoxide and particulates from cooking stoves: results from a simulated village kitchen. Third Annual Conference on Indoor Air Quality and Climate, Stockholm, August.

Smith, K. R. and P. Kunstader. (1985) Domestic smoke pollution and respiratory disease in developing countries. [Revised Draft] East West Center, Honolulu, Hawaii.

Smith, K. R. and J. Ramakrishna. (1984) Biomass Fuels and Health. Draft, Monograph ERG-98. Energy Research Group, International Development Research Centre, Ottawa.

Tinker, I. (1985) Director of Equity Policy Center. Lecture at the Assoc. for Women in Development Conference, Washington, DC. April 27, 1985.

Tinker, I. (1980) Women and Energy: Program Implications. Report prepared for Women in Development Office, U.S. Agency for International Development, Washington, DC.

Tulachan, P. (1984) Energy Technician for the Resource Conservation and Utilization Project, Mustang, Nepal. Personal Communication, Nov. 7, 1984.

World Health Organization. (1984) 1983 Statistics Annual. Geneva: WHO.