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RURAL VILLAGE SURVEYS IN THAILAND

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Students Conducting an Interview with a Family Headman in Nakon Ratchasima Province.

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EXECUTIVE SUMMARY

The Survey Component of the Renewable Nonconventional Energy Project was designed to assist the scientists and engineers in different energy technology components accomplish their research and development activities. The survey was significant in that it provided a record of community characteristics before, during and after the implementation of various renewable nonconventional energy systems and technologies.

The purpose of the Village Survey was:

- To find and present village data in order to promote energy technologies in rural areas, including a survey of alternate energy sources;

- To coordinate work with various component projects in order to choose villages or urban areas for the utilization of renewable nonconventional energy sources and equipment;

- To give basic knowledge to villages concerning these energy technologies in order to enable local communities to have a role in establishing groups or organizations to administer the project both before and after the installation of the new technology. This includes organizing village labor during the construction phase plus maintenance and operation of the technology after installation;

- To coordinate efforts between officials of various subcomponent projects and local officials in the installation of the technology in the local area; and

- To study the various problems which affect the project and to find the solutions, including an estimation of the economic and social impact to the villages or urban areas which use the renewable nonconventional energy technology.

The total surveying process for these research and development projects consisted of four phases: preparation, baseline, transition and evaluation surveys. In this report, evaluation surveys were not included because they have not yet been conducted.

The underlying concepts of the Survey Component as it was originally planned were to try to promote villagers' participation in carrying out implementation activities which hopefully would lead to self-reliance in technology operation and maintenance after implementation.

National baseline surveys were carried out in 1980. Fifty villages from ten provinces were selected for a one-month survey based on agro-ecological conditions and regional distribution. Since some subcomponent agencies needed to select additional villages to install their particular technology, the baseline survey then included an additional fifteen villages. These surveys consisted of:

- Baseline surveys in three villages concerning water pumps utilizing renewable nonconventional energy;
- Hydro-electric surveys of three areas including a total of eleven villages; and
- A survey for the Energy Master Plan Support in one village.

These additional surveys were conducted simultaneously with the operational survey because it was conducted after the installation of the renewable nonconventional energy system in the selected villages.

The baseline surveys were a collection of energy data concerning sources of energy, energy usage, energy needs and economic and social factors. This included the availability of raw materials and the moral support and physical participation of villagers which could be expected in the installation of a renewable nonconventional energy technology appropriate for each village.

There were two phases to the survey. The first phase was carried out in April 1980 in the following provinces: Petchburi, Korat, Sri Saket, Kampangphet and Lampang. The second phase was carried out in May 1980, and the provinces included were Songkhla, Chantaburi, Roi-et, Udorn Thani and Chiang Mai.

The data collected and analyzed does not claim to be a national representation. Villages were selected for in-depth study in preparation for implementation of energy technologies available in the Renewable Nonconventional Energy Project. Because of time restraints, only the baseline data from Phase I was analyzed. Certain statistical techniques were applied as a preliminary analysis and were included in this report as demonstration cases. Full analysis may be carried out at a later date.

The transition surveys considered the initial cooperational stage after the energy technology had been selected for installation. This stage was important because it required good cooperation between technicians, analysts, villagers and local officials. Initially, the

analysts estimated the willingness of the community to cooperate. They conducted public relations efforts designed to familiarize the community with the new technology that was to be installed. When the community was ready to accept the new energy system, the next step established supervisory agencies and prepared a labor force. The establishment of supervisory agencies was a critical step for the analysts because these agencies could determine the success or failure of the project since after the officials departed, the agencies remained to administer the project.

Transition surveys included in this report consist of data from:

- Woodlot surveys in four provinces (Sri Saket, Roi-et, Maha Sarakharm and Yasothorn);
- Community Biogas surveys in two villages in Sri Saket and Roi-et Provinces;
- Micro-hydro surveys in eleven villages in Chiang Mai Province; and
- Water Lifting surveys in three villages in Sakhon Nakorn, Nakhon Ratchasima, and Yala Provinces.

The evaluation survey was set up to determine the impact of the new technologies on the social and economic situation of the villages. It was to include the level of acceptance by the local community of the installed renewable energy technology. Because of time restraints, the evaluation survey has not yet been conducted in depth. This paper only considered problems which arose and surveyed people's overall opinions of the project.

The results of the surveys may be said to be good learning experiences. Conditions were diversified and needed to be treated case by case. In almost all cases, community settings were different, indicating that baseline and transition surveys are essential if implementation is to be carried out to meet the needs of the community. The introduction of a new project should be welcomed by everyone concerned before implementation; therefore, attention should be given to information gathered from the survey, especially when there is an indication of differences in opinions or practices at the village level. Lessons learned and reported in this volume should be treated as guidelines to assist in future projects.

CONCLUSIONS

1. The implementation of an alternative energy technology requires not only specific information of the locality but also a well formulated technique designed to actively involve the local villagers in the formation, implementation, operation and maintenance of the designed technology.

2. For implementation of a project to be successful, one must not walk into the community blindly. The baseline survey, when carried out prior to implementation, should serve as a background and guideline for future activities.

3. Baseline surveys need to be conducted on every component. Transition surveys carried out prior to implementation will lead to successful implementation if social problems identified by the survey are solved.

4. Evaluation surveys were not conducted for this study due to time limitations. They are good measures of social and economic changes in the community, they pinpoint problems of acceptance and provide technology diffusion information.

5. The results claimed in the analyses by the Village Survey Component can only be claimed as guidelines for use in the data analysis of other energy surveys.

6. The surveys conducted by this component have provided important baseline information regarding the rural areas of Thailand that will have many uses in the future. Be cautioned that these surveys cannot be considered as statistically representative of Thailand as a whole, but they are still extremely valuable within themselves as they represent provinces with specific energy resources.

7. The analysis of the structure of variables by factor analysis was not applicable for this set of data. We can view this analysis as an exercise in factor analysis application.

8. These results will be useful in choosing the statistical methods which should be used in future surveys. Thus, in turn, means that scaling and quantification of variables can be built into the questionnaire and will not need to be a separate function during coding or analysis.

9. As far as the analyses of the data are concerned, certain primary conclusions were obtained from the analyses run (factor analysis, multiple regression, discriminant analysis and Pearson's correlation matrix);

- The decision to go further/nearer for fuel collection depended on the size of the household, how many household members were responsible for fuel collection and how many rais of land they had access to;

- Neither the use of firewood nor charcoal were indicated by household economic status. Traditional habits and familiarity determined the energy practice in each household:

- The amount of fuel used depended mainly on the needs of the household as identified by household size;

- Most people used fuel in traditional ways. Most did not apply or even think about methods of fuel conservation, methods of cooking or how to use fuel beneficially; and

- Kerosene consumption showed a relationship to household income and lighting equipment.

10. The energy components cannot always consider themselves as isolated units. The success or failure of a component might well rely on the implementation of other projects, such as a new road to carry produce to market, produce that was grown using an improved nonconventional energy technology. Each element relies on each other.

11. The value of the social scientist has been played down in many instances. However, in several cases, project failures or project marginal successes were due to social rather than technical failures.

RECOMMENDATIONS

1. Special efforts should be made to equip the personnel (especially the technicians) involved in the projects with a good understanding of village life, concentrating on the community's ways of thinking, its behavior and, if possible, important village relationships. Project personnel will, in short, be public relations representatives of the Royal Thai Government and of their energy component, a responsibility which is viewed with as much importance as their technical expertise.

2. Research and Development is important, but without a solid implementation program the results will not pass the "practical application" test. Therefore, attention should be given to the implementation stage with close supervision by the technical specialists.

3. Technical specialists need to give more attention to the implementation stage of the project so that technical/construction difficulties do not cause a failure of project acceptance by the local community.

4. It is recommended that in the future, the Survey Component should proceed with every phase of the surveys (preliminary, baseline, transitional and evaluation) for every technical component in the project.

5. The evaluation surveys should be conducted over a long enough period of time to ensure an accurate assessment of each project.

6. Training on participatory implementation techniques should be offered and required for technicians working on rural energy development.

7. The training curriculum for implementation of nonconventional energy technology should consist of:

- General knowledge on different energy technologies;
- General knowledge on participatory techniques; and
- General knowledge on implementation stages or project cycle.

8. If training cannot be offered, energy implementation personnel should be made aware of the need to involve local people in every stage of implementation, especially the initial stages.

9. Energy personnel should have a positive attitude toward the local people and should be able to work with the local people with an understanding of how to involve the villagers in the formation, implementation, operation and maintenance of the designed technology.

10. In Survey Data Analysis, if the volume of data is large and must be divided into two phases, it is necessary to design the two phases to be the same. Alternation of the questionnaire and alternation of the data frame will only make the computer analysis more complicated and more time consuming, especially if there is any lag time between data coding and data analysis.

11. Data should be prepared for statistical analysis before coding. Preparations such as scaling, arranging all answers to have the same direction of scaling, and quantification of variables requiring it, should be made prior to actual computer analysis.

12. The statistical tools that are to be applied in the analysis should be identified before formulating the questionnaire. In this way, only the necessary variables will be included and redundancy can be avoided.

13. Redundant and unnecessary variables should be minimized. It was found in this analysis that many of the variables were not applicable to Thailand.

14. The surveys should definitely be continued.

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Chapter 1

Introduction

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INTRODUCTION

The Survey Component of the Renewable Nonconventional Energy Project was organized in 1980 to record socio-economic data from representative villages in Thailand. Surveys were conducted and data were collected before, during and after the implementation of specific energy-related technologies, including those of the Charcoal-making, Biogas, Stoves, Woodlots and Water Lifting Components.

This report summarizes the activities of the survey component; identifies the problems, weaknesses and strengths of the individual surveys; gives reasons why certain alternatives were chosen; gives explanations for the success or failure of a specific technology in terms of its social-economic impact; and makes suggestions and recommendations for future survey activities.

A. BACKGROUND

In 1980, Meta Systems Inc. (Boston) was contracted by the U.S. Agency for International Development (USAID) to carry out a 5-year Renewable Nonconventional Energy Project consisting of 14 components. The components in this project included:

Biomass Gasification
Charcoal Improvement
Energy Master Plan Support
Industrial Biogas
Micro-Hydro Project
National Energy Information Center
Pyrolysis of Rice Husk
Regional Energy Centers
Solar Thermal Processes
Solar/Wind Assessment
Stove Improvement
Village Survey
Village Woodlot
Water Lifting Technology

However, the Meta Systems Co. contract was terminated after 3 years of work and responsibility for the project completion was transferred to the National Energy Administration.

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This paper will deal with the findings of the Village Survey component. Within the Survey component there are subcomponents, i.e., preliminary preparation, together with baseline, transition, and evaluation surveys. However, after the survey component was transferred to NEA, many of the activities in the subcomponents were altered from the original proposal. In writing this report, attempts are made to give as accurate a picture of the activities involved as possible. For background information, a brief description of the subcomponents is presented in the following paragraphs.

B. OBJECTIVES OF THE SURVEY COMPONENT

Preliminary Preparation

Activities in this subcomponent included a study of secondary data, design of the sampling framework, and preliminary site visits for baseline village selection. The villages were selected in 10 provinces based on regional location and ecological conditions. Fifty villages were selected purposely to represent different types of villages in the country.

Baseline Survey

The baseline survey examined a number of village activities in detail. The activities surveyed include:

- Cooking - fuel selection and consumption, foods consumed, stove design and use;
- Industry - fuel use, level of production, production costs, labor productivity, production technology, marketing of inputs and outputs, financing;
- Agriculture - Crops, planting cycle, land tenure, size of holdings, use of agrochemicals and equipment, extent and method of irrigation, yields, residues;
- Fuels - prices, moisture content, calorific value, yields, locations, uses, preparation, conversion, and distribution;
- Water supply - location of source, allocation, level of consumption, uses; and
- Markets - prices of major fuels, appliances, industrial products and sources of fuels sold.

Transition Survey

The transition surveys were technology-specific and were originally intended to be conducted just prior to project implementation or during the early stages of operation. These surveys collected a variety of specific data related to the potential uses of the new technologies, the activities and materials for which these technologies provide a substitute, and the resources used prior to the introduction of the new technologies.

These surveys explored the problems associated with introducing the technology into a village including: the difficulty in familiarizing the villagers with the uses of the technologies, the training or availability of the required labor skills for constructing and operating the technology, the operational problems with the technology during the start up phase, and the ability of the community to organize support for the use of this technology. Different surveys were prepared for each technology.

Evaluation Survey

Since evaluation surveys, as originally planned, have not yet been carried out, the description in the following paragraphs is not what was actually done, but rather a description of evaluation surveys as proposed by Meta Systems Inc. in the original proposal submitted to USAID.

The evaluation surveys were planned to measure the changes resulting from the operation of the new technology and the problems of acceptance. The earliest evaluation surveys were to be used to revise the operation of the existing units and to modify the design and implementation plans for subsequent units. These evaluation surveys were also to provide information to assist in planning the technology diffusion program and to prepare cost-benefit analyses.

The evaluation surveys were to be conducted at intervals following the start up of the technology experiments. The frequency and total number of surveys would vary depending on the technology and the planned period for experimentation. In general, evaluation surveys would be organized every six months. They would be structured to determine both the problems which had developed since the start up and the success which the technology had achieved in reaching its goals (as stated in the plans developed from the component scope of work and the baseline survey). The survey procedures and documents would be prepared following the acceptance of the plans for the different technology experiments.

C. SIGNIFICANCE

In Research and Development, which requires the development of technology research as well as the application of the research findings to the development of the communities, the interrelationship between

technology research and social science research is most crucial. Scientists and engineers realize now that development in research on technology may progress to the point where new technology is invented but the implementation and acceptance of the newly developed technology in communities requires another kind of research unfamiliar to the scientists and engineers. It is at this point that cooperation between technical experts and social science experts is necessary.

The survey component was designed to assist the scientists and engineers in accomplishing their research and development activities. The significance of the surveys lays in the provision of systematic records of the community characteristics before, during, and after implementation. These records will help in identifying weaknesses and strengths of the projects leading toward the failure or success of a specific technology.

D. SCOPE OF THE WORK

The Transition and Evaluation Surveys were carried out in the villages where technologies were being tested. The surveyors were selected from among the surveyors and supervisors who worked on the baseline survey. They used both formatted interviews and participant observations. These survey activities were designed to be less comprehensive than the baseline survey. The survey formats were prepared by the consultants using the information gathered for the baseline surveys and the implementation schemes for the different technologies. The analysis of the data collected was performed by the surveyors under the direction of the consultants who were then responsible for preparing reports on the findings.

The number of sites and types of technologies determined the number of survey visits to be performed, subject to budget limitations. Each visit was expected to require two weeks with half a week of training and preparation and half a week for analysis and debriefing. Frequency of site visits were to be twice a year unless technical or seasonal factors necessitated more frequent visits.

The experts in the technologies were to review the transition and initial evaluation surveys to determine if design modifications and operational changes needed to be instituted in the field to improve performance. The surveys were also to be reviewed by the consultants and their counterparts to prepare plans for subsequent implementation and diffusion activities.

E. ORGANIZATION OF THIS REPORT

Materials included in this report are:

1. Preliminary preparation activities carried out by Meta System, Inc. (1981);

2. Baseline surveys carried out by Meta Systems, Inc., Phase I , (1981);

3. Transition surveys carried out by Meta Systems, Inc. in the Woodlot Component and Community Biogas (although the technology of the Biogas Component was developed using NEA funds) 1981-1982; and

4. Baseline/transition surveys carried out by the NEA Survey Team in the Micro-hydro, Windmill, and Photovoltaic Water Lifting Components (1983-1984).

Chapter 2

Concepts of the Survey

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CONCEPTS OF THE SURVEY

A. BACKGROUND

The survey component is designed to be part of a large research and development project on renewable nonconventional energy. It is therefore appropriate to review some of the development concepts proposed and utilized by many agencies working on development.

B. THE WESTERN DEVELOPMENT MODEL

For many decades, developing countries patterned their development on the Western model; to reach the development stage, however, required one to find both the means and the ways. The theory of 5 stages of development (Rostow,1960 and 1971), is a good example of a theory following this concept. According to this model, "underdeveloped" people and nations must change their ways of living, their socio-cultural beliefs, their political organization, etc. in order to become "developed" according to the Western model. Technology transfer and diffusion were some of the concepts used, especially in the earlier period of development studies (Rogers, 1962 and Lerners, 1958). It was later found that technology could not merely be brought into the community to make that community developed. It took more than diffusion of technology or innovation for development to take place.

Economic Indicators as Measures of Development

Following classical economic theories emphasizing demand, supply, profit-making, and the like, a development model was one in which communities were evaluated to be more developed or less developed using certain economic indicators, such as average nationwide per capita income. After this development model was heavily criticized, the gini coefficient was introduced as a second indicator to measure income disbursement or distribution. However, many critics were still not satisfied because not all social conditions were considered.

It appears that though economic indicators have enabled analysts to make certain conclusions, final conclusions cannot be made because either the micro-data were not accurate enough and/or qualitative data were not included in the analysis. In the case of Thailand, Oey Astra Meesook (1979), in her World Bank report, came to the following conclusion:

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"In considering the related issues of growth and equity with respect to Thailand, we thus conclude that economic growth has been accompanied by a reduction in regional and urban-rural disparities in household incomes and in the proportion of the poor population in the total. Moreover, to the extent that the reduction in disparities originates from direct improvements in the agricultural sector, then we have not witnessed any trade-off between economic growth and equity; agriculture-based growth has itself improved agricultural incomes, and hence also aggregate income, and at the same time led to a reduction in disparities between agriculture and non-agriculture, as well as across regions. One would, however, have to know what has happened to the distribution of income within the agricultural and non-agricultural sectors themselves before drawing final conclusions on this issue. As far as the role of the government is concerned, however, the resources available to it have not been used in such a way as to contribute to a reduction in the disparities in the living standards across major population groups."

Social Indicators as Measures of Development

The criticism of economic indicators as a means to measure development led to the identification of social indicators to measure development. So far, no one has come up with an agreed upon set of social indicators. Many have reached the conclusion that it is not possible to identify a specific set of social indicators. However, the social indicators identified or those in the process of being identified are items which are quantifiable, such as life expectancy, literacy rate, infant mortality rate, etc. (Morris, 1979). Even if these sets of variables are identified as social indicators, critics will still not be satisfied because non-quantifiable items were excluded.

C. NON-WESTERN DEVELOPMENT MODEL AND RENEWABLE NONCONVENTIONAL ENERGY

Many international agencies now promote development concepts which are more relevant to the quality or characteristics of development processes than to the measure of development itself. This approach stems from the rejection of Western Development Models which were appropriate for Western societies but were not necessarily appropriate for non-Western societies. Third World countries should have a different process of development. They will not be able to reach the take-off stage of development identified by Rostow, and they should not try. Ways of living are different due to different ecological and geographical conditions as well as socio-political-economic conditions. If Third World countries try to follow development models designed by the West for the West, they will end up being dependent on a Western economic system and will become worse off economically and socially than they were before.

Two important concepts which were being promoted and followed as appropriate development strategies for Third World countries were the concepts of self-reliance and popular participation (Uphoff, Gohen and Goldsmith, 1979 and van Heck, 1979). In this project, these two concepts were used in developing questionnaires for baseline surveys and it is recommended they be followed in the implementation of technology. They are elaborated upon in the following paragraphs.

Self-Reliance

In the renewable nonconventional energy project, energy supply and demand of the communities were two of the most important factors to be identified. The identification of available sources of energy supply indicated the energy technology most appropriate for implementation. The identified energy demand helped determine the magnitude or amount of energy needed to make the community self-reliant. In other words, self-reliance in energy supply is the goal of energy technology in any given community. A renewable energy supply will prevent community dependence on imported fuel.

Participation

The process of making energy available for community use should be participatory. Villagers should be involved in identifying the energy problems and the energy demand and supply for their village, as well as in deciding upon an alternative energy supply which could be introduced through the implementation of energy technology. Once appropriate energy technology is identified, villagers should contribute their labor and/or income in making the energy technology available. Energy technology should not be handed out, leaving it up to the community members to accept or reject the technology. Villagers should be involved and participate from the very beginning in bringing energy technology into their community. Their participation will indicate their needs and their willingness to operate and maintain the technology in the future. Villagers' participation will also create a sense of belonging in the project and in the community, and will prepare them for O&M (operation and maintenance) after the project is completed.

D. THE CONCEPTS OF SELF-RELIANCE AND PARTICIPATION IN THE SURVEYS

The concepts of self-reliance and participation were built into the survey design during preliminary preparation, the baseline survey, the transition survey, and the evaluation survey.

Preliminary Preparation

Secondary data sources were studied to help in identifying regions where certain sources of energy supply were located. For example, the South was identified as having available sufficient wind as required in the windmill water lifting component. The Northeast was identified as having available biomass material such as agricultural waste and animal waste. The North contained sources of water for minihydro and wood for charcoal making. And the Central region represented an ecological zone of fruit growing and other lowland caltivation. The identification of the survey area based on ecological zoning and availability of resources was done in order to make the selected communities self-reliant in energy supply.

Baseline Survey

In the baseline survey, in addition to collecting information on energy supply and demand, information on sociocultural conditions, existing factionalism and/or group participation activities were also collected. The baseline questionnaires and researcher's observations and field notes were designed to enable the survey team to identify villages for implementation of appropriate energy technology leading towards self-reliance in energy supply through participation of villagers. For site selection, potential group participation in energy activities was one of the most important criteria considered.

Transition Survey

The concept of popular participation became very clear in the transition survey. In order to implement energy technology in a village, the social science researcher made preliminary contacts, got villagers together in a meeting to introduce the technology, and asked for their agreement and cooperation. This step was necessary for the transition survey to be carried out properly according to the proposals in the concept papers. It was at this stage that interrelationships between technical people, social science researchers, and villagers became crucial. Where cooperation was possible, villagers contributed towards the implementation of the technology. They felt that the technology was community property to be looked after for the well being of the community. The concept of participation and involvement of villagers was a technique to bring villagers into the project at the earliest possible stage and to prepare them to take over the project when the technical people left the project.

Evaluation Survey

Criteria for evaluating the success or failure of the implementation of any energy technology was not simply a question of whether or not the technology worked, but the evaluation was based on how the technology worked in the community setting. A biogas digester might work technically but if the villagers did not use it, the implementation of this particular energy technology was evaluated to be a failure. When technology failed to serve the community, something must be wrong -- and the evaluation survey of any research and development project should be designed to detect the weakness in implementation and to make adjustments accordingly. A successful project is a project where users (villagers or another target group) adopt the technology and are able to maintain and operate the technology without having to depend on outside assistance.

Chapter 3

Baseline Survey

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BASELINE SURVEY

A. BACKGROUND

Baseline surveys were carried out by Meta Systems Inc. with consultants from Chulalongkorn University, Chiang Mai University, Khon Kaen University, and Kasetsart University. In addition to consultants, field coodinators, field supervisors, and enumerators were also recruited from the four universities. The 10 provinces were selected based on their ecological zone and after the provinces were selected, 5 villages were chosen in each province. The 5 villages were required to be located in the same vicinity in order for field supervisors to visit the enumerators regularly, using motorcycles as their means of transport. The survey of the 10 provinces took place between March and June of 1980. The surveys were divided into 2 phases covering 5 provinces in each phase.

However, additional requests were later made to carry out baseline surveys in Nan and Buriram Provinces. Therefore, Phase III was included in the survey, but the data were not included with the original data and are not discussed in this chapter.

B. PURPOSE OF THE BASELINE SURVEY

The baseline survey had two goals. The first was to provide general data on village activities and energy-use patterns which might be changed by the introduction of renewable energy technologies. These data were used for the selection of sites where the technologies would be demonstrated and for comparison with data to be gathered in evaluation surveys following the demonstrations. The second goal was to provide basic research data for the participants in various components of the project. The baseline survey was extended to include: collection and analysis of biomass samples for the Biomass Assessment component, observation and measurement of the uses and availability of different species of trees for the Woodlot component, experiments on stove operation and efficiency for the Stove component, observation and measurement of charcoal making for the Charcoal Kiln component, observation and measurement of rural industry for the Industrial Conservation component, survey questions on water supply and irrigation for the Water Lifting component, measurement and analysis of animal dung production for the Biogas component, survey questions on electricity use and community organization for the Micro-hydro component and survey questions on local examples of appropriate technology and local sources of credit for all technology components.

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C. SURVEY HISTORY AND LOCATION

The survey was performed in two phases. In the first phase teams were sent to Petchburi, Korat, Srisaket, Kampangphet, and Lampang during the period March-April 1981. In the second phase teams were sent to Songkhla, Chantaburi, Roi-et, Udorn Thani and Chiang Mai during May 1981 (see Table 1). Preparation of the survey documents, pretesting and training survey teams occurred from mid-February until the beginning of the Phase I survey. Data processing commenced after Phase I but did not become a full-time activity until the middle of June. The analysis of all data except computerized questionnaire data was completed by the end of July, and the computer data was processed in the month of September 1981.

The first phase of the survey was conducted during the dry season. The only interruption occurred during the period of the abortive April 1 coup attempt. The second phase occurred at the beginning of the rainy season in all provinces except Roi-et. The collection and transport of samples was hampered by the weather.

D. DEVELOPMENT OF SURVEY DOCUMENTS AND PROCEDURES

The survey documents and procedures were to a large extent derived from on-going research activities in Thailand. The basic household survey evolved in four stages: the preparation period, the baseline survey, the transition survey, and the evaluation survey. First, existing household survey documents developed by the participating universities were reviewed and a composite document was prepared by the survey supervisors. To this was appended Thai translations of an energy survey which had been used in Indonesia and a water supply survey derived from survey work in South America. The completed document was reviewed by the survey coordinators in a three-day workshop. The revised document was then field tested in the central region of Thailand by the survey supervisors and a final revised version printed for Phase I of the survey. Following Phase I, the document was reviewed by the survey supervisors and coordinators in a three-day workshop. Inappropriate or meaningless questions were eliminated, vague questions were reworded, and additional questions evolved in Phase I were incorporated. The revised document was printed for use in Phase II. A final workshop was held with the coordinators and supervisors at the end of Phase II to determine basic problems with the survey document and procedures as well as with the planning and implementation of the survey.

The methodology and procedures for the measurement, collection and analysis of biomass samples and mapping of village land use were prepared by participating researchers from the Faculty of Forestry at Kasetsart University whose expertise included forestry, scatology, and watershed management. They prepared a manual of instruction for the collection

TABLE 3.1

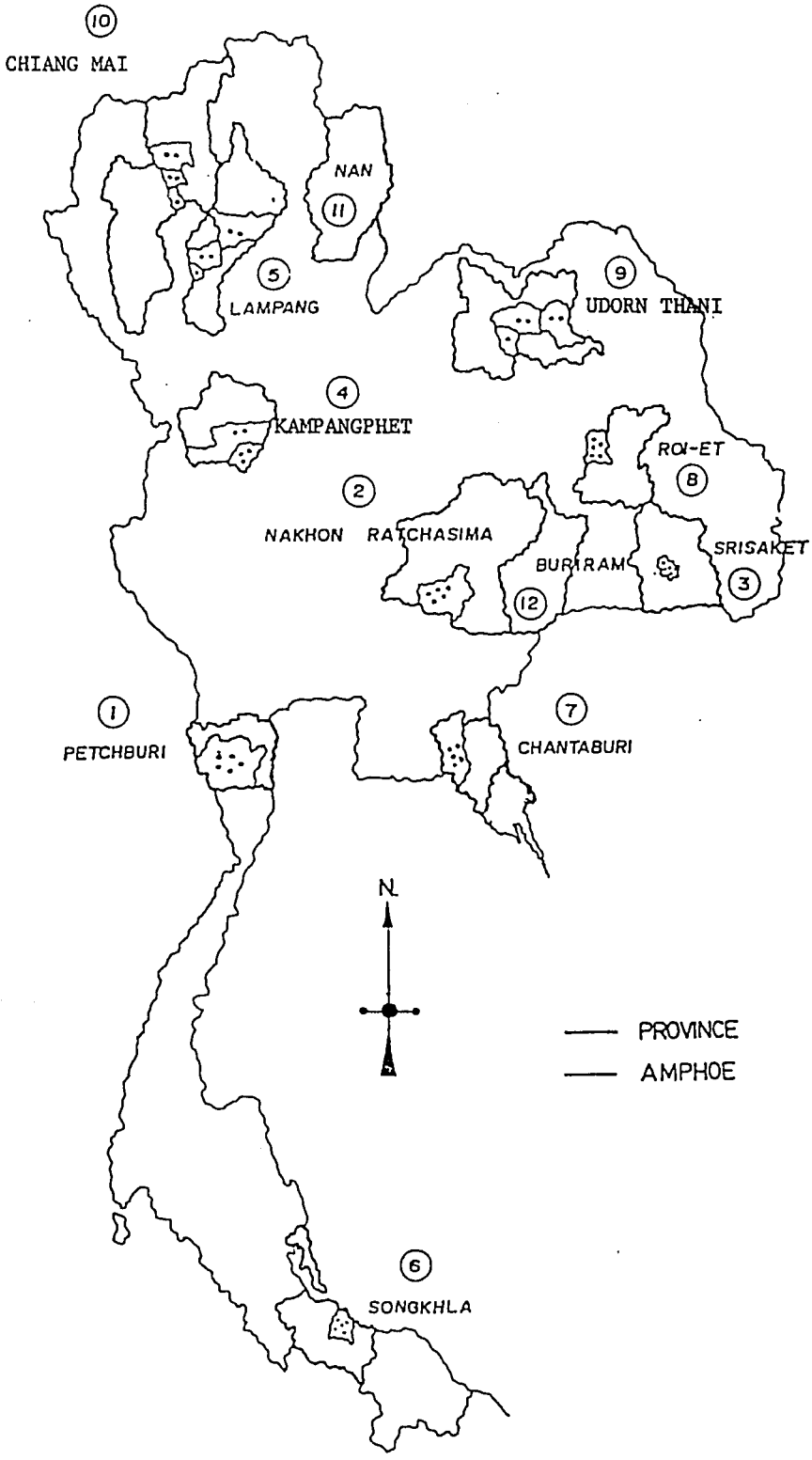
AREAS SURVEYED

PETCHBURI (17 March-17 April)	POPULATION
MAE PRACHAN (1)	750
WANG KAI	700
NONG KATUMP	600
TAHUALOB	800
MAE PRACHAN (2)	602
KORAT (17 March-17 April)	
NONG SALA	300
NON LEUM	800
NON NGUE	850
SRA NOI	580
SRA NOI	450
SRISAKET (20 March-20 April)	
KAO	580
KOK	853
PRAN	520
MAIKAND - SANGKAN	582
PONG	575
KAMPANGPHET (25 March-22 April)	
PREUKMAKUD	550
HUATUNGNOI	600
WANGCHAPOO	2100
BO - TUM	1900
HADCHAOM	1200
LAMPANG (25 March-22 April)	
MAEPUNG	500
LAI HIEN	1857
SALADONGLAN	1011
RAINANOI	2012
BAN PAO	604

SONGKHLA (4-29 May)	POPULATION
PACHING	500
TUNGPHRA	300
PABHU	300
SAI KHUNG	319
CHAI NA	250
CHANTABURI (4-29 May)	
BANG RAHONG	420
NAZA	480
BAN GROG	400
KLONG BON	420
PAK TAPON	250
ROI-ET (7-29 May)	
NONG VANGYAO	658
PA NAI	532
PA VER	462
BAN KUAJ	420
BAN KO	917
UDORN THANI (7-29 May)	
NONG BUADEANG	1019
KHA WUA	631
BAN MEN	568
SAM KHA SAN TISUK	953
KHOK SRICHEINGMAI	1440
CHIANG MAI (7-29 May)	
MAI HO PRA	731
KHEELEK LUANG	700
SANPATOUNG	600
BAN HONG	535
TONG GUY	1159

FIGURE 3.1

BASELINE SURVEY SITES



of different types of biomass and instructed the supervisors on these techniques. Following Phase I these techniques were reviewed by the researchers and the supervisors and revisions in procedure were made. Also, at the researcher's suggestion, five forestry students were recruited to assist the survey teams in cartography and identification and measurement of local wood sources. Following Phase II, meetings were held with the researchers to discuss additional problems. A summary of these problems was included in the report, "Collection and Analysis of Biomass Samples".

The methodology and documents for the stove testing activity were derived from the work of Stephen Joseph and his colleagues at the Intermediate Technology Development Group. For the charcoal-making activity, procedures and documents were prepared by research personnel from Meta Systems Inc. The rural industry survey methodology and documents were developed from a similar survey conducted in Indonesia.

Additional survey documents were developed by the survey coordinators and researchers, field tested by the survey supervisors and revised based on the experiences of Phase I.

The training of the survey supervisors in survey procedures was performed by the survey coordinators and research personnel. All documents and all instructions were in Thai with the exception of the instructions in stove testing, charcoal making, mapping and general measurement procedures which were given in English and Thai.

E. CHANGES BETWEEN PHASES

The household questionnaire was edited between Phases I and II in order to account for problems in Phase I and to expand on certain areas such as credit and transportation.

The sample collection procedures were modified between Phase I and Phase III because of the problem of deterioration in samples which were stored in the field for long periods without being dried. Specifically, the dung and recently-cut biomass samples were sun-dried before being placed in containers in Phase II.

The mapping and forest survey procedures remained unchanged from Phases I to II. However in the second phase graduate forestry students from Kasetsart were brought in to assist each team. The increase in quality of data collected was significant.

Other procedures and activities were unchanged between the first and second phases.

The writing of essays as a mechanism for data collection was introduced after the first phase, but the enumerators were unprepared to answer accurately many of the questions posed in the essay outlines. Following Phase II, the enumerators were much better prepared.

The sample size was cut by 10% from Phase I to Phase II due to time constraints imposed on the enumerators by the end of their vacation period. The charcoal-making observations were reduced because of limited activity during the start of the rainy season. Field residues were also less available during the second phase.

F. DESCRIPTION OF SURVEY COMPONENTS

The survey as conducted by the enumerators, supervisors and coordinators involved a number of activities. These activities included interviews, physical measurements and participant observation. A summary of these activities is presented below:

- HOUSEHOLD QUESTIONNAIRE - 190 households in 50 villages in 10 provinces were interviewed. The subjects covered included employment, agricultural practices, energy use for cooking and lighting, cooking and stove characteristics, credit, water supply, community participation, transport, livestock ownership, use of fish ponds, tree crops, home industry, possessions, and house construction.

- INFORMANT INTERVIEWS - Unstructured interviews were conducted with local leaders including the village headman, abbot, teacher, health worker, community development worker, agricultural extension agent, agricultural bank manager, and energy sellers.

- LAND USE INVENTORY - Maps were prepared of the land use within the village. An inventory of the land use was indicated within the blocks of a 0.5 by 1.0 kilometer grid by the enumerators.

- CHARCOAL MAKING OBSERVATIONS - Measurements were made of the amount of fuelwood used to make charcoal and the amount of charcoal produced. Samples were collected to be analyzed for moisture and energy content. The process, length of time and amount of labor required were also recorded. About 67 charcoal making activities were observed.

- STOVE TESTS - Three tests were conducted on selected household stoves: a boiling water test to determine absolute efficiency, a cooking test to determine relative efficiency and a cooking observation test to determine how villagers use their stoves for normal cooking activities. These observations were made for different types of stoves and different types of fuels. In total about 125 stoves were tested.

- BIOMASS SAMPLE COLLECTION - Samples of dung, fuel wood, charcoal, and agricultural residues were collected. These were tested for moisture and energy content. Approximately 1000 samples were tested for moisture content and about 150 for energy content.

- DUNG COLLECTION - Data was collected on the amount of dung produced by buffaloes, cows and pigs. Samples were collected for testing. Data on the species, size and sex of the animals was recorded.

- FOREST SURVEY - Wooded areas supplying fuel for the villagers were surveyed to determine the amount of standing biomass and the species. Data was also collected on the uses for different species.

- FIELD RESIDUE SURVEY - Field residues (following recent harvest activities) were measured to determine the amount of biomass available from a harvested field. Samples of potential fuels were collected for analysis.

- PHOTOGRAPHIC SURVEY - Photographs were taken of the stove and charcoal-making tests, the land use, village technologies, rural and home industries, and village architecture and layout.

- RURAL INDUSTRY SURVEY - Small-scale rural industries were observed in each province. A total of 55 establishments were visited and the managers were interviewed about their operations. The amount of fuel used as related to the product was measured. Fuel samples were collected where biomass fuels were used.

- APPROPRIATE TECHNOLOGIES - Local technologies and renewable energy technologies were selected in each changwat and interviews were conducted with the owners.

- ENERGY SELLER - A structured interview was conducted with tradesmen who sold fuels in the survey villages.

G. DESCRIPTION OF DATA ANALYSIS

Computerized Questionnaire Data

A large part of the data collected in the household questionnaires was machine-coded for computer processing. The data which was captured on the computer are marked on the questionnaire forms contained in Report XII (Meta, 1982). The format in which this data was stored was presented in Report XIII (Meta, 1982).

The data were initially entered through a data entry system and then transferred from diskette to tapes. The tapes are 9 track, 1,600 EPI, EBDIC-coded records. The basic record structure was formatted according to the pages of the questionnaire records and these were sorted according to village and province.

The data on the tape were checked in five ways; first by the supervisors spot-checking the questionnaires in the field, second through verification of the data during keypunching, third by range checking during entry, fourth by visual inspection of the resulting data and fifth through a series of consistency checks performed by the computer. Where problems were identified, the original questionnaires were consulted and corrections made where indicated. Where the data reported on the questionnaire and entered onto the tapes were illogical, the entry record was marked. Where pages were missing from a questionnaire, a code was added to indicate that the data were not available. This is distinguished from questionnaire pages in which no answers were given because the questions were not applicable to the household.

The computerized data was transferred to disk at the Asian Institute of Technology. Data processing was done using the SPSS software system. Programming was performed by project research assistants.

Forty questionnaires were prepared for each of the villages in the first five provinces. The exception was village number 4 in Srisaket where only 30 households were interviewed. Thirty-six questionnaires were prepared in each of the villages in the second group of five provinces with the exception of village 2 in Roi-et where only 18 questionnaires were prepared. Households were selected by the survey personnel in consultation with the village leader. The population was divided into three classes of wealth and into agricultural and non-agricultural families by the village leader and the survey sample was chosen on a proportional basis.

The questionnaires were identified by a basic code which indicated the province, the village and the number of the family. A translation of this code together with the sample size is shown in Table 2. The questionnaire page record numbers were identified by a separate code. This code and a description of what was contained in the record was included in Report XIII (Meta, 1982).

TABLE 3.2

VILLAGE SAMPLE SIZE

Code	Name	Sample Size	Total Household
	1. Petchburi		
11	MAE PRACHAN (1)	40	124
12	MAE PRACHAN (2)	40	73
13	WANG KAI	40	109
14	NONG KATUMP	40	83
15	TAHUALOB	40	163
	2. Korat		
21	NONG SALA	40	67
22	NON LEUM	40	140
23	NON NGUE	40	155
24	SRA NOI	40	85
25	SRA NOI	40	78
	3. Srisaket		
31	KAO	40	85
32	KOK	40	134
33	PRAN	40	82
34	MAIKAND-SANGKAN	30	87
35	PONG	40	86
	4. Kampangphet		
41	PREUKMAKUD	40	100
42	HUATUNGNOI	40	120
43	WANGCHAPOO	40	447
44	BO - TUM	40	340
45	HAKCHAOM	40	150
	5. Lampang		
51	MAEPUNG	40	100
52	LAI HIEN	40	327
53	SALADONGLAN	40	272
54	RAINANOI	40	334
55	BANPAO	40	123

TABLE 3.2 (Continued)

VILLAGE SAMPLE SIZE

Code	Name	Sample Size	Total Household
	6. Songkhla		
61	PACHING	36	140
62	TUNGPHRA	36	76
63	PABHU	36	100
64	SAI KHUNG	36	115
65	CHAI NA	36	60
	7. Chantaburi		
71	BANG RAHONG	36	77
72	NAZA	36	85
73	BAN GROG	36	73
74	KLONG BON	36	80
75	PAK TAPON	36	45
	8. Roi-et		
81	NON VANG YAO	36	94
82	PA NAI	18	76
83	PA VER	36	66
84	BAN KUAJ	36	60
85	BAN KO	36	131
	9. Udorn Thani		
91	NONG BUADEANG	36	105
92	KHU WUA	36	86
93	BAN MEN	36	78
94	SAMKHA SANTISUK	36	100
95	KHOK SRICHEINGMAI	36	180
	10. Chiang Mai		
01	MAI HO PRA	36	160
02	KHEE LEK LUANG	36	176
03	SANPATOONG	36	141
04	BAN HONG	36	107
05	TONG GUY	36	236

Included in this report (in Chapter IV) is an analysis of the baseline data, since the cross-tabulations of variables recorded by Meta Systems in 1982 was considered inadequate. Statistical analysis was attempted. However, due to time constraints and data recording difficulties, only data collected in Phase I was analyzed and presented in Chapter IV. Additional analysis will be made in due course.

Essays for Non-household Data

Information about the village rather than the individual households was collected through informant interviews and participant observation. The data from the informant interviews was initially recorded in field notebooks. After returning from the field the enumerators were asked to prepare a series of essays on specific topics related to energy use and renewable energy technologies. The essay outlines covered most of the questions asked in the informant interviews. Where additional datum was needed to complete the essays, the enumerators had to rely on their field notebooks. The essays were prepared jointly by the two enumerators that worked in each village.

The nine essay topics were:

1. Basic Data - describing the village and basic demographic data;

2. Agricultural Crops and Activities;

3. Agricultural Processing and Marketing;

4. Energy Supply and Demand;

5. Woodlots - describing the resources available for establishing woodlots and the need for the woodlot;

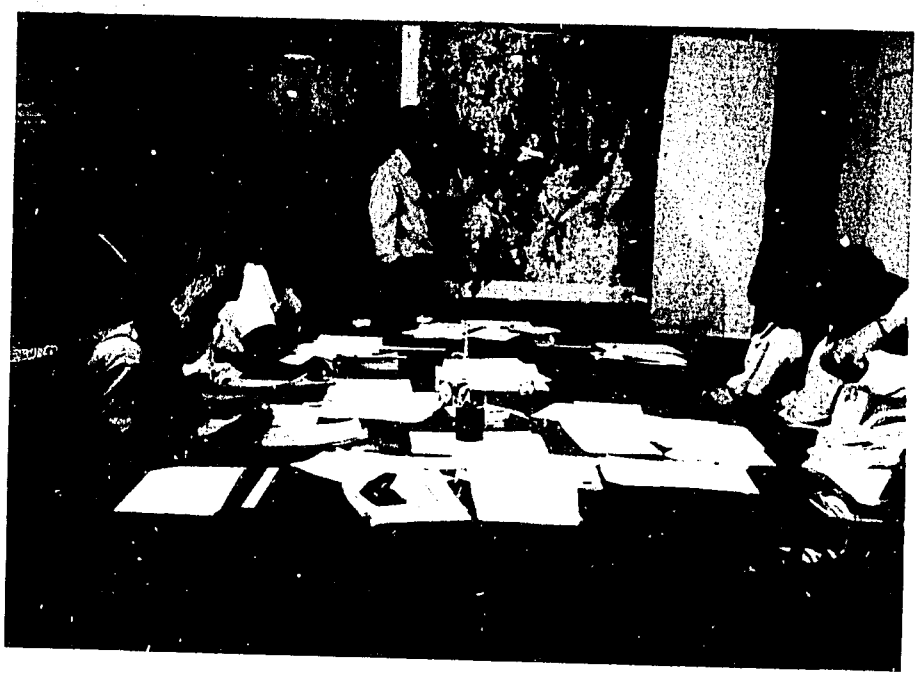
6. Cooking Stoves and Charcoal Kilns - describing the types of stoves and kilns used in the village and their use;

7. Biomass, Pyrolysis and Gasification - sources of biomass and their potential use for pyrolysis and gasification;

8. Solar, Crop Drying, Water Distillation, Water Lifting and Micro-Hydro; and

9. Village Development - describing village leadership and paths of innovation.

In addition, the enumerators completed questionnaires listing village problems and useful project technologies and rank ordered them for each village.



Photograph 3.1 Preliminary Preparation: Coordinators and Supervisors Planning and Preparing the Questionnaires.

Photograph 3.2 Supervisors Receiving Basic Training on Renewable Energy Equipment Systems.

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Photograph 3.3 Supervisor Interviewing Village Headman for the Village Profile in Yala Province.

Ancillary Questionnaires

Questionnaires used in addition to the household questionnaire included those used to interview operators of rural industry, owners of appropriate technology, energy sellers, and energy administrators. The data from all of these questionnaires was manually processed.

The data on rural industries included information on technologies, processes, utilization of labor and fuel, and sources of capital. The findings from some 55 establishments were compared with earlier survey work undertaken by the NEA in Thailand as well as secondary sources including the International Labour Organization (ILO), the United Nations Industrial Development Organization (UNIDO) and others.

The questionnaire regarding appropriate technology presented problems because of difficulties in defining "appropriate technology". Among the technologies examined were powered water pumps, portable power units, biogas digesters, stoves using rice husk and sawdust, water lifting devices, small-scale generators, foot-powered threshers, small transport units, small crop-processing units, and water filters. The owners' responses regarding the uses, benefits and disadvantages of these technologies were summarized in the interim report.

The questions asked of the energy sellers and administrators concerned current and future problems affecting the supply of and demand for energy. The majority of the energy sellers handled petroleum products. The energy administrators included the village headman and the district officers.

Biomass Samples

Five types of biomass samples were collected during the survey:

1. Fuels used in stove tests and charcoal-making tests;

2. Agricultural field residues;

3. Animal dung;

4. Cooking fuels other than those used in the stove tests; and

5. Fuels used in rural industries.

The samples were collected and placed in plastic bags or aluminium foil. The weight of the sample and the container was recorded as well as the reason for collection. The samples were then brought back to the laboratory where they were weighed a second time and transferred to drying ovens. The losses of weight between collection and transfer to

the laboratory and while in the drying ovens were added and compared with the initial sample weight to determine the moisture content. The samples were then screened and a sub-sample selected for testing in a bomb calorimeter to determine their heat value*.

The data on moisture content were used directly in energy calculations concerning the samples. Since only a subset of the samples was tested for heat value, an attempt was made to determine standard values. The data on heat values of the dried matter were analyzed for consistency for each type of biomass and between points of collection. Where the energy content for a given type or species of samples proved to have a low variance, a standard number was calculated and used in the energy calculations for the untested samples.

Stove Tests

Two stove tests, one for calculating absolute and the other relative efficiency, were conducted on 72 charcoal stoves and 58 wood stoves. For the first, the heat captured in the boiling water tests was computed by recording the increase in temperature of the water and the amount of water evaporated during the test. The calculation of heat released from the fuel was computed from the heat value and moisture content of the fuel and the amount burned. Where not directly measured, the heat value was estimated from the standard number for that fuel. The information on efficiency of different units was aggregated according to basic stove and fuel types. The reasons for variation in efficiency were examined to determine the important variables affecting stove operation.

Charcoal Making Tests

The observations of charcoal making included the measurement of the fuel input to the process and the charcoal produced. This data was calculated on a weight and energy content basis for both inputs and outputs. The energy content was computed by taking samples of both the input fuels and the charcoal and performing tests for moisture and heat content. The information on the quality of charcoal (as measured by heat value and moisture content) and the efficiency of conversion (as measured by energy input versus energy output) was aggregated according to type of input fuels and kilns. The variables associated with the production process were then examined to determine their effect on the conversion efficiency and quality.

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* The information determined from a bomb calorimeter is properly referred to as the calorific value or heat value. However, in parts of this report the terms energy content or heat content are used as synonyms though in fact they are not.

3.4 Charcoal-making Survey to Test the Efficiency of the Charcoal Stove.

3.5 Fuelwood Measurement for Assessment of Cooking Fuel Potential in Chiang Mai Province.

Agricultural Field Residues

Where recent harvest activities had taken place or were about to occur, measurements were made of the amount of plant residue left in the field following harvest. A fixed area was demarcated and the residue within that area collected and weighed. A sample of the residue was taken and processed in the laboratory to determine the energy and moisture content. The energy content per unit area was calculated and statistics prepared for the same species in different locations. Factors affecting the variation in these statistics, including density of planting and plant height, were analyzed.

Animal Dung

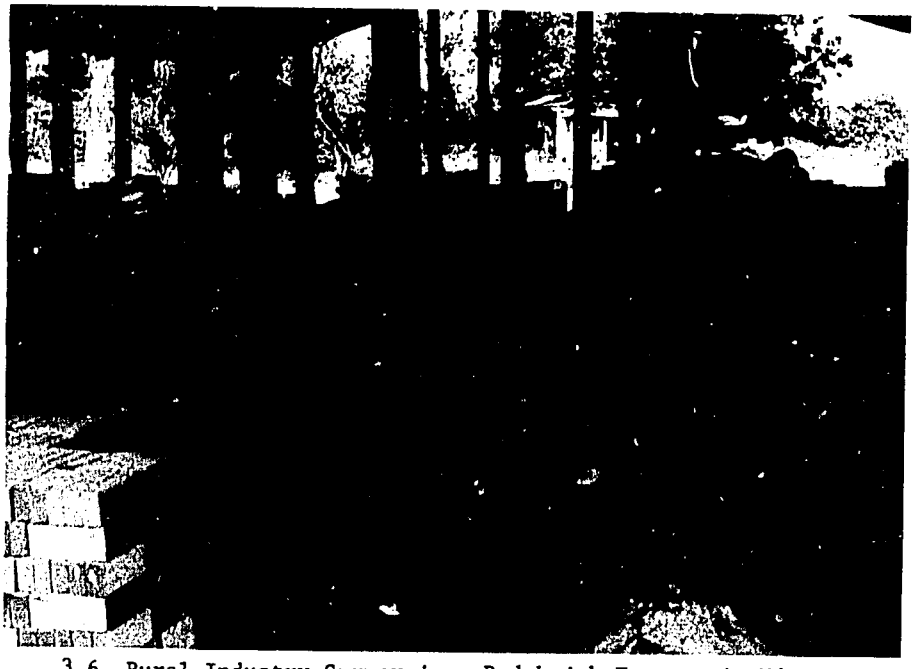
Data on the amount of dung produced by different animals were collected by hiring villagers to observe the number of times during a day that the animals produced dung and then weighing typical feces. A sample was collected from these feces and sent to the laboratory for moisture and heat value measurements. This data was then used to calculate the energy content of the dung produced by the animal. Statistics were collected for the different species. Variations within species were compared with data collected on the size, sex and location of the animals.

Forests and Wooded Areas

The wooded areas which provided fuelwood for the survey villages were surveyed by demarcating a sample plot and inventorying the trees within that area for species, height, and diameter at chest height. These data were used to estimate the biomass productivity of the sample area and by extrapolation to the entire wooded area. Data on the uses of the different species were collected by interviewing villagers. Other sources of wood in tree crop areas, in agricultural fields and within household compounds were surveyed either through field measurements or as part of the household survey. The data included information on species and number of trees.

Graphical Data

Three types of graphical data were collected as part of the survey activity. The first was a land-use map for each village. These maps were drawn by the supervisors in the first phase and the forestry assistants in the second phase. The maps were prepared by direct survey of the area using motorcycle odometers and compasses to layout the main village road as the baseline. From this baseline a grid pattern was walked by the enumerators with the land use being noted every half kilometer. The measurement of the 0.5 kilometer distance was accomplished



3.6 Rural Industry Survey in a Red-brick Factory in Udorn Thani Province. Data Collected was Used in the Energy Master Plan.

3.7 Efficiency Testing of a Stove Commonly Used by Rural Villagers.

3.8 Supervisors Receiving Training on Sampling Plot for Agricultural Assessments.

3.9 Biomass Collecting: Buffalo Dung Sample.

by fixing the time it took the enumerator to walk cross-country. The maps with the land use marked on them were prepared in the field. Reproductions of these with a standardized scale and format were prepared by the project draftsmen using a 1:10,000 scale. These were further reduced to report size. Copies of maps in the report format were included in Report XIV (Meta, 1982).

The second type of graphical information was the layout of the house compounds. For each house that was interviewed, the enumerator prepared a sketch of the land use within the compound including the buildings. The orientation of the compound with respect to magnetic north was also indicated. These drawings have been collected in their original form by changwat and were stored in folders at the project office.

The third type of graphical data was dimensioned field drawings of stoves, pots and charcoal kilns. These were prepared as part of the stove testing and charcoal making observation activities. These drawings are included with the backup data for the stove and charcoal files in the project office.

Photographic Documentation

Each survey team was provided with a camera and film. They were instructed to take pictures of all stoves and charcoal kilns which were tested. In addition, they took pictures of the village layout and architecture, major sources of biomass, appropriate technologies, and scenes of general interest. The supervisors and coordinators who took part in the rural industry survey were also provided with cameras and film and were instructed to take pictures of the establishment and the production activities. The film was Kodacolor II and prints were produced from all developable negatives. The negatives were catalogued by province, roll number and negative number and a brief description of the subject of each picture was provided. The prints were labeled as to the negative number, roll number, province number, and subject and were stored in photo albums. The albums were separated according to subject as follows:

- Stoves
- Charcoal making
- Rural industry
- General - Petchburi and Korat
  - Srisaket, Kampangphet and Lampang
  - Songkhla, Chantaburi, and Roi-et
  - Udorn Thani and Chiang Mai
- Training and personnel

H. LOCATION OF DATA

About 60% of the information on the household questionnaires was entered onto computer tapes at the Asian Institute of Technology. A description of this data base and the means for analyzing it were included in Report XIII (Meta, 1982). Copies of the tape and access to the data are available for use by project and non-project researchers under the supervision of Robert Vernstrom, the project manager, and the research assistants responsible for programming.

The remaining 40% of the data collected in the questionnaires was manually processed by the survey staff. The data tables were stored in project files.

The non-household questionnaires have been manually analyzed and the data work sheets were stored in project files. All completed questionnaires, household and non-household, were stored in boxes at the project office.

A series of data files were compiled for the physical data collection activities. These include the data collection forms, backup calculation sheets, and preliminary graphics. The files were divided according to subject matter and stored at the project offices. The subjects were:

- Charcoal-Making
- Stove Testing
- Biomass Samples
- Dung
- Field Residues
- Forests and Woodlots

A complete collection of prints and negatives for all photographs taken by the survey personnel were stored in photo albums and binders.

Typed copies of the essays prepared by the enumerators were stored in the project files by subject and village. The classification of the answers given in these essays was stored with the essay as were a limited number of English translations of the better essays.

Maps for each of the fifty villages in report format were prepared with legends to describe the land use within the village. The field originals and report originals were stored in tubes at the project office.

I. ADDITIONAL SURVEYS CARRIED OUT IN 1983, 1984 BY THE NEA SURVEY COMPONENT

Since many of the component leaders preferred to select sites for implementation outside of the sites included in the baseline survey, additional surveys were carried out to record baseline information.

However, the questionnaires and field technique used in the survey were less comprehensive in these cases. Data collected are general socio-economic conditions of the villages. Since these surveys were carried out at the time of implementation, they may also be considered transition surveys as well as baseline surveys. Cases where the surveys of this type were carried out and documented included.

Component	Location
Windmill	Village 4; Tha Thong Subdistrict, Raman District, Yala Province
Micro-hydro	Village 3; Huai Kaew Subdistrict, San Kamphaeng District, Chiang Mai Province
	Village 6, 7, 8; Pa Mieng Subdistrict, Doi Saket District, Chiang Mai Province
	Village 1-7; Huai Puei Subdistrict, Phrao District, Chiang Mai Province
Photovoltaic Cell	Village 1; Non Hom Subdistrict, Muang District, Sakon Nakhon Province.
	Village 10; Ban Sukon, Chum Phuang Subdistrict, Chum Phuang District, Nakhon Ratchasima Province.

Since these surveys served as both baseline and transition surveys, detailed discussion is given in Chapter V on Transition Surveys.

Chapter 4

Analysis of Phase I Baseline Survey

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ANALYSIS OF PHASE I BASELINE SURVEY

A. INTRODUCTION

Baseline surveys made in 1981 were separated into 3 phases. Details were presented in Chapter III. Attempts at analysis were made by Meta Systems Inc. in two stages. Stage one was the preliminary presentation of the data in a 14-volume report where descriptions and tabulations were presented (Meta, 1981). At Stage two analysis was presented in a three-volume series prepared as part of the Energy Master Plan component (Meta, 1983). Since analyses were made for the benefit of the baseline survey data from a socio-economic point of view, it is hoped that the new dimension will provide planners with more insight and a different perspective regarding rural energy use.

B. OBJECTIVES OF ANALYSIS

This analytical Study attempted to reinvestigate the data collected in the baseline survey of 1981, and to see the possibility of applying statistical tools for meaningful analysis. In order to narrow down the above objectives, the following specific items of analysis were proposed.

- An analysis of factors influencing the amount of fuels used in a household;
- An analysis of the indicators of fuel scarcity;
- An analysis of the differentiation between households using different types of fuel; and
- An analysis of appropriate variables to be included in baseline rural energy surveys.

These objectives of analysis were proposed after the overall data reinvestigation had been made. The existing data partly showed what should be analyzed. When the proposed objectives of analysis were put forward, however, it did not guarantee reliable results. Observations of raw data investigation revealed that there were many errors in recording the raw data onto the tapes and in some cases, variables were missing. Because of these limitations, the validity of results from this imperfect data cannot be guaranteed. Therefore, methodology for future project analyses are proposed.

C. SCOPE OF THE ANALYSIS

The data source used in this analysis was the Phase I - baseline survey. It included data from 5 provinces, namely, Petchburi, Korat, Lampang, Kampangphet and Srisaket. The analysis included all 5 provinces since the separation into individual provinces might affect the completeness of data, e.g. it may not reach the requirement of sampling size of a particular analysis. Moreover, though the sampling method was explicitly purposive, the preliminary investigation of basic data from frequency and cross tabulation tables indicated that there was not much difference in fuel consumption among the provinces.

An attempt to include data from the Phase II - baseline survey was not possible since the data was recorded onto computer tapes using a different format; an analysis using complicated statistical tools for two phases with different formats was, therefore, not possible.

This analysis confined itself to charcoal and firewood as cooking fuels and to kerosene as a lighting fuel. This was for three reasons. First, there were studies on the demand and supply of LPG and oil using econometric models. Second, the available data from the Phase I - baseline survey indicated charcoal, firewood and kerosene were the major sources of household fuel. Third, special attention should be given to traditional and noncommercial fuels used in households since there were technology components for firewood and charcoal, e.g. woodlots, charcoal producing unit, etc., in the Renewable Nonconventional Energy Project for which the baseline survey was conducted.

D. METHODS OF ANALYSIS

This analysis tried to involve many variables because it was believed that a single factor could not determine or explain a phenomenon. Consequently, the statistical tools used in the analysis were multivariate, including factor analysis, multiple regression and discriminant analysis. Each objective used a different statistical method. In some cases bivariate analysis, e.g. chi-square test and Pearson's correlation were applied to support multivariate analysis. The methods of analysis for each objective were as follows:

Multiple Regression

Multiple regression helps to identify the variables which determined the amount of fuel used in each household (as corresponds to the first objective of analysis). Besides indicating the relationship between dependent variables and independent variables, multiple regression can identify the pattern of the relationship as well.

The amounts of firewood and charcoal used in the household were set as dependent variables, and these variables were tested to prove their power of determination. Accordingly, an hypothesis was proposed to help select the variables to be entered in the analysis.

Besides the amount of fuel used in the household, multiple regression was applied to sources of non-commercial fuel and other variables. This was to help explain the situation of fuel scarcity as proposed in the second objective.

Discriminant Analysis

Discriminant analysis is used to meet the third objective. It can reveal the important discriminating variables which differentiate one group from another. In this case, discriminant analysis was used to differentiate the households using firewood from those using charcoal. A list of potential variables was entered into the formula and the output indicated the weight as a discriminating variable. An hypothesis was also needed to identify the possible groups of variables to be included in the analysis.

Factor Analysis

A great variety of information was collected from the field surveys. Factor analysis can help reorganize all this information into different groups. Variables which do not correlate with the major groups of variable can be extracted. The results of factor analysis can specify which variables should be included in the over-all analysis. This is only expected to be an exploratory factor analysis. Actually, factor analysis should first be applied for all variables in order to screen related variables and to help organize hypotheses for other analyses.

E. FRAMEWORK AND HYPOTHESIS OF THE ANALYSIS

It should be noted that this analysis was made after the data had been collected. Thus, the framework of analysis was limited within the boundaries of the existing data. Variables were selected on the basis of the completeness of coded data. Certain variables were not included because the data were not complete. Framework and hypothesis were set for each objective as follows:

Fuel Consumption

An analysis of the amount of fuel consumed by each household was designed to identify the variables which apprise us of changes in fuel amounts. In other words, there should be variable(s) to indicate or determine the amount of fuel used in households.

As mentioned earlier, in the Phase I - baseline data the types of cooking fuel used in households were charcoal and firewood; with kerosene being used as a lighting fuel. This pattern is characteristic of households in rural Thailand. The analysis assumed that each household used only one type of cooking fuel, either charcoal or firewood, but not both. The data on the amount of fuel used each day was collected based on the activities in the kitchen of each household. Charcoal and firewood used in other activities were excluded because this did not represent the picture of a rural household.

Next, the question of different types of fuel in different seasons arose in the analysis, but cross-tabulations showed no significant differences in types of fuel used in different seasons*. Only small differences among rice boiling, water boiling, and food cooking were observed.

There was no observed usage of charcoal and firewood for livestock, i.e., as mosquito protection for cows and buffaloes. People preferred to burn agricultural residues or biomas, which could easily be collected near the house, instead of firewood. Therefore, the use of charcoal and firewood was narrowed down to only activities in the kitchen of each household.

Having classified the types of fuel and the purpose of usage, the hypothesis of the study was then examined. Regarding the amount of fuel for household consumption, the factors which may influence the amount of fuel consumed included the following:

- Number of members in the household;
- Number of household members who go out to collect fuel;
- Total household income;
- Total land holdings;
- Number of times of cooking per day;
- Number of cooking hours per day;
- Types of food cooked; and
- Number of meals per day.

The reasons for selecting these variables were:

1. It was assumed that the amount of fuel used each day depended on cooking hours which was determined by the number of times of cooking, number of meals and types of food. Initially, the type of stove was taken into account. However, stove type was not a numeric variable and was not appropriate for multiple regression analysis. There was an attempt to transform stove type into a numeric variable by giving scores for each

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* This judgement was made simply from analysis of the cross-tabulation results available. It cannot be tested statistically, i.e. Chi square, due to incomplete available data.

type. The attempt failed since there was no acceptable quantifiable method based on amount of fuel used. Consequently, stove type was not included in the analysis, though it was assumed that stove design affected the amount of fuel used.

2. Besides variables related to cooking activities, the number of household members could indicate the amount of fuel used as well. It is easily evident that with more people in a household, more food will be consumed. The number of people collecting fuel should also indicate the amount of fuel used. The analysis positively assessed that the number of fuel-collecting members correlated with the amount of fuel consumed.

3. The latent variables which probably determined the amount of fuel used in a household were fuel purchasing power and an available source of non-commercial fuel. The former is considered as income and the latter as land holdings. It was expected that the level of income was more important for households using charcoal than the one using firewood. This was supported by the assumption that people buy charcoal instead of producing it themselves. Likewise, the size of land holding, whatever type of tenure, was expected to be a relevant variable indicating which household used firewood and which one used charcoal.

It was noteworthy to separate land ownership from land rentals since this might also affect the amount of fuel available to be collected for household consumption. Households who own their land should find it easier to collect fuel and consequently should consume more of it.

Fuel Scarcity

Analysis of fuel scarcity included variables which should indicate the situation of scarcity. Generally, the scarcity of fuel is measured by the distance to source; approximately 5 kilometers from home to source of fuel is considered as scarcity. Therefore, we can use the distance to source to determine other variables which might indicate a scarcity of fuel. Responses to the question of how low fuel is obtained should be compatible with distance to source and should also indicate the scarcity of fuel in that household. Two other variables, the changing price of charcoal and the changing type of fuel used in the household, should also indicate fuel scarcity, but these were not included in the field survey. They could be taken into account but could not be put into the analysis.

Differentiation Between Households

The analysis of differentiation between households using charcoal and firewood focused on prosperity and the way of using fuel. In this context, prosperity meant household income, property, land holdings and

other household facilities. The way of using fuel included how fuel was obtained, how much fuel was available and how the fuel was collected. The demand for cooking fuel, as indicated by the total number of household members, should have tole the type of fuel that households would decide to use. The type of stove used should certainly have differentiated households using firewood from those using charcoal.

It was expected that a household's prosperity would facilitate that household's ability to use charcoal. This was based on the assumption that people would prefer to use charcoal if they could afford it. Furthermore, the modern household, indicated by household properties, tended to use charcoal rather than firewood. In analyzing how people gathered fuel, we assumed that a household using firewood searched closer to home but had to go out to gather fuel more frequently because they did not need to use good wood for cooking. Along with different types of fuel, households also stored cooking fuels differently.

Other Variables

For factor analysis, as many variables as are available in the data list should be entered in the two analyses. Different functions of variables were expected, for example, the demand for fuel, household fuel supply, characteristics of the household, household-community participation, and household modernization.

F. RESULTS OF THE ANALYSIS

The Structure of the Variables: Factor Analysis

Since there were almost 2,000 variables, the first requirement of analysis was to determine the structure of all variables. Factor analysis was used for this purpose. The process was limited due to the SPSS program: only 100 variables could be included in one factor analysis. Inevitably, all variables had to be divided into smaller sections. The different sections were, namely, the demand for fuel consumption, household supply for fuel consumption, characteristics of household or socio-economic status, community participation, and household innovation. Variables in those different sections were initiated as shown in Table 4.1.

Some of the variables mentioned overlapped because they were indicated in several categories. Having placed variables into categories, factor analysis was first applied to energy demand and supply. The result found a bad correlation matrix among all those variables written in the SPSS programme (see Annex, Printout 1).

Table 4.1 Presupposition of Structure of Variables

Demand for Fuel	Supply of Fuel	Socio-economic Status	Household Innovation	Community Participation
Source of Water - distance - season - usage Transportation - type - number of trips - distance - purpose Type of Stove Usage Type of Food Cooked Type of Fuel Used - Household activities - Cooking fuel Household Size Household Activities Amount of Fuel Used Number of Hours for Cooking/day Water Boiling, Volume Electrical Appliances Lighting Equipment Expenditure for Electricity	Source of Water - distance - seasons - usage Source of Fuel Availability Fuel Storage - Drying - Method - Place - Time Fuel Gathering - Time in different seasons - Method of transportation distance Household Responsibility on Fuel Gathering Fuel in Different Seasons	Household Size Sex, Age Education Employment - Occupation - Seasonal employment - Type of remuneration Income - Off-farm - Farm Style of House - Size - Material - Kitchen - Pound - Pens - Garden - Compound Household Utilities Agricultural Equipment Land Holdings - Cultivated land Crop - Type of crop - Production distribution Animal Husbandry - Usage - Production distribution Loan, Money Borrowing - Source - Condition	Sickness & Treatment Birth Control - Place - Type - Period Electrical Appliances Agricultural Equipment	Labour Exchange - Sex - Day Group Involvement - Type of group - membership - benefit - meeting Team Working - Preferable person to work with - Participation in community activities - Period of participation

In the analysis, the principle component was used for factor extraction, and factors were rotated by the varimax method. Only 60 variables were put into analysis but a bad correlation still existed among those variables. Factor analysis cannot be processed unless there is some relationship among variables. At this stage, it was assumed that a bad correlation might be due to:

- Missing data and/or error(s) in the data;
- Variable transformation required to avoid small values which could cause the computer system to miss values; or
- Variables inappropriate for factor analysis due to a low scale of variable data.

In the last case, it was evident that many variables had answers or choices scaled from 1 to 3, for example yes or no questions, which were not good for making a correlation matrix. The most appropriate variable should have a scale of answers up to 2 or more (Tong-U-Thai, 1981).

The limitations due to a bad correlation matrix required a reduction of the number of variables until it was accepted with better correlation. Under testing, it was found that only 10 selective variables from this set of data could be applied with factor analysis. Those variables were:

- Household size
- Income*
- Land holding
- Household member collecting fuel
- Distance to source of fuel
- Amount of charcoal
- Amount of kerosene
- Frequency of fuel collecting in Summer
- Frequency of fuel collecting in the Rainy season
- Frequency of fuel collecting in Winter

The results from the computer output are shown in Annex, Printout 2.

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* It should be noted here that net income was not computed due to incomplete available data.

The results revealed that there were four critical factors from 10 input variables. We selected variables which had heavy loadings (usually above 0.3) in one particular factor. Considering loadings after rotation variables could be arranged into factors as shown in Table 4.2.

Table 4.2 Critical Factors and Variables

Factor 1	Factor 2	Factor 3	Factor 4
1. Frequency of fuel collection in Winter	1. Income	1. Household size	1. Distance to source of fuel
2. Frequency of fuel collection in Rainy season	2. Land holdings	2. Number of people collecting fuel	
3. Frequency of fuel collection in Summer	3. Amount of charcoal		
	4. Amount of kerosene		

Factor one explicitly showed variables related to the number of times that people go out to gather fuel. This function was called FUEL COLLECTION. The second factor included variables related to household economic status and to the amount of fuel used. The household economic status was more or less related to the amount of fuel consumed in the household, particularly charcoal and kerosene. This function was called HOUSEHOLD ECONOMIC CAPACITY. The third factor gave only two variables dealing with people and their collection of fuel. This function was known as the SOCIAL ASPECT OF HOUSEHOLD. The last factor consisted of only one variable, distance to source of fuel. Therefore it was a single variable with less correlation with other variables. This factor was the variable itself, which was called DISTANCE TO SOURCE OF NONCOMMERCIAL FUEL. Statisticians may not consider one variable as a factor, but here it was considered as a guideline to variables included in the questionnaire.

The names of variable groups have been presented, to show the structure of the variables. (This is still an example of factor analysis.) Because too few variables were included in the analysis, in terms of research, this factor analysis was not meaningful. A good factor analysis should consist of at least 4-5 variables. In this example it was not worthwhile to add the correlation matrix among the factors as well.

However, the results of the factor analysis revealed guidelines of data to collect for further rural energy surveys. We may make further interpretations of these factors as follows:

The factor of FUEL COLLECTION presupposes that it is a necessity in non-commercial fuel surveys, for example, firewood and charcoal collecting. This factor may include more variables than the frequency of fuel collecting in different seasons. For example, from the existing data, it may include types of wood, methods of collection, transportation, expenditure, places, and some additional personal attitudes towards difficulties experienced in gathering fuels.

The factor of HOUSEHOLD ECONOMIC CAPACITY includes income, land holdings, and the amount of fuel used. This is counter to the assumption that social and economic household status should be combined. The economic indicator, on the contrary, matches with the amount of fuel consumed rather than social aspects which exist seperately in the factor of SOCIAL ASPECT OF HOUSEHOLD. This HOUSEHOLD ECONOMIC CAPACITY is not purely economic but is related to, if not determined by, the amount of fuel consumed. The economic variables, therefore, should be geared to the economic capability of the household to consume fuel. In the field of energy research, the economic variables are cash income, expenditure for fuel purchasing, occupations, types of fuel used, loans, etc.

The factor of SOCIAL ASPECT OF HOUSEHOLD is hard to explain further since it involves only two variables. The existing variables in this factor show how a household obtains and uses fuel. This social aspect may be related to the attitudes of the people toward the types of fuel used; and whether the attitudes are due to economic status, educational level, or cultural heritage. Community modernization and changes in the types of fuel used may give some ideas of what fuels people will prefer to use in the future.

The last factor, DISTANCE TO SOURCE OF FUEL, reveals the implications of fuel scarcity, though there are no accompanying variables in the factor. The variables which indicate fuel scarcity are availability, quality, fuel substitution, fuel conservation, etc.

In addition, an investigation of the variables revealed that there were some redundant and unnecessary variables in the questionnaire used for the baseline survey. Variables which appear several times in the same set of data, such as TYPE OF FUEL and TYPE OF STOVE, cause confusion in analysis. Unnecessary variables, such as fuel used in the beginning and end of a certain season, type of food, and number of people eating per meal, are useless in the Thai social context. First of all, the food in a village is not usually variable. Second, the seasons in Thailand are too short to be divided. Third, it is too specific to deal with the number of people eating at home and at each meal. Researchers should be aware that data relating to stove efficiency are very technical and should not be asked in the questionnaire. Unnecessary variables may cause difficulties in using computer programs. This will become evident in the section on multiple regression analysis.

In conclusion, the structure of variables proposed at the beginning of this section has not yet been reconfirmed, because factor analysis was not efficiently applied for this set of data. However, a small number of variables were tried for factor analysis. Factors derived from analysis represented only part of a presupposed structure of variables. Therefore, unrelated variables cannot be screened. (In other words, variables to be used in the next analysis are eventually determined by the researcher himself.)

What we can propose for future analyses, if factor analysis is successful, is the indicator of a specific aspect of the energy situation in various areas. To this extent, the equation is formulated as follows:

$$F_i = f(v_i a_i)$$

For instance, the coefficient of variables for factor I, FUEL COLLECTION, was used in this equation.

$$F_1 = .76284v_1 + .89657v_2 + .93841v_3$$

where v_1 = Frequency of Fuel Collection in Summer

v_2 = Frequency of Fuel Collection in the Rainy season

v_3 = Frequency of Fuel Collection in Winter

Values of variables, v_1 to v_3, are changed from one area to another. Consequently, the value of F_i in each area is different. The F_i value will compare the situation of FUEL COLLECTION in different areas.

Other factors can be handled the same way. The results will be the indicator of the energy situation under different aspects according to different factors derived from factor analysis.

Scarcity of Fuel: Regression Analysis and Correlation Matrix

In energy planning, it is necessary to know whether or not there is a problem of fuel scarcity in a particular community. The criteria usually used to indicate the scarcity of fuel is distance to source of fuel. Generally, 5 kilometres (in some places even 2 kilometres) from home to source of fuel is considered to be too far, and fuel is considered scarce.

From Phase I - Baseline data, if 5 km was considered as an indicator of scarcity, people did not have to go too far for fuel collecting. It means that fuel was still available nearby or within the village. Table 4.6 also shows that households using charcoal had to go farther. We may assume that the better wood needed for charcoal production was often scarce since

one-third of the households using charcoal had to go farther than 5 kilometres. It can also be observed from Table 4.3 that very few households in the Phase I survey areas used other types of fuels such as agricultural residues and rick husk. It means that people have not yet considered other possible sources of fuel.

Table 4.3 Distance to Source of Fuel

Distance (Km) / Type of Fuel	1-4	%	>5	%	No Answer	%	Total	%
1. Firewood	330	34.2	36	3.7	10	1.0	376	38.9
2. Charcoal	242	25.1	122	12.6	11	1.1	375	38.8
3. Rice Husk	1	0.1	-	-	-	-	1	0.1
4. Agricultural Residue	-	-	1	0.1	2	0.3	3	0.4
5. n.a.	-	-	-	-	209	21.8	209	21.8
Total	573	59.4	159	16.4	232	24.2	964	100

Table 4.6 shows only the distance variable without regard for other relevant variables. Therefore, we created the correlation matrix to include variables other than DISTANCE TO SOURCE. However, our main interest was to see whether any of the variables had a remarkable relationship with DISTANCE TO SOURCE OF FUEL. (See Table 4.4).

The Correlation Matrix table revealed only 2 variables having relationships with DISTANCE TO SOURCE. They were HOUSEHOLD SIZE and FUEL COLLECTING MEMBERS in the household. However, neither seemed to be very highly related: 0.1043 between DISTANCE TO SOURCE and HOUSEHOLD SIZE, and -0.0754 between DISTANCE TO SOURCE and FUEL COLLECTING MEMBERS.

It was surprising that all of the selective variables presented in the matrix could not reveal situations of fuel scarcity because there was no relationship with any known variable indicating fuel scarcity. On the other hand, it might be that DISTANCE TO SOURCE did not indicate fuel scarcity, nor was DISTANCE TO SOURCE alone enough to indicate fuel scarcity. We will discuss it later on.

Table 4.4 Correlation Matrix of the Variables of Fuel Scarcity

	1. Fuel collecting in Winter	2. Fuel collecting in Summer	3. Fuel collecting in Rainy season	4. Amount of Charcoal	5. Amount of Firewood	6. Source of Fuel	7. Distance to Source	8. Energy Producing Devices	9. Household Activities	10. Household Income	11. Fuel collecting members	12. Household Size
1. Fuel collecting in Winter		+	+					+	-	-	+	
2. Fuel collecting in Summer	+		+			-			-	+		+
3. Fuel collecting in Rainy season	+	+						+		-		
4. Amount of Charcoal												+
5. Amount of Firewood						-		-	+		+	+
6. Source of Fuel		-			-					+		
7. Distance to Source											-	+
8. Energy Producing Devices			+		-				-			-
9. Household Activities	+	+						-				+
10. Household Income	+	+	+			+					-	+
11. Fuel collecting members	+	+			+		-			-		+
12. Household Size		+		+	+		+	-	+	+	+	+

Notes: 1. + shows positive correlation
- shows negative correlation

2. This tables derived from Pearson Correlation with level of significance from 0.05 to 0.000.

3. Absolute Figures of Correlation Matrix are shown in Annex, Printout 3.

The question which arose from this Correlation Matrix was how HOUSEHOLD SIZE and FUEL COLLECTING MEMBERS were related to the DISTANCE TO SOURCE. One primary assumption was that household size probably indicated the demand of fuel. Big households certainly needed more fuel which was more available at farther distances. In addition, if there were fewer FUEL COLLECTING MEMBERS in the household, the need to go a long distance was essential, a reverse relationship. However, we believe that HOUSEHOLD SIZE and FUEL COLLECTING MEMBERS do not reflect scarcity in terms of no available source, but they do reflect scarcity in terms of an adequate fuel supply for the whole family. This means that a household may have to go more or less often, farther or nearer than another household, regardless of whether they are easily able to search for fuel or not.

Looking at the matrix, the amount of fuel consumed does not indicate whether people are facing the problem of fuel scarcity; it only reflects the need for fuel. No relationship was observed between AMOUNT OF FUEL CONSUMED, no matter what type it was, and the DISTANCE TO SOURCE. At this stage, variables which show no relation to DISTANCE TO SOURCE will be ignored.

Previously, DISTANCE TO SOURCE OF FUEL was examined in a one-to-one relationship with other variables. We will now look at the relationship of many variables at the same time. Variables from the Correlation Matrix were selected for Multiple Regression. The main question in this analysis was what determines the DISTANCE TO SOURCE OF FUEL. The variables put into the equation were:

X_1 = NUMBER OF FUEL COLLECTING MEMBERS

X_2 = HOUSEHOLD SIZE

X_3 = LAND HOLDINGS

X_4 = TYPE OF FUEL

X_5 = SOURCE OF FUEL

X_6 = FREQUENCY OF FUEL COLLECTING

Y = DISTANCE TO SOURCE OF FUEL

The equation is as follows:

$$Y = f\ (X_1X_2X_3X_4X_5X_6)$$

Results from Multiple Regression (Annex, Printout 4) show the equation to be:

$$Y = 1.32079 - \underset{(-3.643)}{.95340X_1}{}^{*} + \underset{(3.731)}{.64937X_2}{}^{*} + \underset{(1.517)}{.7591X_3}{}^{**} + \underset{(-.123)}{.01965X_4}{}^{***}$$

$$+ \underset{(.515)}{.07566X_5}{}^{***} + \underset{(.953)}{.07591X_6}{}^{***}$$

R^2 = 0.02787

F = 4.54906

α = 0.0001 (Eq. 4.2)

where ( ) = t value

* = level of significance at .0002 and .0003

** = level of significance at .1297

*** = level of significance above .3409

The equation indicated three significant variables, namely, FUEL COLLECTING MEMBERS, HOUSEHOLD SIZE, and LAND HOLDINGS. The equation can explain DISTANCE TO SOURCE OF FUEL to a power of only 3 percent. The remainder would be explained by other variables which were not in the equation. The result shows that perhaps no other variable is as suitable as DISTANCE TO SOURCE OF FUEL to indicate the scarcity of fuel. Even though variables in the equation were very selective, the level of explanation is still very low.

It may be that, while other variables are not shown to be related to fuel scarcity, energy planners can rely on DISTANCE TO SOURCE OF FUEL to help explain the scarcity of fuel. The intent of this analysis was not to prove whether DISTANCE TO SOURCE is appropriate to judge the scarcity of fuel, but to identify variables which could describe the situation of scarcity. Despite the low power of determination, it was learned that the decision to go farther or nearer for fuel collecting depended on the size of the household, how many household members were responsible for fuel collection, and how many rais of land they had access to.

The Indicator of Amount of Fuel Consumption

Cooking fuel consumption

The data shows the average amount of cooking fuel used in a household as 1.7 kilograms per day for charcoal, and 3.1 kilograms per day for firewood. Charcoal and firewood were separate in the analysis for two reasons. First, they were clearly different types of fuels whose amounts could not be combined. Secondly, since their types were different, the amounts may be justified by different variables.

Socio-economic Aspects

The first set of variables for Multiple Regression was found in the household socio-economic condition. The variables included in the equations were:

- Amount of Charcoal;
- Amount of Firewood;
- Household Size;
- Fuel Collecting Members;
- Household Income;
- Off-farm Income; and
- Land Holdings

The equation is shown below. (See also Annex, Printout 5).

$$Y_1 = 1.00134 + \underset{(3.181)}{.09670X_1*} - \underset{(-.284)}{8.18958^{-3}X_2**} + \underset{(.004)}{1.85654^{-3}X_3**}$$

$$+ \underset{(1.268)}{2.74100^{-3}X_4**} + \underset{(.423)}{8.63587^{-3}X_5**}$$

$$R^2 = 0.03298$$

$$F = 3.56771$$

$$\alpha = 0.0035 \qquad \text{(Eq. 4.3)}$$

where Y_1 = Amount of Charcoal Consumed

X_1 = Household Size

X_2 = Off-farm Income

X_3 = Fuel Collecting Members

X_4 = Land Holdings

X_5 = Household Income

and where ( ) = t value

* = level of significance at .002

** = level of significance above .2

Eq. 4.3 indicates only one significant variable which has a level of significance lower than .05: than is HOUSEHOLD SIZE. Other variables in the same equation have no confidence to determine the amount of charcoal used since the level of significance has not reached the standard of .05. The power of this equation to explain the amount of charcoal used in a household is only 3% (R^2 = 0.03298). Out of this 3%, HOUSEHOLD SIZE is the major variable in explaining the amount of charcoal used in the household. The relationship of the amount of charcoal consumed to household size goes in the same direction. In other words, when the size of the household becomes larger, the tendency to consume more charcoal increases. However a change in household size of 1 unit (one person) causes a change in charcoal consumption of only .096 times the regular amount used (coefficient of X_1 = 0.09760). The equation convinces us to ignore other variables in the equation, namely, HOUSEHOLD OFF-FARM INCOME, NUMBER OF FUEL COLLECTING MEMBERS, and LAND HOLDINGS, due to the low level of confidence and the low coefficient of multiple regression.

It may be concluded here that the amount of charcoal consumed by a household was not related to the economic condition of the household; on the contrary,it was related to the needs of the household identified by its size. Of course, richer households would use charcoal rather than firewood. But once they selected a type of fuel to use, the amount of selected fuel was no longer dependent on income. We will discuss the classification of firewood consuming households and charcoal consuming households in the following section. (See also Annex, Printout 6).

$$Y_2 = 1.3890 + \underset{(4.491)}{.23105X_1}^{*} + \underset{(2.918)}{.01873X_2}^{**} - \underset{(-.784)}{.04750X_3}^{***}$$

$$+ \underset{(.920)}{.06418X_4}^{***} - \underset{(-.010)}{9.58308^{-4}X_5}^{***}$$

	R^2	=	0.13123	
	F	=	10.6349	
	α	=	0.0000	(Eq. 4.4)
where	Y_1	=	Amount of Firewood Consumed	
	X_1	=	Household Size	
	X_2	=	Land Holdings	
	X_3	=	Household Income	
	X_4	=	Fuel Collecting Members	
	X_5	=	Off-farm Income	
and where	( )	=	t value	
	*	=	level of significance at .000	
	**	=	level of significance at .003	
	***	=	level of significance above .3	

Eq. 4.4 gives firewood as a dependent variable. In addition to HOUSEHOLD SIZE, the size of LAND HOLDINGS was found to have a significant relationship to the amount of firewood consumed. Since these are two significant variables, the equation has increased its power of explanation to 13.12% (R^2 = .13123). Of this 13.12%, HOUSEHOLD SIZE dominates by 10.4%. (R^2 = .10388 from stepwise analysis).

It has been observed that the change in household size creates a greater effect on the use of firewood than on charcoal, because the coefficient value is higher (see Eq. 4.4). Size of land holdings, which has no significant relationship to the amount of charcoal used, does have importance in Eq. 4.4. It corresponds to the preliminary assumption that firewood collection is usually not far from the household's agricultural land. Again in Eq. 4.4, economic determination was not shown to be highly related to the amount of firewood consumed, the same as in Eq. 4.3.

Both equations gave a low value for R^2 which clearly shows that there must be other variables to explain the amount of fuel used. Due to the limited time and the characteristics of the available data, the analysis did not include other variables outside the scope of the original hypothesis. We attempted autocorrelations among variables in the equations which could cause a low value of R^2. As a result, the correlation matrix (Table 4.2) was traced and it was found that HOUSEHOLD SIZE had a correlation with many variables, though at low levels.

Eqs. 4.3 and 4.4 were re-evaluated, taking variable HOUSEHOLD SIZE out of the equations. Nevertheless, the R^2 value did not increase. In fact, the opposite effect was observed. Therefore, Eqs. 4.3 and 4.4 were retained.

In the case of firewood, the number of FUEL COLLECTION MEMBERS showed its significance in Eq. 4.4 (α = .005). R^2 was decreased from .10388 in Eq. 4.4 to .0798 in the new equation. It was found in the correlation matrix that HOUSEHOLD SIZE and FUEL COLLECTING MEMBERS had a remarkable correlation. When these two variables were put in the same equation FUEL COLLECTING MEMBERS did not show any significance. We must just keep in mind that FUEL COLLECTING MEMBERS is a latent variable connected with the amount of firewood.

As mentioned in the framework of the analysis, there might be some distinction between land holdings and land owning in the amount of fuel consumed. Therefore, other equations were tried in which land holding were changed to land owning, excluding rented land.

In the case of charcoal, the results showed little difference from Eq. 4.3: only R^2 was lowered from .03298 to .03187. However, this is irrelevant since the information from Eq. 4.4 tells us that charcoal was not contingent with land occupancy. What is more important is whether there was any change in Eq. 4.4 if land owning was substituted for land holdings. In this case, as in Eq. 4.3, R^2 was reduced from .13123 to .11936. The coefficient of variable land holdings and land owning was similar, .01873 and .01232 respectively. The conclusion of this analysis is that it is better to use the variable LAND HOLDINGS than LAND OWNING.

Non Socio-economic Aspects

We now turn to another set of variables which are less related to the socio-economic aspects. Those variables are:

- AMOUNT OF CHARCOAL;
- AMOUNT OF FIREWOOD;
- DISTANCE TO SOURCE OF FUEL;
- HOUSEHOLD SIZE;
- FREQUENCY OF FUEL COLLECTION;
- FREQUENCY OF FUEL COLLECTION;
- FREQUENCY OF COOKING PER DAY; and
- HOURS OF COOKING.

The multiple regression of this set of variables was separated into two equations, with charcoal and firewood as dependent variables. These are presented as follows (see also Annex, Printout 7):

$$Y_1 = .58024 + .29604X_1{}^{*} + .08279X_2{}^{**} + 2.24519^{-3}X_3{}^{***}$$

$$(3.949) \qquad (2.889) \qquad (.107)$$

$$- 2.46756^{-3}X_4{}^{***} - 3.03475^{-3}X_5{}^{***}$$

$$(-.484) \qquad (-.018)$$

R^2 = 0.05639

F = 6.36305

α = 0.0000 (Eq. 4.5)

where Y_1 = Amount of Charcoal Consumed

X_1 = Hours of Cooking

X_2 = Household Size

X_3 = Frequency of Fuel Collection

X_4 = Distance to Source of Fuel

X_5 = Frequency of Cooking per day

and where ( ) = t value

* = level of significance at .0001

** = level of significance at .004

*** = level of significance above .6

Eq. 4.5 reveals a new significant variable called HOURS OF COOKING. When HOUSEHOLD SIZE was accompanied by HOURS OF COOKING, its domination in the equation decreased. Multiple Regression Stepwise analysis shows that even without HOUSEHOLD SIZE, R^2 was already up to .04156 while R^2 from Eq. 4.5 which includes HOUSEHOLD SIZE was .05639. Yet, the R^2 value of Eq. 4.5 was still low. This implies that the explanation of the amount of charcoal consumed by a household depended very much on other variables which were not in the hypothesis. This was also true in Eqs. 4.3 and 4.4.

From Eq. 4.5, a primary conclusion emerged: that household size was not as important as the number of cooking hours. Both the significance level and the coefficient value supported this statement. A change in cooking hours affected the amount of charcoal used more than a change in the size of the household.

The analysis then dealt with types of food cooked. From experiences in field surveys, it was observed that people in the same community did not eat different types of food. Moreover, data collected by questionnaires relating to types of food cooked were incomplete, which rendered it inappropriate for multivariate analysis.

In an attempt to prove the above statements, TYPES OF FOOD and NUMBER OF MEALS were surveyed. Types of food were calculated in terms of the frequency of preparing different types of food, for example, beef, pork, chicken, or duck. In addition, respondents were asked whether they drank boiled water and if so, how much. In the case of charcoal, these variables failed to explain the amount of charcoal used because the equation was not significant. (In the equation, F = .55931, with a significant F value of .8305). For firewood, the relevant type of food entering the equation was duck: Duck consumption did have an effect on the amount of firewood used. As this was the only food to provide a correlating relationship it is suggested that TYPE OF FOOD should be analyzed by qualitative methods.

Longer cooking time might also be connected to cultural aspects, for example, the methods of cooking or the taste of food. These types of information should also be explained qualitatively.

The remaining variables in Eq. 4.5 will not be discussed since their levels of significance did not show a good statistic and the explanation may not be accurate.

Equation 4.6 gives the amount of firewood as a dependent variable. (See Annex, Printout 8).

$$Y_2 = 1.53693 + \underset{(6.350)}{.29347X_1{}^*} - \underset{(-1.010)}{.01754X_2{}^{**}} + \underset{(.409)}{7.20747^{-3}X_3{}^{**}}$$

$$+ \underset{(.112)}{.01438X_4{}^{**}} - \underset{(-.333)}{.06537X_5{}^{**}}$$

$$R^2 = 0.10716$$

$$F = 8.52135$$

$$\alpha = 0.0000 \qquad \text{(Eq. 4.6)}$$

where	Y_2	=	Amount of Firewood Consumed
	X_1	=	Household Size
	X_2	=	Distance to Source of Fuel
	X_3	=	Frequency of Fuel Collection
	X_4	=	Hours of Cooking
	X_5	=	Frequency of Cooking per day.
and where	( )	=	t value
	*	=	level of significance at 0.0000
	**	=	level of significance above .3

This equation does not give new information about variables concerning the amount of firewood consumed by households. Only HOUSEHOLD SIZE remains in the equation. As a result, amount of firewood is not indicated by cooking hours as it was with charcoal. This is supported by the fact (also observed in the field) that people do not extinguish firewood after cooking. They leave it in the stove until it gradually burns itself out. This is different from using charcoal. Charcoal is burnt in a small pot, extinguished after cooking, then used for the next cooking. The results from the equation and from observations indicated that people are careless about firewood. They use it wastefully. This is why the number of cooking hours is not necessarily related to the amount of firewood consumed by household.

A description of the indicators for the amount of cooking fuel used has been presented. Charcoal and firewood have a common variable indicating their amount: HOUSEHOLD SIZE. The amounts of both types relate to the need of fuel in the household, not the economic status. For charcoal, which is more expensive and less accessible, people tend to economize the utilization. Thus, the amount of charcoal consumed also depends on number of COOKING HOURS, whereas the amount of firewood used has no relationship with it. Another observation from the equations is that the amount of firewood has some relationship with the number of FUEL COLLECTING MEMBERS in the household, while that of charcoal has none. This implies that firewood collection needs more people than does charcoal. More people look for firewood at shorter distances, fewer people look for wood for charcoal making at longer distances.

Lighting fuel consumption

Kerosene is a common fuel found in rural areas, and often used for fire starting. It is applied with simple lighting equipment such as a kerosene

jar, wick, or pump. We will investigate what variables indicate the amount of kerosene used by a household. We put the variables in Multiple Regression Analysis, and obtained the following results (see also Annex, Printout 9):

$$
\begin{aligned}
Y_1 = \; & 8.20291 + \underset{(4.908)}{1.9971X_1{}^{*}} + \underset{(2.589)}{2.55503X_2{}^{***}} + \underset{(1.138)}{5.59407X_3{}^{****}} \\
& - \underset{(-2.872)}{2.36316X_4{}^{**}} + \underset{(2.360)}{10.13226X_5{}^{***}} - \underset{(-2.941)}{1.85618X_6{}^{**}} - \underset{(-.228)}{.04618X_7{}^{****}} \\
& + \underset{(1.670)}{.63362X_8{}^{****}} + \underset{(.634)}{5.11267X_9{}^{****}} + \underset{(1.427)}{2.93033X_{10}{}^{****}} + \underset{(.587)}{.18587X_{11}{}^{****}} \\
& + \underset{(1.90)}{.10221X_{12}{}^{****}} + \underset{(1.699)}{8.49681X_{13}{}^{****}} - \underset{(-.633)}{2.81132X_{14}{}^{****}}
\end{aligned}
$$

R^2 = 0.16309

F = 6.24983

α = 0.000 (Eq. 4.7)

where Y_1 = Amount of Kerosene

X_1 = Household Income

X_2 = Number of Kerosene Jars

X_3 = Number of Kerosene Pumps

X_4 = Household Activities

X_5 = Number of Kerosene Wicks

X_6 = Off-farm Income

X_7 = Kilowatt-hours per Month

X_8 = Household Size

X_9 = Number of Fluorescent Lights

X_{10} = Number of Kerosene Pump Working Hours

X_{11} = Number of Kerosene Jar Working Hours

X_{12} = Number of Kerosene Wick Working Hours

X_{13} = Number of Incandescent Lights

X_{14} = Number of Fluorescent Light Working Hours

and where ( ) = t value

* = Significance level at .0000

** = Significance level below .004

*** = Significance level below .01

**** = Significance level above .09

This equation is the first one to find that amount of fuel consumption is related to economic status. The amount of kerosene from Eq. 4.7 explicitly shows that it is dependent on INCOME, and the capability to afford lighting equipment, particulaly KEROSENE JARS and KEROSENE WICKS. Furthermore, number of HOUSEHOLD ACTIVITIES is also important, though it shows a negative relationship. R^2 of this equation is higher than those before. However, it appears there were many unnecessary variables in this equation.

It was decided that another equation should be tried by eliminating variables having significance levels below .05 so that R^2 might increase. However, R^2 actually decreased after eliminating those variables. A new equation was formulated which included another significant variable, the number of KEROSENE PUMPS, to explain the amount of kerosene used. The equation is shown below. (See Annex, Printout 10).

$$Y_1 = 11.08067 + \underset{(4.657)}{1.85976X_1{}^{*}} + \underset{(4.023)}{3.26034X_2{}^{*}} + \underset{(2.761)}{10.96695X_3{}^{**}}$$

$$- \underset{(-3.102)}{2.45840X_4{}^{**}} + \underset{(3.041)}{10.35536X_5{}^{**}} - \underset{(-2.285)}{1.28939X_6{}^{***}}$$

R^2 = 0.14504

F = 12.92180

α = 0.0000 (Eq. 4.8)

where	Y_1	=	Amount of Kerosene
	X_1	=	Household Income
	X_2	=	Number of Kerosene Jars
	X_3	=	Number of Kerosene Pumps
	X_4	=	Number of Household Activities
	X_5	=	Number of Kerosene Wicks
	X_6	=	Off-farm Income
and where	( )	=	t value
	*	=	Significance level at .0000 or .0001
	**	=	Significance level below .006
	***	=	Significance level at .02

Both Eqs. 4.7 and 4.8 reveal that Household Income (cash) certainly determined the amount of kerosene consumed. This is simply explained by the fact that kerosene must be purchased. It is not available in the local environment like firewood is. However, since it is necessary to use kerosene in certain amounts, a change in income does not make a big difference in the amount of kerosene consumed (coefficient of household income = 1.85976). In richer households kerosene may be used for soaking firewood or charcoal for fire preparation. In poorer houses kerosene is the only source of lighting. In some cases, kerosene is used to operate electrical generators, for example, in Petchburi and Lampang.

The number of lighting equipments obviously shows the amount of kerosene consumed. Generally, people use kerosene jars made from small bottles or cans. 77.7% of the total sampling households used kerosene jars. Each of those houses usually had two (36.7%) or three (18%) jars. Fewer households used kerosene wicks (6.25%) or kerosene pumps (5.7%). Usually, households use kerosene jars for their daily activities, but use a kerosene wick or pump for special occasions. It is evident that people use kerosene jars for 6 hours each day (mode value) while wicks and pumps are used occasionally, 1 hour per day (mode value). This corresponds to the equation where kerosene jars have a higher level of confidence. However, kerosene jars consume less kerosene, therefore, the change in number of jars does not make a big difference in the amount used. On the contrary, wicks and pumps consume much kerosene: one wick or pump may increase ten times the amount of kerosene regularly used (coefficients of 10.96695 and 10.35536 for pumps and wicks respectively).

Two astonishing variables were NUMBER OF HOUSEHOLD ACTIVITIES and OFF-FARM INCOME. It was assumed that household activities and off-farm income would be related to amount of kerosene in the same direction. The equation reveals the opposite expected result. Off-farm income was put in the equation because it was expected that a household would earn cash from off-farm employment. They probably use cash to purchase kerosene. The result from the equation shows a negative sign in front of off-farm income. In other words, when off-farm income increases, amount of kerosene may decrease. The reason for this is unknown. Only one assumption can be made: that people spend their cash from off-farm income for other purposes, and not for lighting fuel. It may not be necessary to separate off-farm income from total household income.

Number of HOUSEHOLD ACTIVITIES is in the same situation as OFF-FARM INCOME. Household activities here means activities which need some light to facilitate work, for example, reading, social activities, cooking, eating, security, etc. It was assumed that more light had been used and, consequently more kerosene consumed. The result is reverse from our assumption however, due to the negative sign in front of X_4 in Eqs. 4.8 and 4.7. This requires deeper analysis of how households manage lighting equipment. One kerosene jar, or other relevant equipment, may be used for various purposes, for example, eating, talking, and reading. This analysis is unable to make a clear explanation on this situation.

The consumption of kerosene as a lighting fuel is better understood now that INCOME and LIGHTING EQUIPMENTS can partly indicate the amount of kerosene consumed by a household. This confirms our preliminary assumption. However, the number of working hours of a particular lighting equipment does not seem to be a significant indicator. Two variables, OFF-FARM INCOME and HOUSEHOLD ACTIVITIES, show negative relationships with the amount of kerosene consumed. This is reverse from our preliminary assumption and needs more analysis for a better explanation.

Differentiation Between Households Consuming Charcoal and Firewood

It was evident earlier that a change in income does not effect a change in the amount of fuel consumed. Yet, we still believe that a household's initial decision regarding the type of fuel selected was most likely related to that household's economic status and its modernization. Moreover, the household's decision on the type of fuel to use and its energy consumption behavior was assumed to be different with each type of fuel. Therefore, we now want to make it clear whether there was a distinction between households using charcoal and households using firewood or not. If there was, then, what discriminates them from each other? It is essential for energy planners to learn the differentiation of groups of households using various type of fuel since the way they cope with their energy problems may not be the same.

We used discriminant analysis for this purpose. In this analysis the relationship between two groups, charcoal and firewood, was justified by Canonical Correlation with chi-square or F-test as the significance assessment. The method of analysis is stepwise, selecting only significant discriminating variables. The discriminating power of such significant variables was considered by their loadings in a particular function.

As mentioned in the Framework of Analysis at the begining of this chapter, the differentiation of households focused on variables concerning economic status or household prosperity, and the way of using and managing fuel. They are itemized in the following list and in Annex, Printout 11.

Household Economic Status	Fuel Managing
Household Size	Household Collecting Member
Type of Occupation	Household Activities***
Movable Properties*	Method of Fuel Obtainment
Unmovable Properties**	Fuel Availability
Land Holding	Fuel Storage
Household Income	Distance to Source
Off-Farm Income	Frequency of Fuel Collection

In this list, MOVABLE PROPERTIES include the electric generator, car, motorcycle, bicycle, motorboat, rowboat, radio or cassette player, television, electric fan, refrigerator, sewing machine, electric iron, charcoal iron, thermos, rice storehouse, small tractor, large tractor, rice mill machine, sprayer, hand water pump, plough, water wheel, water sprinkler, threshing machine, pick-up truck, electric water pump, minibus, animal cart, trailer, push-cart and other engines.

UNMOVABLE PROPERTIES include a pond, latrine, pens, garden, compound, and others; while HOUSEHOLD ACTIVITIES include any activities using light such as for sewing, socializing, movement, night work, meals, cooking, security and others.

A total of 959 households were divided into two groups. The first group consisted of households which used charcoal (588 households) while another 300 households were defined as the firewood group. The remaining households used other type of working fuels and were not included in the discriminant analysis.

An analysis of the selected discriminating variables showed nine significant variables, namely, HOUSEHOLD SIZE, FUEL COLLECTING MEMBERS, UNMOVABLE PROPERTIES, MOVABLE PROPERTIES, LAND HOLDINGS, HOUSEHOLD ACTIVITIES using light, method of FUEL OBTAINMENT, FUEL STORAGE, and frequency of FUEL COLLECTION.

Since there were only two groups and the number of variables was also small, we derived only one discriminant function. The discriminant function derived from the computer output showed only 5 variables having remarkable loadings (usually above .3). They were HOUSEHOLD ACTIVITIES using light, LAND HOLDING, FREQUENCY OF FUEL COLLECTION, FUEL STORAGE and MOVABLE PROPERTIES. All five variables were considered to have power in discriminating one group from another - i.e., charcoal from firewood. Among these five variables HOUSEHOLD ACTIVITIES showed the highest power of discriminating variable; the lowest was MOVABLE PROPERTIES. The remaining variables in the preliminary list were ignored due to low levels of loadings as shown in the computer results.

The five discriminating variables included in one function clearly showed that HOUSEHOLD FUEL, MANAGEMENT dominated the function.

If we plot the discriminant score of each household on one line, we see that the charcoal and firewood groups partly overlap, though group means (groups centroids) were quite separated, 0.47878 and - 0.93842 for charcoal and firewood respectively. The canonical correlation between groups was nearly high (0.55890) which implies that these two groups do not completely separate

The results also reported that, on the basis of 9 significant discriminating variables, 75% of valid households were correctly classified. In other words only 25% of valid household were not characterized by those discriminating variables. These 25% were the overlapping cases. There was no doubt that charcoal and firewood households were mainly differentiated by HOUSEHOLD ACTIVITIES, LAND HOLDING, FREQUENCY OF FUEL COLLECTION, FUEL STORAGE and MOVABLE PROPERTIES.

When subjected to each of the five discriminating variables by comparing average values (mean) between the charcoal and firewood groups, it was found that there was a tendency for a higher mean of household prosperity in the charcoal group, namely, MOVABLE PROPERTIES and LAND HOLDINGS. (See Table 4.8). In addition, firewood group has a higher means in fuel management. There were variables of FUEL STORAGE* and FREQUENCY OF FUEL COLLECTION. We also observed that the charcoal group used light for many purposes and many activities.

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* There were four levels of fuel storage, ranked by the convenience of its location: 1. Open Air; 2. House Shade; 3. Shelter; and 4. Shelter with Wall.

Figure 4.1 Plotting of All Groups

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23 JUL 84   SPSS-X RELEASE 1.0 FOR IBM OS
            CHULALONGKORN COMPUTER CENTER  IBM-3031-AM   VS1-VMSP-1.7

                                ALL-GROUPS STACKED HISTOGRAM

                          -- CANONICAL DISCRIMINANT FUNCTION 1 --
            80 +
               .
               .
F              .
R           60 +
E              .
Q              .
U              .                                  ?
E           40 +                                  ?  1
N              .                          2 22 2    1  1    2
C              .                          2 22 222 21  1222 1
Y              .                       22  222222222121111121
            20 +                    2222222212122222111111111 1
               .                   22222222211111111111111111111 21
               .                 222222222211111111111111111111111 1   1
               .2        2      2 2222221111111111111111111111111111111111 11
              OUT.........+.........+.........+.........+.........+.........+.........+.........OUT
                         -3        -2        -1         0         1         2         3
GROUP CENTROIDS                      2                   1

CLASSIFICATION RESULTS -

                              NO. OF     PREDICTED GROUP MEMBERSHIP
     ACTUAL GROUP             CASES          1          2
     ------------------       ------     --------   --------

     GROUP      1              592         448        144
                                           75.7%      24.3%

     GROUP      2              367          89        278
                                          24.3%      75.7%

     PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED:   75.70%

     CLASSIFICATION PROCESSING SUMMARY

           959 CASES WERE PROCESSED.
             0 CASES WERE EXCLUDED FOR MISSING OR OUT-OF-RANGE GROUP CODES.
             0 CASES HAD AT LEAST ONE MISSING DISCRIMINATING VARIABLE.
           959 CASES WERE USED FOR PRINTED OUTPUT.
```

Table 4.5 Group Means of Remarkable Discriminating Variables

Item	Movable Properties	Land Holdings	Household Activities	Fuel Storage	Frequency of Fuel Collection
Charcoal	6.01361	31.48129	1.00850	0.42177	1.40646
Firewood	4.68000	11.96333	0.29667	0.02333	3.74000
Total	5.56306	24.88739	0.76802	0.28716	2.19482

We may make a primary conclusion about group differentiation: That households are separated, on the basis of type of fuel used, by variables related to household economic status and household fuel management. The specific discriminating variables were mentioned above. Our hypothesis of group differentiation is partially confirmed. Not all variables of economic status explain the differences between charcoal and firewood groups. The results revealed economic status in terms of household modernization, identified by MOVABLE PROPERTIES, rather than income. LAND HOLDINGS was another economic status variable that discriminated the groups. In addition, due to the different types of fuel used, fuel management was definitely different between the two groups. The variables of fuel management were FUEL STORAGE, FREQUENCY OF FUEL COLLECTION and HOUSEHOLD ACTIVITIES.

It is unfortunate that only one discriminant function was derived from the analysis. One discriminant function does not give us new dimensions of group classification. We would expect to get more discriminant functions if more variables were in the analysis. This shows that preparation of complete data is very important. This analytical study was not able to do that due to time limitation.

An additional result from discriminant analysis was the classification coefficient used for classifying unknown groups. (See Table 4.6).

Table 4.6 Classification Coefficients Derived from the Analysis

Variables	Charcoal Group (Group 1)	Firewood Group (Group 2)
Household Size (HS)	.9951200	1.072179
Household Fuel Collecting Member (HP)	.4531794	.5578930
Unmovable Properties (UP)	1.376394	1.657592
Movable Properties (MP)	.2377153	1.020885
Land Holdings (L)	.241469D-02	.2988483D-01
Household Activities (HA)	1.040330	.2540472
Fuel Obtainment (FO)	.9247860	1.110441
Fuel Storage (FS)	.1989480	-.2837266
Frequency of Fuel Collection (FC)	.1899678	.3350856
(Constant)	-9.403052	-10.54680

To classify the cases in the target sample, use the following transformation:

Group 1 = .9951200HS + .4531794HF + 1.376394UP + .2377153MP + .241469D-02L + 1.040330HA + .9247860FO + .1989480FS + .1899678FC - 9.403052

Group 2 = 1.072179HS + .5578930HF + 1.657592UP + 1.020885MP + .2988483D-01L + .2540472HA + 1.110441FO - .2837266FS + .3350856FC - 10.54680

The result of each computation was compared with the centroid value of each group which was mentioned earlier. The value close to the centroid of either group will be classified respectively.

This methodology can be applied in areas where a planner has to identify households, for example, to participate in an energy technology project. The set of variables can be changed and any group identification can be used.

Chapter 5

Transition Surveys

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TRANSITION SURVEYS

A. BACKGROUND

A description of the transition surveys as planned by Meta Systems Inc. in the early phase of the project follows:

Transition surveys have two goals. The first is to collect additional technology-specific data for use in conjunction with the baseline and evaluation surveys for evaluating technologies. The second is to observe the implementation of the technology in the field and to identify the problems in training villagers to construct, operate, use and maintain the technology, establishing a pattern of ownership administration, and disseminating information about the technology. These surveys would be conducted in the period preceding and closely following the introduction of the technology. Where the component and technology permit, the two activities would be conducted in a single period of survey commencing approximately three weeks before the implementation and lasting until three weeks after.

The manpower requirements for this survey activity include a two week preparation phase during which the survey supervisor, the technical assistant and the research assistant assigned to that technology would prepare a list of data requirements, determine a methodology, and produce and print the necessary documents for conducting the survey. Following this activity the research assistant would go into the village for a period during which he or she would collect the required data. The same individual would spend another period (up to four weeks) in the village during or after the introduction of the technology to observe the process and the problems. The information from this second phase would be collected through participant observation and recorded in a field notebook. The surveyor would then return to Bangkok and spend up to four weeks preparing the data from the first phase either in tabular form or as computer data for coding. The observations from the second phase would be summarized in a report prepared under the supervision of the technical assistant. This survey would then be submitted for review by the component leaders.

However, in practice there were both major and minor changes. Meta Systems Inc. invited a Chulalongkorn University Social Research Institute (CUSRI) team to act as consultants and to work closely with research assistants in two Survey Components. These were the Woodlot and Biogas Components (even though the two Community Biogas Digester units installed in the

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villages were not part of the United States Agency for International Development (USAID) Renewable Nonconventional Energy Project). Other transition surveys carried out by the National Energy Administration (NEA) Survey Component were the Micro-hydro and Water Lifting (windmill and photovoltaic) Components. To date no other transition surveys have been carried out by the survey component team. Other components have either not reached the implementation stage, their technologies were implemented without conducting a transition survey, or they carried out transition surveys on their own. In this chapter only transition surveys conducted by the Survey Component (both the CUSRI team and the NEA team) will be summarized. Actual reports may be consulted if further detailed information is required.

B. TRANSITION SURVEYS: WOODLOT COMPONENT

The purpose of the Village Woodlot Project was to plant fast-growing trees in selected public areas at a rate of approximately 128 hectare (ha.) per year. The principal concepts of the Village Woodlot Project were:

- To be a reforestation project able to provide firewood for people in selected villages;
- The administration of the project should be the responsibility of each selected community; and
- The project area should fall within the public grounds of each community.

The Village Woodlot Project component is under the jurisdiction of the Royal Forestry Department of Thailand. The first stage of project implementation was the selection of sample communities for experimental village woodlot cultivation according to the following criteria:

- The village should have enough public land to operate the woodlot project without affecting other activities on this land, i.e. grazing of cattle, etc.;
- There should be no forest near the village and the problem of firewood shortage should exist; and
- The priority in demand by villagers for the village woodlot project should be determined by examination of the baseline data.

Tree Type

The types of tree which should be planted are the fast-growing varieties which may be grown in a rotation period of not less than five years. The type selected for the project sites considered here was *Eucalyptus camaldulynsis*.

Stages in Implementation

In principle, the stages of implementation for the Village Woodlot Project should be as follows:

- Site selection;
- Public relations with the people in the area;
- Plantation; and
- Maintenance.

The site selection and public relations stages should be the responsibility of the project officers, while the plantation and maintenance stages should be the responsibility of each community.

Site selection

The site selection stage was divided into two phases due to the different management of operations in each.

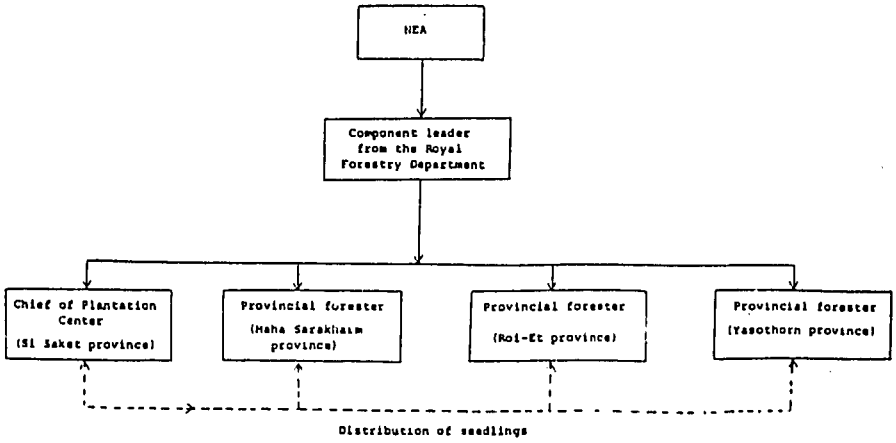
Phase 1 (Year I: 1981)

The initial year of the Village Woodlot Project was 1981 when three pilot villages were selected from the baseline data, all of which were located in the Northeastern Region. The initial purpose of selection was only to compare project success with the difference in demand priority among the villages. The three chosen sites were Ban Khwao, Ban Pong, and Ban Chang Khra Darn, all located in the Pri Bung district of Si Saket province.

According to the baseline data, the degree of demand in each village differed. Among the ten types of energy technology introduced to the community (for instance community biogas, windmills, etc.) the village woodlot method was the first choice of respondents in Ban Khwao, while Ban Pong and Ban Chang Khra Darn selected it as their second and third choices.

Due to space constraints, however, the Woodlot Project was not operable in Ban Khwao, since the public land in the village covered only 2.50 ha. What was accomplished in Ban Khwao was the planting of the recommended type of fast-growing tree, *Eucalyptus camaldulensis*, in the small public area and on the temple grounds as demonstration plots, while seedlings were given to the villagers to plant in their own fields.

Figure 5.1 Administration Chart of Village Woodlot Project for The First 2 Years



Although Ban Pong and Ban Chang Khra Darn did not rank the Woodlot Project as their first choice, both were nevertheless selected as pilot sites in the first year of Woodlot Project implementation due to the severe problem of a fuel wood shortage in that area.

Under the project plan, the total land covered by all village woodlots would amount to 128 ha. annually for all selected villages. However, due to the time constraint, the full 128 ha. could not be put into operation and only 31.5 ha. were used in pilot areas during the first project year (1981).

Phase 2 (Years 2, 3, 4: 1982-1984)

The second phase of implementation began in January 1982, when the component leader delegated the responsibility of site selection and project management to local foresters in the chosen provinces. During this phase, the criteria for woodlot village selection were: (1) The public ground must be large enough to grow sufficient fuel wood to meet community needs; and (2) these grounds should be adjacent to a public road for proper demonstration of the project.

In the second project year, sites selected were in Maha Sarakham, Roi-et, and Yasothorn provinces. The total area planted in 1982 was 160 ha., above the area specified in the plan since Yasothorn province had exceptionally large public areas available for woodlot planting. All of the selected public areas also served as the local grazing pasture.

Public relations

Due to the main project concept that administration should be conducted by the people in each project area, public relations with local residents had to be taken into account during implementation. For the project to succeed, it must be certain that the villagers understood their responsibilities and were ready to manage the project themselves under the supervision of project officials.

Public relations concerning the Woodlot Project was the job of the social scientists working with the villagers from the initial stages of implementation onward. They attempted to coordinate activities between villagers and officials in order for both groups to work closely toward project goals. The most important task of the social scientists, however, was to help villagers form a project committee to administer the woodlot operation after the departure of the officials.

Plantation

The optimum planting times for woodlot trees were August and September, since this was the middle of the rainy season. Land for planting had to be

cleared and prepared before the rains began. Work done in this period included land clearing, staking, and planting. Due to the differences in management between the three chosen provinces each province will be discussed individually below.

Maintenance

In theory, maintenance should be the responsibility of individual villagers or of the village woodlot committee. However, in practice, maintenance was relegated to official management except in the case of Yasothorn province. In Si Saket and Roi-et some villagers were hired to care for the trees, and in Maha Sarakham province, upon agreement by the Woodlot committee, some village volunteers were established as guardians of the project plantings.

For years 3 and 4, each provincial forester was given an assignment to plant a certain amount of woodlot. Each forester followed his own policy and strategy in carrying out the project with one common agreement, there would be no volunteers in the planting of the trees. Villagers must be hired for the purpose. This was in order to set up a pattern to be followed in every province to avoid discrepencies.

However, since no transition surveys were carried out on the woodlot project for years 3 and 4, discussion in this section will include transition surveys for years 1 and 2 only.

Si Saket Province

Although three villages were chosen in Si Saket, one (Ban Khwao) had to be eliminated due to a shortage of public land, as mentioned earlier. Ban Pong and Ban Chang Khra Darn remained the only sites in the province (planted in Years 1 and 2).

Ban Pong

The village's public area measured 40.7 ha. and was used for cattle grazing. The project administrator established a plan to grow 8.8 ha. of Eucalyptus trees annually. The public land was located in front of the village, adjacent to the main road. All plans for the village were made by project officers with no participation by villagers. During planting, laborers from the Plantation Center and a small number of students were hired to work.

Ban Chang Khra Darn

The public land in this village was far from the settlement, about 2 kilometers away, and measured approximately 32 ha. It was planned to plant 6.8 ha. per year in woodlot trees.

During the first year of implementation no one in the village, not even the headman, was aware of the project. He only knew that foresters came and planted trees in the area, but he was not aware of the purpose of the project. As with Ban Pong, the planting phase used labor from the Plantation Center, with no outside help.

Considering the results of first-year implementation in Ban Pong, the trees were thought to have grown well since the officials had hired the village headman and his assistant, who lived on the public land, to take care of the trees. In Ban Chang Khra Darn, however, nearly all the planted trees died because no one took care of them and cattle were allowed to graze in the area.

Due to the problem of tree survival, especially in Ban Chang Khra Darn, the project chief had to change the management plan during the second year of implementation. The main cause of low tree survival was lack of participation by villagers; no one took responsibility for the Woodlot Project. To solve this problem, the chief used the technique of agro-forestry, where villagers would be permitted to grow cash crops in the area between rows of trees on the condition that they helped maintain the trees. The results were good in that trees grew well, with a better survival rate, in Ban Pong and Ban Chang Khra Darn.

Although this situation appears to have better participation by villagers, it is nevertheless not true participation: people having permission to grow cash crops in the project area did so without knowing the purpose of the project. They knew that the government allowed them to plant there because the woodlot area was within their village boundary, and they knew it was their duty to take care of the trees for the government. They were told that the trees belonged to the villagers and it would be up to the subdistrict council to decide what to do with the trees. No definite plan was made. To date they do not consider it proper to use these trees as a fuel. They believe the tree trunks should be used to build houses or furniture, and that they are too good to make fuel wood.

A Woodlot committee existed in each village, but this committee only took responsibility for supervising villagers who grew cash crops and agreed to care for the trees. Project administration was solely under the direction of the chief of the Plantation Center.

Maha Sarakham Province

In Maha Sarakham, one village woodlot project was implemented over a public land area of approximately 64 ha. located about 3 kilometers from the village and adjacent to the main road. Twelve ha. per year of woodlot trees were planned for planting.

Woodlot project management in Maha Sarakham was under the jurisdiction of the provincial forestry official and the Village Woodlot committee. At first, the forestry official managed the project by himself without informing any of the villagers of its purpose, only reporting to the subdistrict council to request permission to plant trees in the specified area. As a result, some misunderstandings in the selection of the project area within the total public land and in the hiring of laborers during the plantation phase were evident.

The problem concerning the selection of the woodlot area was related to forest encroachment on the public land, where in fact another nearby village was using area thought to belong to the Woodlot Village. The forestry official selected the encroached area for planting; this resulted in a conflict between the two villages over rights to the public land.

The problem of labor hiring for planting centered around the number of laborers hired from the Woodlot Village, which was small. Villagers complained to the forestry official and in the end he was forced to hire most of the villagers for planting by reducing the daily wage.

Subsequently, the villagers, on the advice of the social scientist working on the project, formed a Woodlot committee to manage the project in conjunction with the forestry official. Problems such as the land conflict between villages were solved by using agro-forestry, as in Si Saket province, allowing the poorer residents of the two villages to grow cassava between the lines of planted trees.

A conflict over the use of the public land of a third village not originally included in the project was solved by inviting two members of the third village to join the committee and have rights over the use of the land for intercropping. Whether the third village will be allowed to benefit from the harvest of the woodlot or not will be decided when the time comes. The present reaction is that the land belongs to the two villages and since the third village does not own the land it should have no right over the harvested product.

In summary, in the case of Maha Sarakham province, the project results closely approached the main concept of the plan, since villagers participated in the project and the project committee became quite strong. Moreover, there was cooperation between the forestry official and the committee. It is hoped that this concept and its operation will spread to nearby villages in the future as well.

Roi-et Province

Two project plots were planted in Roi-et province with each plot including three villages as follows.

Plot 1

Three villages were located in a one-kilometer radius around the total public area of 240 ha., of which the Woodlot Project took 36 ha. It was planned to grow 12 ha. of trees in 1982, and 8 ha. thereafter for the next three years. The public land was being used for grazing by the nearby villages; some 7,000 head of cattle were said to have used it before the project.

Plot 2

Three villages located about 2 kilometers distant from the public area shared this woodlot, which comprised 24 ha. of the total 64 ha. of public land.

The reasons these two plots were chosen for woodlots included the following:

- The plot sizes were large and used only for grazing, not agriculture;

- A Public Voluntary Tree-Planting Project had been located near the Woodlot Project area; and

- A demonstration garden already existed near Plot 1, tended by the abbot of the village temple.

Two reasons(the nearby location of a Voluntary Tree-Planting Project and the existence of a demonstration garden) were important for the Woodlot Project. The provincial forester held the opinion that villagers were accustomed to tree planting and thus should readily adopt the Woodlot Project.

Most villagers in the pilot Woodlot Villages, however, did not participate in the project. Furthermore, a serious conflict between villagers took place in Plot 1. The then-provincial forester paid no attention to the conflict, thinking it would not affect the outcome of the project. In his opinion, the villagers were not relevant to project management and it was solely his responsibility to carry it out. This resulted in the absence of an active Village Woodlot Committee, since project administration was handled by the forester alone.

During planting a small number of residents of the woodlot village were hired to work, including the head of the senior village committee, who was hired to care for the trees. Nevertheless, most villagers were still unaware of the project since there was no communication between the provincial forester and the residents. Despite the efforts of the social scientists to clarify the matter to villagers, the result was the same: no participation in the project except by those hired to plant trees Even when told that the trees would belong to the village they had no idea how such a benefit could be utilized.

In May 1984 when the survey team visited the woodlot sites, a new provincial forester was met. From discussions with him it became very clear that he knew nothing of the participation and self-reliance concept. His understanding of the Woodlot Project was that it was an USAID support activity where USAID provided the necessary funding and the it was the responsibility of the Department of Forestry provincial personnel to see that the trees got planted and grew well. The project was just another job to be done.

However, when the concepts of participation and self-reliance were discussed he seemed sympathetic and indicated that the concepts might be introduced after the trees were grown and almost ready for harvesting. From the team's observation, it appears that the new provincial forester has no choice but to follow the pattern set up by the previous provincial forester. Alternative strategies may be possible in the future.

Yasothorn Province

Implementation in Yasothorn province was very different than in others. Since the public land areas were very large but the soil quality poor, with the agreement of the governor the provincial forester promoted the woodlot project by selecting two villages in Kho Wang district and allowing them to grow cashew nuts in the public area. He provided an incentive by also allowing them to lease out ownership of the trees. Each village would receive rights to 200 trees per household. This project was initiated in 1980 before the operation of the Village Woodlot Project.

Although grazing land was used to implement the Woodlot Project, no problems of disturbance by cattle occurred since the villagers were required to maintain their own trees. From their experience in the volunteer reforestation project, it is expected that people in this area will readily accept the concept behind the Woodlot Project.

No hired labor was used in the Yasothorn project areas; people living near the public land and interested in the project could participate by giving their names to the provincial forester, and were required to implement the planting on their own with advice and supervision from him.

In using this different method of management, the Yasothorn Woodlot Project covered a larger area than planned but nevertheless did not need extra budgeting due to the free labor available for planting.

However, after the trees were planted it was decided that all labor used must be paid. Since Yasothorn was the only province where participation of villagers in woodlot planting was possible, Yasothorn should follow the practice of other provinces and pay for the labor. As a result labor contributed was later compensated for in cash. This practice has

been carried out in Woodlot Projects in following years. The provincial forester claims, however, that when UASID funds terminate, it will still be possible to request labor contributions from the villagers for planting additional woodlots.

It turns out that the Eucalyptus trees are now growing at a faster rate than cashew nuts. In fact, many of the cashew nut trees are dying. The villagers prefer Eucalyptus trees for their woodlots and the acceptance of this species is no longer a problem. Instead, seeding permeation to serve the demand of the public has become a problem instead.

Woodlot Activities in 1983 and 1984

Woodlot areas for 1983 and 1984 were planned using the availability of large plots of land as the main criterion. No baseline survey was conducted. The woodlot activities of 1983 and 1984 were treated as a regular duty of the provincial foresters. And, since there were no transition surveys conducted to record woodlot activities in 1983 and 1984, in this section it will suffice to present a summary report. It was agreed among the implementation agencies, i.e. the provincial foresters, that woodlots would be planted by hired laborers and the foresters in each province were responsible for seeing to it that the trees grew well. A few years after the trees were grown, the woodlots would then be transferred to be under the responsibility of the sub-district concil. Members of the subdistrict councils would then make decisions regarding the woodlots.

Table 5.1 Village Woodlot Activities for 1981-1984

Province	Total Area Planted (Rai)						
	1981	1982		1983		1984*	
	(rai)	(rai)	(ha)	(rai)	(ha)	(rai)	(ha)
Kalasin	-	-	-	600	96	200	32
Yasothorn	-	200	32	550	88	250	40
Roi-et	-	250	40	580	92.8	180	28.8
Maha Sarakham	-	150	24	580	92.8	250	40
Khon Kaen	-	-	-	450	72	170	27.2
Surin	-	-	-	200	32	100	16
Sri Saket	200	200	32	540	86.4	350	56
Total	200	800	128	3500	560	1500	240

* target figures

Photograph 5.1 Village Woodlots Growing (Si Saket Province, 1981).

Photograph 5.2 The Village Woodlot 2 Years After Planting in Maha Sarakham Province.

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C. TRANSITION SURVEYS: BIOGAS COMPONENT

Background

The aim of the Community Biogas Project was to construct a large biogas digester capable of producting sufficient gas to supply electricity for an entire pilot village, whose size should include approximately 100 households. Though the digesters were not built with USAID funds, the survey component was involved in the transition survey, and the component is therefore included in this chapter.

Pre-Implementation Period

The first phase of the pre-implementation stage was village selection. The selected villages must fulfill the following requirements:

- Need a renewable source of energy;
- Have a considerable amount of livestock (e.g. cows, buffaloes, and pigs);
- Have strong leadership and local institutional support;
- Have the physical form of a clustered village;
- Lack an electrical supply;
- Have a year-round water supply to mix with the biomass; and
- Have the organization and potential for following up the work plan.

Data from the baseline survey was used for village selection according to the above criteria established by the project implementors. Social scientists joined the technicians during the implementation stage.

From the 50 villages covered by the baseline survey, two villages in the northeastern region were selected as demonstration sites for the Community Biogas Project. These villages were Ban Khwao and Ban Pa Haen.

Ban Khwao in Si Saket province, is located 8 km from the district site and 32 km from the provincial town. Transportation is by a year-round laterite road connecting Ban Khwao with the main highway. The village is characterized by strong leadership and strong group organization.

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Ban Pa Haen in Roi-et province, is located 35 km from the provincial town. Transportation consists of a 12-km dirt road connecting Ban Pa Haen with the main highway. Physically there are two settlement clusters in the village, Pa Haen and Nong Rai, approximately 800 meters apart. This village is also characterized by strong leadership and group organization.

Both villages fulfill the seven criteria required for village selection, and those need not be detailed here.

The second phase of the pre-implementation stage was the preparation of villagers for the adoption of the new technology. The Biogas Project required both understanding by villagers and their participation. The villagers needed to be convinced that the project belonged to their own community and that they must assume the responsibility for maintaining it.

Technicians explained the project in detail to the villagers who accepted it at once,thinking they needed electricity. Some were captivated by the idea of changing cow dung into electricity. Overall, they were willing to try the project.

The technicians explained that a large biogas digester would be constructed which could produce enough gas to generate electricity. The electricity generated should be sufficient to provide light at least four hours daily, using a total of 40 watts per household. Some help in construction was needed from the villagers. This meant that villagers would participate in the project from the very beginning. In addition, they were to organize a working group to maintain and operate the digesters in the two villages. The required maintenance organization structure was to include:

- Village Biogas Digester Committee;
- Digester biomass filler group;
- Watchmen;
- Village technical representatives;
- Local technicians.

These groups were formed by the villagers under the guidance of local leaders. Some of the people selected to sit on the Village Biogas Digester Committees were members of the village committee as well, voted in as popularly respected by the community. In Ban Khwao, nine people were recommended to sit on the Biogas Committee, including five average villagers with no title and four formal village leaders. In Ban Pa Haen, villagers voted 13 people onto the Biogas Committee, consisting of seven formal leaders and six villagers. The duties of the Biogas Committees in the two villages included the following:

- Organizating work groups to carry out the jobs of the digester biomass filler group and local technicians as noted in the previously mentioned structure;

- Selecting the site for digester construction; and

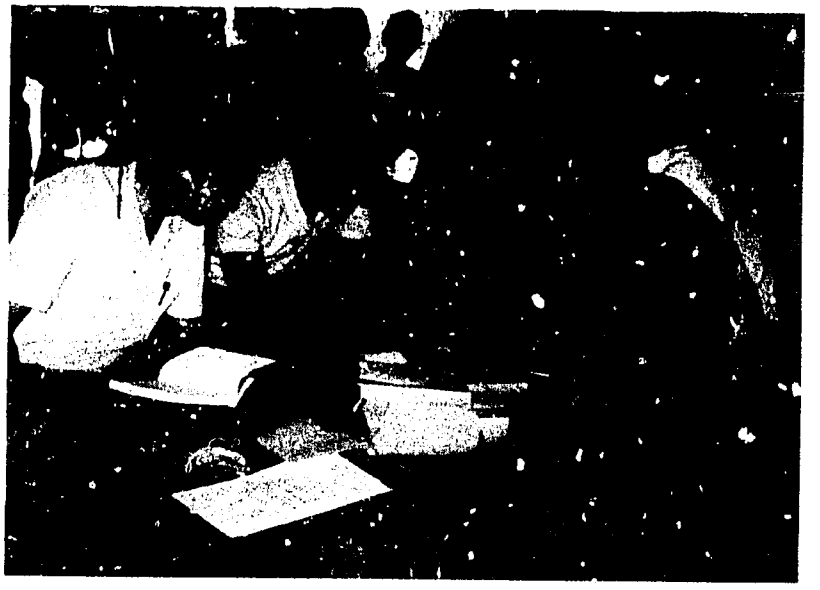
- Planning the work jointly with technicians.

In the organization of the work group, each committee member was required to form his own subgroup. Nine subgroups were thus formed in Ban Khwao and 13 in Ban Pa Haen. These subgroups were responsible for filling the digester with biomass and for general care of the system. Every household head was required to sit on a subgroup; therefore, all village households would be involved in the biogas project. The subgroup tasks were organized by the villagers themselves, while the social scientists merely guided and provided assistance when necessary.

After organizing the work group, the committee selected the site for the construction of the biogas digester with the approval of the villagers. Both villages chose to construct the digester in the village center, for convenience to all members. Ban Khwao selected the temple grounds as the construction site, while Ban Pa Kaen chose the area between the two village residential clusters.

Work was jointly planned with the project technicians by means of a village schedule for time and labor contribution. The construction period was set for mid-March, since at that time the rice harvest would be finished and the villagers would have the spare time to participate in the project.

The first task in construction was the clearing of the selected site before the arrival of the technicians, in order that work could start immediately upon their arrival in the village. The technicians, social scientists, and villagers fixed the following time schedule and work plan for project operation:



Photograph 5.3 Analysts Coordinating Social Affairs Work with Technicians in Roi-et Province.

Photograph 5.4 The Introduction of Technological Knowledge on the Biogas Community Project in Si-Saket Province.

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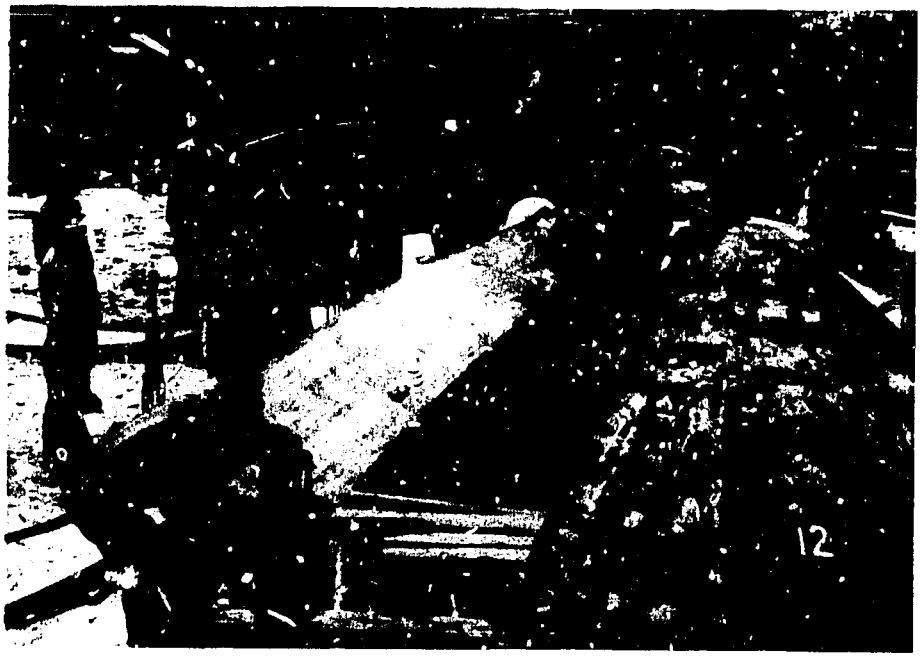

Photograph 5.5 The Construction of a Biogas Digester Using Human Labor (Biogas Community Project, Si-Saket Province).

Photograph 5.6 Installation of an Electric Generator in the Biogas Community Project in Roi-et Province.

Table 5.2 Time Schedule and Work Plan for Biomas Project Operation

Activity	Ban Pa Haen (1982)	Ban Khwao (1982)	Responsible agent
Ground preparation	10-17 Mar	17-27 Mar	Villagers
Construction	17-27 Mar	28 Mar - 12 Apr	Technicians and villagers
Insertion of master design	28 Mar - 11 Apr	13-27 Apr	Technicians
Removal of master design	12 Apr	28 Apr	Technicians
Filling of biomass (30,000 liters of biomass and 30,000 liters of water)	16 Apr	1 May	Villagers

During the construction period, approximately two work groups a day came to work with the technicians, a total of about 20 people. Some limitations in the villagers' technical skills appeared. Since the workers from the two villages could not be classified as skilled laborers, they thus worked as helpers under close instruction from the technicians. Work during this period included bricklaying and concrete mixing.

A fixed-dome, Chinese-style digester was chosen for construction at the two sites. It was approximately 6 meters in diameter and 4 meters high, with 2.50 meters above ground and 1.50 meters below ground. The water and biomass capacity was 60,000 liters (30,000 liters of biomass and 30,000 liters of water).

According to the work plan, construction was to be finished and villagers able to use the digester to generate electricity as of mid-May, 1982 in both villages. In practice, however, this was not feasible due to many technical problems and the completion date was delayed. Furthermore, a flood occurred in the Northeast during August 1982 which caused further delay.

The main problem preventing project completion was the digester's failure to hold gas. This may have been due to an error in concrete mixing; however, the technicians and village helpers cannot be blamed since the technical cause is unknown. Even though the villagers could not use electricity, they still had to fill the digester every week for

another 6 months (until December 1982), when a second group of technicians arrived in the two villages and replaced the fixed-dome digester with a floating-dome type. Finally construction was complete, and the villagers could use electricity as of January 1983.

Villagers' Labor Contribution

The construction period may be separated into two stages: the construction of the fixed-dome digesters and that of the floating-dome digesters. The latter was an attempt to solve the problems arising from the former's construction.

The first phase of digester construction was completed in June 1982. The work of the technicians during this period consisted of:

- Demonstrating the techniques of electricity use to villagers; and
- Teaching and demonstrating how to control the gas and electric generator.

The villagers formed a group of village technical representatives to be responsible for learning this information. As most of the villagers had a low educational background, it was difficult to teach them in the short demonstration time available.

The work of the villagers during the first (fixed-dome) stage of digester construction included:

1. Filling with biomass. As mentioned earlier, subgroups were organized to fill the digester with biomass each week. Due to the number of cattle in the village the amount of biomass was not a problem. For the first filling, however, it was necessary to obtain additional biomass from nearby villages as well. Villagers attempted to fill the digestor regularly since they wanted to use the electricity.

2. Operating and maintaining the biogas digester. A technical group was formed by the villagers to care for the digester under supervision by the technicians.

Although the fixed-dome digester was constructed by June 1982 and filled weekly with biomass, villagers were not able to produce electricity. The digester developed holes on the surface and could not retain gas. It was necessary for technicians to return many times to the two villages to make repairs. A second major problem was the delayed arrival of electrical accessories from the central project office in Bangkok. This was not the fault of the technicians, who could only continue to encourage villagers to keep filling the digester while waiting for the accessories.

Implementation Period

Project implementation, in the sense of using biogas to generate electricity, was temporarily achieved in October 1982 during the first phase of construction, i.e., that of the fixed-dome digesters. However, the problem of poor gas storage could not be solved, and it was necessary to replace the type of digester. In December 1982, the second stage of construction was started with the installation of two floating-dome digesters.

Implementation was finally achieved in January 1983 when the digesters became operable as a source of village electricity.

However, implementation of the project did not proceed smoothly, due to the lack of experience and the low educational background of the villagers in operating the electrical generator. After only three months the electricity generators in both villages broke down. The following will detail this event in each village:

Ban Khwao Minor problems were reported and solved both by villagers and technicians until May 1983, when the generator broke down. The NEA technician brought the generator to Bangkok for repairs and a new generator was tested for installation in the village. The village had had electricity for a total of three months, i.e., January - March 1983. In early September it was reported that the generator had been sent from Bangkok for installation.

Pa Haen Minor problems were also reported during the first few months of utilization, and the villagers partially solved the problems by reducing the number of watts allowed per household. The technician also helped solve the problem by installing a diesel generator. Therefore, the biogas was complemented by diesel and the system utilized mixed fuel instead of biogas alone. In April 1983 the generator broke down and was sent to Bangkok for repair.

In early 1984, problems again occurred at both sites, and technicians were later sent in. It was decided that the generators were too small for Ban Pa Haen. The two generators were then sent to Bangkok and a larger generator was returned to Ban Pa Haen at the end of April. In the case of Ban Khwao the same generator was fixed and returned in March and the system operated well the entire month of April. However, when the survey team visited the site in early May 1984 it was found that the generator was turned on for only 1½ hours each night or not at all even though there was a sufficient amount of gas to electrify the village for 3-4 hours every night. The young men responsible for operating the generators did not see the need to electrify the village for a longer period since this required them to remain in the village until 9 or 10 P.M. Since these young men preferred to go to town or to carry on their own

Photograph 5.7 Flood Problems Causing Difficulties in Transporting Equipment and Materials. (Flooding was one reason behind the delay of the Biogas Community Project at Si-saket Province).

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activities outside the village, they usually turned the generator off when they went elsewhere. Apparently no one in the village complained and they relied on kerosene lamps after electricity was turned off every night.

When the villages were visited again in June, the team found that the villagers had stopped filling the digester with dung and that the village had not been electrified during the months of May and early June. Apparently, electrification was not needed and filling the digester with dung turned out to be too great a burden. Since the rainy season started in May, villagers started their planting activities and they had no time for this extra-curricular activity. They left their house early in the morning and returned home late in the evening and had no need for electricity.

At this point, it is necessary to ask the question of whether electricity was needed in the two villages. Villagers responded very eagerly to the idea and they participated regularly in the construction of the digesters. It becomes obvious that when the villagers had the choice to contribute labor planting (or other income generating activities) or to contribute labor towards electricity generating activities, they choose the former.

But in Ban Pa Haen, Roi-et, a solution was found. One man was responsible for filling the biogas digester with dung at a cost of 5 baht per household per month. If this solution proves to be operable, there is still hope for the project. Otherwise, implementation of biogas digesters for village electrification will have to be seriously reconsidered.

D. TRANSITION SURVEYS: MICRO-HYDRO COMPONENT

Background

In contrast to the previous two components, the implementation of the Micro-hydro projects were made without using the Meta Systems baseline data. There were three sites involved in this component, each of which were selected for different reasons, and all of which were located in Chiang Mai Province. Furthermore, surveys for this component were carried out by the NEA survey component in 1983 and 1984 after Meta Systems Inc. left the project. These surveys were considered transition surveys since they were collected over a period of several months during implementation. However, some baseline type data and a limited amount of evaluation data were also collected at the same time.

Like the Biogas Digester Component, this component required villagers' involvement in the following activities during the pre-operation stage:

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- Construction of weir;
- Construction of power house;
- Construction of pipe line bringing water from weir to power house; and
- Installation of electricity post lines, and household lights and outlets.

During the operation stage the following subcommittees were identified:

- Switch controller;
- Pipe line inspector;
- Electrical line inspector;
- Electricians; and
- Accountant.

Site Selection

In the three USAID supported Micro-hydro Components of the Renewable Nonconventional Energy Project, sites were selected in Chiang Mai Province because of its topographic requirements and the historical development of NEA Micro-hydro projects in the area.

Kampong Project, San Kamphang District

This is one of the King's projects. In 1980, an abbot and local leaders of the District organized a field trip to Fang District to observe a small hydro-power plant. The produced electricity was used for the production of canned food by a local manufacturer. After the tour, the villagers of San Kamphang expressed a desire for village electrification using hydro-power. The next year, in 1981, His Majesty the King happened to visit the village and learned of their request. He ordered one of his team members to show village leaders another micro-hydro plant at Pangbong, in Doi Saket District. (Pangbong Project was a joint project built by a cooperative effort between the NEA and the villagers. The NEA provided project officials, necessary supplies and equipment such as an electric power generator, water pipes, electric wires, etc., for the construction. The villagers provided local supplies and equipment, such as rocks, sand, wood for electric poles, etc, and their labor. The NEA responded to the King's project and sent its officials to the village to conduct a feasibility study. Later, with the cooperation of the NEA and the villagers, the construction of an electric power plant using micro-hydro power (12 kw) was begun in December 1982.

Photograph 5.8 The Building of a Wier for the Micro-Hydro Project by Village Laborers Working in Teams on Rotating Shifts (Kampong Project).

Photograph 5.9 Analysts Observing Village Teamwork Closely on Kampong Micro-Hydro Project.

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Photograph 5.13 Problem-Solving Meeting of Executive Committee of the Kampong Project.

Photograph 5.14 A Village Meeting Arranged by a Temple Abbot and Executive Members of the Kampong Project on the Installation of Household Electrical Equipment.

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Photograph 5.16 Executive Committee Members Install Electrical Equipment for Villagers (Kampong Project).

Photograph 5.17 Local Officials, Deputy District Chief, District Developers, and Analysts Combine Efforts to Administer Executive Committee Election in the Micro-Hydro Project (Mae Ton Luang Project).

Photograph 5.18 Election of Administrators for the Micro-Hydro Project (Mae Ton Luang Project).

Mae Ton Luang Project, Doi Saket District

As mentioned earlier, the NEA was constructing a micro-hydro power plant at Pangbong Village (10 km from Mae Ton Luang Village). During the initial construction phase of the Pangbong Project, villagers from Village 6 (5 km from Pangbong Village) came to contribute to the construction because they wanted to be included in the village electrification scheme. However, since this was a small project it was not able to produce sufficient electricity to supply another village. Thus, Village 6 (Mae Wan) and two neighboring villages, Villages 7 (Pa Pan) and 8 (Mae Ton Luang) sent a joint request for the NEA to consider a new Mae Ton Luang Project. The three villages guaranteed to supply the labor. The NEA began the project in 1983 by building the weir in Village 7 and the powerhouse in Village 8.

Huai Pui Project, Phrao District

The NEA's program to build micro-hydro electric power plants for village electrification was well-known to many villages in Chiang Mai. One Chiang Mai representative suggested that the Long Kord District Council officially request NEA to construct a micro-hydro plant for seven of their villages, i.e. villages 1, 2, 3, 4, 5, 6 and 8. Villages 7 and 9 were excluded because of their distance from the proposed site. The NEA agreed to this request and sent its officials to conduct a feasibility study. Construction on the project began in April 1983. All seven villages have significantly cooperated with the NEA by donating labor, in rotation, towards the construction of the micro-hydro power plant.

Pre-operation Stage

The initial stage involved introducing the participatory concept of labor contribution during construction. NEA engineers responsible for construction activities contacted subdistrict and/or village headmen and made clear to community members that hydro-power electrification would become possible if and only if a labor contribution was made possible. The Thai government, with assistance from USAID, would pay for construction materials and personnel. In almost all cases, the cooperation of the villagers was very good. Based on a technical survey, NEA surveyors calculated the amount of electricity to be produced and the number of villages and households to be electrified.

When more than one village was involved in the project and cooperation between villages was required, written contracts were made to guarantee full cooperation during the construction period. The household heads were responsible for organizing labor according to requests made by NEA engineers.

For construction, after the number of villages were identified, labor was organized into groups of approximately 20-30 households. By working on the project, or paying for someone else to work, each household became a member and was provided an electrical hookup. Each household was responsible for sending one member of the household to join the work force on a rotational basis. The rotation interval was determined by the number of work teams organized and the number of laborers required on any particular day. The NEA engineers had to tell the headmen the number of laborers required for the next day and the headmen then informed the team leaders to organize their teams. If the number of laborers required was small, only one team would take its turn to work. But when 60 or 90 laborers were required, two or three teams were then requested to work. This arrangement worked out very well at all three sites.

Work teams were also organized for the installation of light bulbs and electric wiring in the houses and to the village mainline. In Kampong Village, villagers paid only for the materials and the cost of labor was not calculated. For 3 light bulbs, one outlet, one meter, internal wiring (40 meters), and external wiring (40 meters), each household paid 900 baht. This was because electric wiring was carried out by a work team organized in a manner similar to the construction work team.

In Mae Ton Luang Village, however, work teams were organized for construction of the weir, the power house and piping only. Electric wiring was carried out commercially by a few subcontractors who charged between 1,500-2,000 baht per household. Since construction was not completed at the third site, wiring has not been done.

At Huai Pui, the topographic conditions proved to be very bad. Rocks were the main obstruction and caused much delay. Finally, small dynamite charges were used to break rocks and additional mechanical equipment was borrowed from other sites. Construction of the weir and pipeline is nearly completed after one full year of construction.

The unexpected delay made many villagers anxious and complaints have been heard. Information that 2 of the 7 villages will be electrified by the Provincial Energy Authority has also made the cooperation of the villagers in those 2 villages less strong.

Since two of the sites are still at the pre-operation stage, descriptions of the activities are summarized in Table 5.3.

Operation Stage

Since the Kampong Project is the only project in operation, the discussion in section will concentrate only on the Kampong Project.

Table 5.3 Time Schedule and Work Plan for the Micro-Hydro Project

Project	Starting Date	Activities	Date Completed	Remarks
1) Kampong, San Kamphaeng District	1981	1. Technical Survey	1981	All activities completed
	1982	2. Construction	1983	
		3. Installation of internal and external electrical supplies		
		4. Installation of turbine		
		5. Operation	Nov 83	
		6. Village committee for operation and maintenance	Nov 83	
2) Mae Ton Luang, Doi Saket District	1982	1. Technical Survey	1982	
	Aug 83	2. Construction	Apr 84	
		3. Installation of internal and external electrical supplies	Mar 84	
		4. Installation of turbine	not yet	Waiting for parts from China
		5. Operation	not yet	
		6. Village committee for operation and maintenance	not yet	
3) Huai Pui, Phrao District	1983	1. Technical Survey	1983	
	Apr 83	2. Construction	not yet	Construction in difficult area
		3. Installation of internal and external supplies		
		4. Installation of turbine	1983	
		5. Operation	not yet	
		6. Village committee for operation and maintenance	not yet	

In this project villagers are familiar with the concept of participation since they participated and contributed labor during construction. Therefore, when the NEA survey team introduced the idea of establishing group organization for operation and maintenance of the electrification system, the villagers readily agreed with the idea.

Originally a village electricity committee was set up composed of 25 members having the abbot and the school headmaster as their advisory members. Rules and regulations were set up. The committee was supposed to meet 1-2 times a month or when necessary. NEA officials were to be consulted closely when technical problems arose.

Mae Kampong is a small village of 120 households which is divided into three groups. During the construction period, each group worked once every 3 days with a rotation of one group per day. Each group had a leader responsible for ensuring full participation of all the households. When necessary, the labor contribution could be substituted by someone else or by paying the minimum wage of 61 baht (cash) per day. Money was contributed to the village cooperative.

In July 1983 a new village committee was set up with the community development officer, the agriculture extension worker, the abbot, the school headmaster, and the 3 village headmen as members in addition to 29 villagers. The following subcommittees were also established:

Mae Kampong Subcommittees	Number of Committee Members
Electrician	9
Pipeline	6
Electric line	7
Generator	3
Treasurer	4
Advisory	13

Rules and Regulations Set Up By the Village Electricity Committee

Operation hours

Week days	1600-0800	hours
Weekends and holidays	24	hours

Additional operating hours may be requested when necessary.

Tariff

1. The rate is 2 baht per kwh. For 5 units or less, a minimum fee of 10 baht will be charged.

2. Tariffs will be collected on the fifth of every month. Members of the treasury subcommittee are assigned with specific duties to be carried out every month.

3. Tariffs are to be paid at once; at 7 days a warning will be issued; at 15 days a monetary penalty (double the cost) will be issued; at more than 15 days the electricity service will be terminated.

Regulations

1. Electricity wiring cannot be extended to non-members.

2. Children of members are given the right to use the electricity when they establish new homes.

3. High voltage appliances are not to be used between 1800-2300 hours.

4. If regulations are broken, a warning will be issued for the first offence, a monetary penalty of 100-1,000 baht will be charged for a second offense, the termination of electric service of not less than one month for a third offense; and termination of membership for breaking the rules more than three times.

Addition membership

1. Households which migrate into the community after operation of the electric system commences must pay 1,000-5,000 baht to become a member of the cooperative (they must pay because they did not contribute towards the construction of the system).

2. Households which lived in the community during the construction period but did not contribute towards the construction must pay 2,000-8,000 baht to become members of the cooperative (they must pay a higher price because they were given the opportunity to become members but did not cooperate and contribute towards the construction).

Terms of the committee

1. The term of this committee is 2 years;

2. Committee membership is terminated in case of death, resignation, end of term, or misbehavior (in which case the person will be voted out).

E. TRANSITION SURVEYS: WINDMILL WATER LIFTING COMPONENT

Background and Site Selection

Implementation of the Windmill Water Lifting Project was carried out by the NEA water lifting component. A request for the project was made by the Agriculture District Officer of Raman district, Yala Province to the NEA. Yala is a Thai-Muslim province and implementation of a development project in a Thai-Buddhist and Thai-Muslim village was considered an admirable effort to help promote integration of the two ethnic groups. In Village 4 where the experimental plot was set up there were 562 Buddhists and 306 Muslims.

In 1982, an experimental plot was set up and a request for the windmills was made. Three windmills were set up by commercial firms (paid for from the USAID budget) to irrigate the plot for dry season cropping. The experimental plot was situated on public pasture land. The total available public pasture area was 400 rai (64 ha). But in the initial stage only about 100-120 rai (16-20 ha) were cleared. At present about 150 rai (24 ha) are cultivated with upland rice and is an example of rainfed agriculture. Approximately 60 rai (10 ha) are irrigated for dry season cropping.

Villagers' Participation

When the experimental plot was set up in 1982, there were 49 members from Ban Samoh, a Thai-Buddhist community, and Ban Champun, a Thai-Muslim community. There were 11 plots and members were separated into 11 groups, 9 Buddhist and 2 Muslim. In 1983, 21 new members joined the project, 19 were Muslims and 2 were Buddhist. A new Muslim group was then organized making a total of 12 groups. More members joined the project in 1984 and only 3 members left the project. The total membership is now 84 people.

Each of the 12 plots had a leader and distribution of the land to members of the plots as well as the management within the plots was under the supervision of the leaders. In 1982 and 1983, the management and production of the experimental plots was reported to be successful although production was somewhat low. Water lifted from the deep and shallow wells by the 3 windmills helped villagers in terms of labor savings. Instead of having to lift water out of the wells by hand or with hand pumps, which were usually broken, water could be lifted by a windmill. Water was distributed into the different plots through extension pipes on a first come first serve basis. Villagers were reported to be quite generous to their neighbors and no one tried to keep the water on his plot selfishly. Conflicts or disputes over water rights were not reported. This was probably because water was abundant and the windmills served as labor

saving devices for dry season cropping. Besides the well water which was lifted by the windmills, other water resources were also available. In addition to the 3 windmills lifting water from the deep wells, three were 11 shallow wells (dug by the dry season employment budget) and 5 pounds located within the 60 rai (10 ha) of irrigated land. Therefore, cultivators could always depend on water from the shallow wells and the pounds. One villager reported that by piping water from the windmill he spent 45 minutes watering his plot. But without piping, and depending on the shallow wells where he had to carry water with 2 buckets, he spent 2 hours watering the same plot. This also counted rest periods between trips.

Although villagers' participation in activities of the experimental plots are definite and crucial, in the installation of the windmill there was no villager participation. The three windmills were installed by commercial and professional (or semi-professional) firms under subcontract. Unlike other projects, a labor contribution by the villagers was not required at all.

Committees

The experimental plot committee consisted of:

- Chairman;
- Vice-chairman;
- Accountant;
- Supply;
- Pesticide;
- Water;
- Marketing; and
- Secretary.

This committee was responsible for the management of all activities within the 12 plots of the experimental plot project.

Leadership

Nai Chuang Phromlek was the most active person coordinating all activities relating to the experimental plot project. It is accurate to say that without him this project would have faced difficulties. Since he had connections with officers in other government offices, he was able to

make a request for a tractor to clear the land before cultivation each year and other similar requests. Although his contribution should be commended, he also made ther villagers dependent on him and retarded self-reliance and participation somewhat. At the moment, the Agriculture officer has not been able to identify an assistant to replace him when needed. It is risky to depend on only one person for the success of the project.

Problems

1. *Flood*

In 1984 the experimental plots were flooded because of continuous and excessive rainfall even during the dry season. In February, plots were prepared. But before crops were planted, unexpected rain came and continued at frequent intervals until it had to be decided that dry season cropping was not possible. If one were cost-benefit conscious, one would have to question the worth of the implementation of the windmills as this year showed a loss. However, this aspect of the project is not in the scope of the survey component and will have to be discussed in the component report.

2. *Production*

Approximate production figures for 1983 were:

1) Watermelons

Total production	32,500	kg
Total sale value	50,000	baht
Total consumption value	10,000	baht

2) Supersweet Corn

Total production	5,000	ears
Total sale value	2,800	baht

3) Cucumbers

Total production	515	kg
Total sale value	2,060	baht

4) String Beans

Total production	200 kg
Total sale value	1,200 baht

It was reported that production was low and the size of the produce was also small due to a lack of water in 1983.

Improvement Scheme

An economist would ask if the cost invested in windmill installation was compensated for by the benefits gained in terms of labor savings and time spent watering the plots. The answer would definitely be negative even without doing any calculations. Since social benefits are difficult to compute, it is necessary to maximize or optimize the potential benefits at this stage.

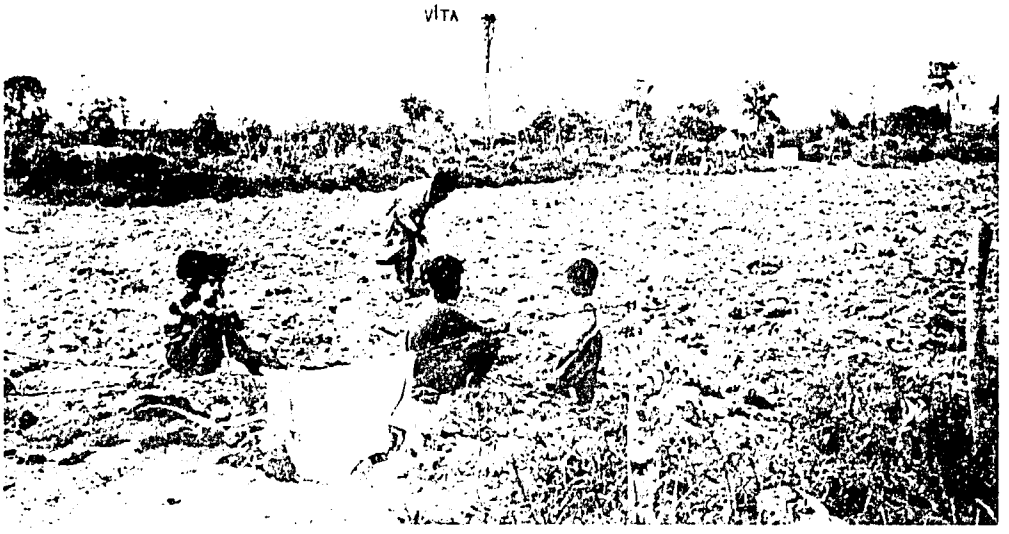
One way to increase benefits is to try and develop the area into an irrigation system where canals are dug around the area and secondary canals channel the water into individual plots. This would also require a reservoir to be dug to store the water lifted by the windmill during the 24-hour period. When water was needed in the plots, water gates could be lifted and the water could flow accordingly. However, this system would require additional investment. The committee managing the experimental plot tried submitting the proposal to the subdistrict council for funding through the dry season employment budget, but the subdistrict council rejected the proposal and allotted the budget for road construction instead.

Another suggestion was to buy tractors, since land must be tilled every year before plots can be made. If the experimental plot members acquired a tractor, it could be paid for by charging a fee to members who use the service.

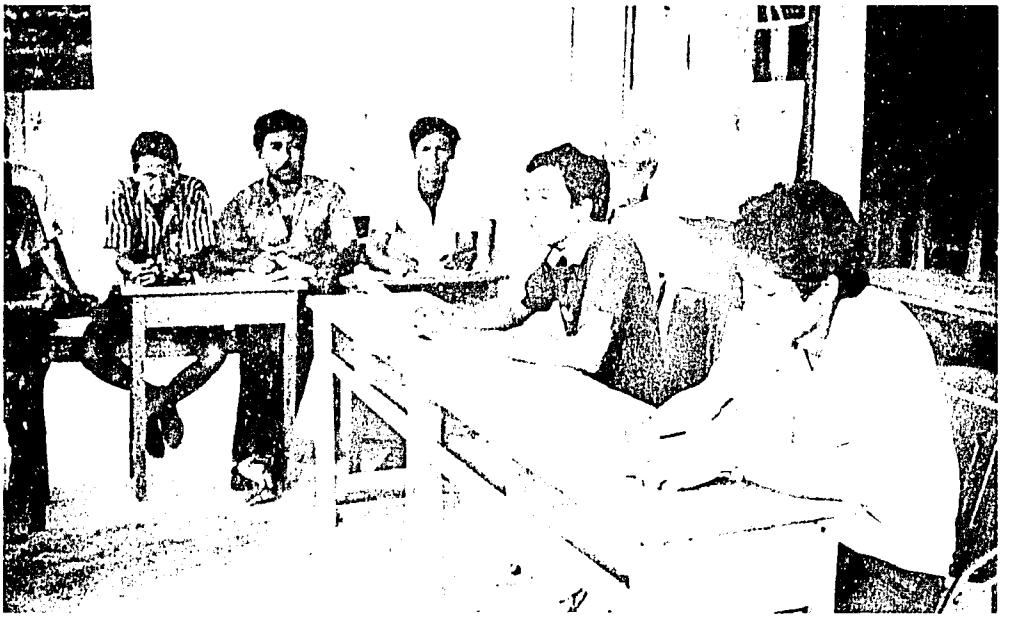
Additional windmills may also prove to be useful because there is another group of cultivators whose plots are located far away from the deep wells where the windmills are now located. However, only if the additional windmills can be supplied free of charge would the project be worthwhile to the cultivators since they cannot afford to pay for them.

Other Activities and Its Implication

It turns out that the site for implementation of the Windmill Water Lifting Project was also the site where other activities were designated. It was the site where the King's project was launched. Therefore, from the point of view of the concerned government officials, activities to



Photograph 5.19 Wind-powered Water Pumping Project to Provide Water for Agriculture in Yala Province.



Photograph 5.20 A Meeting of Analysts and Villagers to Establish a Committee to Administer the Wind Mill Project in Yala Province.

help increase the potential for a successful project, i.e., the Experimental Plot Project, should be recommended and welcomed. Therefore the request for a Windmill Water Lifting Project to help irrigate the experimental plots was made. The success of the experimental plots will not only be a credit to the project itself but will also be a credit to the community where other activities also took place. The community is now identified as a "development village" where many development activities were launched and the village represents a "development village".

It is therefore difficult to judge the merit of the water lifting activity on its own. It is fully integrated into the Experimental Plot Project of the Department of Agriculture where other inputs also contributed to the success of the project.

If one can claim (for 1982 and 1983) that the Water Lifting Component of the Renewable Nonconventional Energy project contributed to the success of the experimental plot project and therefore helped bring "development" into the community and contributed to the success in ethnic integration of the Buddhists and the Muslims in the community, the claim would be invaluable. National security and political stability in the four most southern provinces of the country is an aspect of vital importance to the government of Thailand. The question is whether the claim can be made with supporting evidence.

F. TRANSITION SURVEY: PHOTOVOLTAIC CELL WATER LIFTING COMPONENT

Background and Site Selection

The photovoltaic cell as a technology for Renewable Nonconventional Energy has been proven but has not been commercialized because of the high cost. In this component, photovoltaic cells were imported at a high cost. Since the technology had been proven for water lifting, installation of the cells at the identified water sources was the main activity. Two sites were selected by the component team, one in Sakon Nakhon and another in Nakhon Ratchasima Province. The requests for installation of the photovoltaic cells in the general area of the provinces were made to the NEA by other government agencies but the actual locations and village selections were made on technical grounds. Since end-use differs in both sites, discussions will be made separately.

Village 1, Ban Tha Yiem, Non Hom Subdistrict, Muang District, Sakon Nakhon Province

Initial site selection

This village was selected by the Water Lifting Component team because

of its potential to use a photovoltaic cell to lift water from a deep well for household consumption. The installation of a pump whose energy supply was solar would supplement existing activities within the village and help improve production of the village. Since this village had been classified as a very poor village and was the lowest grade in terms of development, many "development" projects were needed to supplement each other. It was believed that with all the efforts concentrating in the same location, potential for development would be likely to take place.

An agricultural group had already been organized to cultivate tomatoes and other crops for a small food producing factory in a nearby village. Members of the groups were supplied with seeds, fertilizer, pesticide, etc. Records of farm supplies taken at the beginning of the planting season were kept by the factory and deducted from the output accordingly. The factory is one of the four rural food industries under the King's patronage.

A deep well was dug by the office of Accelerated Rural Development and a hand pump was also installed. But the hand pump was broken when the component technician visited the village. As a result of the physical survey made by the Water Lifting Component, this village was selected and a photovoltaic cell was installed to lift water in place of the hand pump which was broken.

After installation of the cell, it was found that the cell had the capacity to generate a motor to lift about 6,000-9,000 litre of water which was not sufficient for household purposes.

Water was lifted using solar energy collected by the photovoltaic cells. The cells operated between 9:00 a.m. and 3:00 p.m. when water was lifted and stored in a 10 cubic meter tank. At 3:00 p.m., when the sunlight was inefficient, water was transferred from the large tank to four smaller tanks located at different spots in the village. Villagers were then allowed to collect water with their buckets to store in their houses for daily use. It was reported that the amount of water available was insufficient. Either the amount of water lifted from 9:00 a.m. to 3:00 p.m. was lower than estimated or the villagers have been using more water than they did when water had to be lifted by human labor. At any rate, an attempt should be made to make more water available since it was reported that the amount of water in the well was not the problem.

Villagers labor contribution

A labor contribution was made when the photovoltaic cell and the water pump was installed. There were 2 stages. The first stage lasted about one week when pipe lines were dug and a cement ground prepared for the pump and photovoltaic cell areas. Since this village is a self-defence village where village organization had been set up by military officers

of Region 2, the villagers were familiar with group organization and a pattern of communal work. There were 7 groups in the village. One group was required to work each day under the supervision of the Water Lifting Component team. Only on the occasional day when a large amount of labor was required would 2 groups work on the same day. Since labor requirements for this project were minimal, each group only worked once or twice at the most. There was no problem in getting a labor contribution from the villagers.

In stage two, pipes were installed underground where pipe lines were dug in the first stage. Since the installation of pipes needed some special training and because of a lack of equipment, most of the installation was done by the component technician. When labor was required, requests were made and the villagers responded willingly. Everyone was eager to see the project completed.

Village committee

This was a fairly simple project. It was also small. Operation and management were designated to different members of the project committee identified in writing and recorded in the report of the NEA survey team. However, in reality, and in accordance with the preference of the Water Lifting Component team, operation and maintenance was carried out by the village headman only. On paper the committee consisted of one chairman, one vice-chairman, a secretary, and two subcommittees which were designated as: (1) The pump and photovoltaic cell subcommittee, and (2) the tanks and pipes subcommittee. Later, additional members were recruited and a reorganization of the subcommittees was made resulting in 3 subcommittees separating pump maintenance and photovoltaic cell maintenance into 2 groups.

In case of operation failure, the headman would write a letter to NEA indicating in as much detail as possible the type of failure, and a mechanic would then be sent out to help repair the equipment.

Outcome

The installation of the project has enabled the villagers to obtain water for household consumption more easily. It has improved the way of living of the people somewhat. Instead of having to walk farther and use more effort to get their water, the installation of the photovoltaic cell has saved time and reduced labor input to obtain water. However, since the amount of water available is insufficient, complaints are being made and people have been accusing each other of taking too much water. At the moment conflicts are still small, but one should be cautious and make sure that the convenience and "development" brought into the village do not result in conflicts which were not in existence prior to the installation of the water pump.

Comments

This project, even if viewed as a research and development project, is still questionable. The project only involves the installation of a photovoltaic cell, a pump, pipelines, and water tanks. Solar energy is converted and made to operate a water pump which can easily be operated using benzine or diesel or other energy sources. The project only proves that renewable energy can be used instead of a petroleum-related product. Yet, the output is not yet sufficient. Villagers found that the amount of water lifted for household use was not enough and they started blaming each other for using or taking too much water, of an unequal distribution of water. One should seriously evaluate this project in terms of "development" results, if not in terms of cost-benefit. One rationale working in favor of this project was the social or psychological impact on the villagers. This was a village located near the border where communist insurgency was reported. Now the government has moved in and brought many development projects into village. The King and the Queen have also introduced many projects in this and nearby villages. Social impact alone may be sufficient to measure the success of the village.

Improvement scheme

Many villagers would now like to have a water lifting project to draw water from the Nam Phung River to irrigate the upland side of the river. The beach or lowland side of the river is now used for vegetable plots because cultivators can carry water from the river without much difficulty. If water could be lifted up to the more inaccessible areas by some mechanical means, additional dry season crops could be cultivated. However, to supply water for agriculture, a larger unit of photovoltaic cells would be required and an irrigation ditch system would have to be designed.

Since photovoltaic cells are still expensive, and rural electrification will become available soon, perhaps an electric water pump would be a better alternative for water lifting for agricultural purposes.

Village 10, Ban Sukon/Ban Lam Pradong, Chumphuang Subdistrict, Chumphuang District, Nakhon Ratchasima Province

Initial site selection

When the request for a photovoltaic cell water Lifting Project was made to NEA, the site in village 10 was identified because it was located near a river which in the past was very small and dried up. After the Department of Irrigation built a weir upstream, the river became larger and more water became available. The NEA Water Lifting Component then designed a system to use photovoltaic cells to draw water from the river to irrigate the areas 20-40 meters from the river bank.

An area was suggested by the subdistrict headman (kamnan). The kamnan's eagerness to push the project forward made him overlook some of the details regarding land rights and ownership. Though the land designated for the project was public land in the past, in 1975 legal papers (no so sam) were issued, legally or otherwise, to many individuals in the village. If the policy of the government was to help out the landless and poor villagers, the issuance of land ownership documents may be looked upon as a legalization of common law practices. Villagers have accepted the fact that these plots of land are no longer public land.

When the kamnan learned that these plots of land were private properties he felt that the individuals involved should be willing to give up a certain amount of land for public use, and that there should be no difficulty in getting permission from the land owners. Therefore, the NEA Water Lifting Component team was assured that they could move forward with no difficulty.

Villagers labor contribution

Like the implementation of other Renewable Nonconventional Energy Components, labor contribution was made on a rotational basis. Approximately one month was required for a construction of the cement ground and for the installation of the photovoltaic cell and the water pump. The villagers willingly contributed their labor when their turns came. If unavailable, hired laborers replaced volunteers.

However, the decision to become involved in the project was not unanimous. Because of existing conflicts and factionalism within the village, a few individuals preferred not to be involved in the project and they were left uninvolved. When construction and installation were almost complete and a meeting was called for allocation of plots to the villagers for dry season cropping, it became clear that at least two individuals would not give up their rights over a large portion of the land.

A lesson to be learned here is that villager participation is very important in action research. Full involvement in the project is a good indicator of the lack of conflict and disagreement which, in turn, indicates successful projects. In this particular case the matter was much more complicated and is too lengthy to be included in this chapter. Reports of the Division of Energy Economics, National Energy Administration, should be consulted for more detail.

Records of activities of NEA officers

Two groups of NEA officials were involved in this project, i.e., the Water Lifting Component and the Survey Component. Activities are summarized briefly in the following paragraphs. In addition to activities of NEA officials, local activities are also recorded.

Date		Activities
1975		Issuance of land documents (no so sam) of public land to individuals.
1980		The newly elected kamnan (subdistrict headman) promised to redistribute the area known to be public land prior to 1975 to villagers at 2 rai per household. However, this project was not carried out.
1982 July 23	1.	Chumphuang District requested NEA to install a water lifting device for dry season cultivation.
	2.	Water lifting component team surveyed and selected Ban Sukon Village.
1983 April 20-26	1.	The survey component carried out a baseline socio-economic survey of the village by request of the Water Lifting Component.
	2.	The Survey Component identified the following potential problems: • The redistribution of land promised by the kamnan never took place; • Village leadership was weak and the headman was not accepted by all; • Public land identified as plots to be irrigated were privately owned and the owners were not willing to let go of their land even for community interest; • Paddy fields to be irrigated belonged to only 26 out of 115 households. Therefore, this project could not claim to benefit the majority of the people; and • Photovoltaic cells to be installed would not have the capability to irrigate the large areas of land expected by the villagers. Water was to be pumped to irrigate the strip of land near the river to which villagers had already been able to carry water with their buckets.

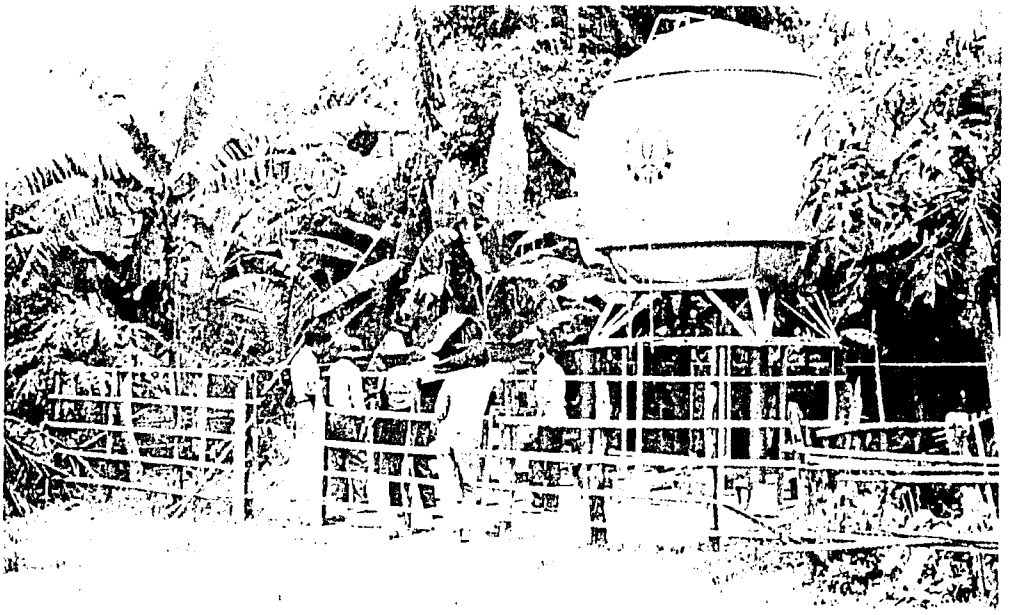
Date		Activities
June 21 - July 21		The Survey Component team carried out a transition socio-economic survey of the village and set up a village committee to manage the project.
July 20		The kamnan wrote a letter to NEA confirming that there was no problem over land rights.
November 15-20		The survey team revisited the village and was informed by the villagers that land right problems had not been solved.
1984 February 6	1.	The Water Lifting Component team and the survey team went into the village to install equipment.
	2.	The kamnan wrote a letter to NEA stating that if there were any conflicts leading to unsuccessful implementation, NEA could removed the equipment. The letter was signed by the kamnan, the district officer, and the chairman of the village water users committee.
February 28	1.	Land measurements were carried out by the kamnan and the district land officer to identify the location for irrigation canals.
	2.	Objections were made by individuals who disagreed with the measurements and the new land use plan where the old wagon trails were abolished and replaced with a more distant trail.
March	1.	Land measurements were made in order to redistribute small plots to every household. Land documents issued in 1975 were still in the hands of individuals. Rights over land given for public use were made verbally with no written document.
	2.	Specific requests were made by two individuals, i.e., Nai Chom Phalathip and Nai Hom Phalathip. The requests were not complied with.
	3.	Land disputes were negotiated unsuccessfully. Though Nai Hom signed a paper giving up his right over the plot of land, Nai Chom disagreed.

Date	Activities
May	The new district officer replaced the former officer.
June	Land settlement was negotiated. Nai Chom signed a letter agreeing to trade his plot of land for another unidentified plot. Minor details were not made and there was no full understanding. Each individual had his own understanding of the situation.

Comments

To date this project cannot be said to be implemented. It is very clear that implementation is not a simple matter to be neglected and taken for granted. Local politics became the most important issue in this case. The influence of the kamnan, the village headman and the 2 individuals in the village are factors one must examine closely. Apparently, the kamnan and the headman had carried out activities in their interest and had stepped on the toes of at least 2 villagers (who did not talk to each other). For implementation, one must not walk into the community blindly. The baseline survey, when carried out prior to implementation, should serve as a background and guideline for future activities. In this case, the baseline survey was not treated with care. If treated accordingly, many of the problems might have been avoided.

Another problem to consider is marketing. If agricultural products are made available by the water pumped with solar energy, the sales of these products would be another problem. At present, the road system into the village is very bad. There is no all-weather road and the cost of transport would double the cost of the produce, taking into consideration damage due to bad roads. The kamnan and the new district officer hope to obtain additional funds from the rural job creation project and other sources to repair the road connecting the village directly to the district site. The success of this road project also depends on the success of the photovoltaic cell project.



5.21 Photovoltaic Water Pumping Project for General Consumption in Sakon Nakorn Province.

5.22 Villagers Pick the Administrative Council for the Photovoltaic Project.

5.23 Analysts Observe the Election of the Administrative Committee of the Photovoltaic Water Pumping Project in Sakon Nakorn Province.

5.24 Sociologists from Chulalongkorn University Gather Data from the Village Headman Concerning the Photovoltaic Water Pumping Project.

5.25 Photovoltaic Water Pumping Project for Agriculture at Nakon Ratchasima Province.

5.26 Cheers as the Administrative Committee for the Photovoltaic Water Pumping Project is selected in Nakorn Ratchasima Province.

Chapter 6

Discussion

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DISCUSSION

A. PRELIMINARY REMARKS

Rural Energy Survey Carried Out By NEA

The USAID Renewable Nonconventional Energy Survey was carried out one year after the NEA carried out a rural energy survey supported by the Asia Development Bank (ADB). Therefore, NEA personnel were not as enthusiastic towards the USAID survey as they were initially expected to be. As a consequence, there was not full cooperation.

The Terms of Reference and Proposal

At the outset of the project, neither the Terms of Reference nor the Proposal were available. Therefore, in the earlier phase of the project, it was assumed that the survey was to be used to collect baseline data only for the implementation of different energy technologies which were being developed by the other components of the Renewable Nonconventional Energy Project. Only later was it learned that the baseline survey was to be conducted also for the use of the Energy Master Plan component.

B. THE OBJECTIVES OF THE SURVEY COMPONENT AND THE NECESSARY SAMPLING FRAME

The Rural Energy Survey and the Energy Master Plan: The Necessary Sampling Frame

If the rural energy survey was to be used in the Energy Master Plan to forecast demand and supply of energy and to make projections for the future, villages and households selected in the sample should have been randomly selected and should have included different types of villages and households. However, in this survey provinces were initially selected to represent provinces with specific energy resources. Therefore, data from the survey cannot be used to represent national energy statistics for macro planning.

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The Rural Energy Survey and the Implementation of Energy Technology

In this project the rural energy survey was intended to serve as a baseline or pre-implementation survey to be followed by transition and evaluation surveys. The sampling frame was designed in order that villages selected in the baseline survey represented areas with different natural resources required by different energy technologies. The plan was to serve other component leaders in site selection and implementation. But since the other component leaders either were not aware of the plan or did not need the service, the baseline survey was not as fully utilized by the other component as was originally intended.

C. PARTICIPATION AND SELF-RELIANCE: THE CONCEPTS OF DEVELOPMENT USED IN THE SURVEY

Self-reliance and participation are the two concepts inherent in the survey component. The implementation of energy technology should be carried out to promote both concepts. In the baseline survey, questions regarding group activities in existence in the communities and other questions were asked in an attempt to predict the degree of participation and self-reliance of the villagers in carrying out development projects with little outside assistance. Self-reliance was also viewed in terms of self-reliance in energy supply. If natural resources were available to supply a particular energy technology, the introduction of that technology would certainly help make that village self-reliant in energy supply.

The Concept of Self-Reliance and Participation in the Woodlot Component

In the selection of the first woodlot sites in 1981, a need for energy resources and the availability of land were the most crucial criteria for site selection. Sri Saket was identified and four plots of land were selected. If the participation concept were to be used, once plots were identified, community members in the vicinity would have to participate in all activities related to woodlot from the beginning. Community members must agree that the woodlot would become community property meaning that labor input (planting, weeding and harvesting) would be communal and the output (the trees) would also be communal. Community members should become woodlot committee members having their say in the management of the woodlot plots from the beginning of planting until harvest time. However, in this project villagers were not involved in the Woodlot Project because seedlings were planted with paid labor. The foresters and their hired laborers took care of the

plots the first few years. It has been decided to transfer the woodlots to the subdistrict councils under the supervision of the districts and the provinces. This transfer of the woodlots from the Department of Forestry of the Ministry of Agriculture and Agricultural Cooperative to the Ministry of Interior will be made officially at the conclusion of this project. After that the subdistrict councils will take care of the woodlots and "participation" will then take place.

Most officers of the Department of Forestry were familiar with hiring local laborers to plant the forest. The provincial foresters had staffs whose main duty was tree planting. Therefore, they felt that there was no way to make the villagers plant the trees in the woodlot without pay. But the statement was made under the assumption that the villagers would not benefit from the project. If the entire picture of the Community Woodlot Project was presented to the villagers, participation in the community woodlot project would not be a problem. However, initially the foresters did not fully realize that the woodlots were to be established for the benefit of the villagers. Therefore, they saw no reason why the villagers should contribute unpaid labor to the project.

It appears that in the Woodlot Component, the concept of participation and self-reliance in fuel wood supply were not fully understood by the foresters who implemented the project. The foresters assumed that woodlot planting was a reforestation project which was the duty of officers in the Department of Forestry and which should be carried out in a manner similar to other projects. Trees were planted by the government and belonged to the government. Conservation was understood to be the main purpose and harvesting was not possible. It is understandable that the community woodlot concept is not readily acceptable by most foresters. It will take a few more years to change the traditional values.

The Concept of Self-Reliance and Participation in the Biogas and Micro-hydro Components

Since the Community Biogas and Micro-hydro Components required labor input during the construction phase, participation of villagers was necessary from the beginning. The component leaders and the technical teams had neither labor nor cash in hand to construct the necessary infrastructure without a labor contribution from the villagers. Therefore, the concept of participation of community members in the energy self-reliance projects were tried by these two components. Villagers were called to meetings where the projects were explained in full and participation of the villagers in the different phases of the project was identified. Participation of villagers during the construction phase was admirable. Rotation systems for labor contributions were set up. A punishment system for those who neglected their duties was introduced and labor was monitored strictly to guarantee participation.

After construction was completed and the systems were operating, the monitoring and operating job descriptions and schedules were set up and carried out. To date only 3 systems (2 Biogas and one Micro-hydro) are in full operation, and each have been operational for only a few months. Therefore, it is too early to make any final statements about the success of the program. However, in the Mae Kampong Micro-hydro Project at Ban Huai Kaew, San Kamphaeng District, Chiang Mai Province which has been operating for several months, maintenance crews are very active. Subcommittees were set up to take care of different sub-sections of the project. The social scientist of the survey component had done an excellent job in helping to establish a committee system to enable the villagers to take care of the project in the future. It is here that both participation and self-reliance were seen in operation--Participation of villagers in the construction and implementation/operation phase and self-reliance of energy supply and self-reliance in operation. The villagers knew how to operate all aspects of the micro-hydro system for village electrification and they knew who to contact at NEA in case of technical problems.

Although the biogas village electrification had been in operation in a manner similar to Mae Kampong micro-hydro system, the operation was very brief--just prior to the last visit of the survey team in early May. Since the completion of the construction phase, a series of problems arose. All of the problems were technical difficulties which required many months to solve. Therefore, although the project started in 1981, neither of the two villages have been electrified for more than 3 continuous months. In this component, villagers' participation can be said to be exceptionally good so far, when needed. But the participation had not been required over a long period of time because the system broke down immediately. It is difficult to judge and predict how the villagers' participation will hold up over a long period. One danger is that the routine requirements of filling dung and operating the generator may prove to be boring and may be neglected over a long period.

At one site, Ban Khwao, Sri Saket Province, enough pressure was seen on the gauge, but the dung filler appeared to be very dry and clean as if not much in use. Furthermore, upon examining the operating records, the generator was operated only 1 to 1½ hour each day. It turned out that the young men who were responsible for operating the generator turned the generator off when they wanted to leave the village to see their friends or to go to town. None of the villagers complained and were content with having electricity during the evening meals. After dinner, there was no need for electricity and if anyone needed light, they put on their kerosene lamps instead. Life was the way it was last year, with or without electricity.

One reason the villagers were not dependent on electricity was because electricity had not been available continously over a long period. The villagers needed more time to adjust to this new way of life and to learn to utilize the availability of light during the early evening hours. One month afterwards, when another visit was made, the survey team found that electricity had not been used for the whole month of May. The digester had not been filled and the generator had not been operated. May was the month when villagers started planting and they did not seem to have the time or the incentive to carry out their responsibilities of operating the biogas digester. When one or two groups neglected to fulfill their responsibilities of operating the digester, other groups followed the same course and the biogas digester had been left idle. The survey team encouraged everyone in the village to continue the biogas operation and the villagers promised to do so. The need for electricity has yet to be proven to the villagers as they do not yet feel they can give up a certain amount of time during the busy months to fill the digester with dung. The household energy model developed by Meta Systems Inc., which is a model indicating choices of energy technology preferred by each household, indicated that the biogas digester and the gasifier were the two technologies which would be chosen last because of the daily labor input requirement. It is evident that during the planting and harvesting seasons the villagers do not feel they can afford to spend the time on energy production. In rural Thailand the villagers had been able to do without electricity and so, during the busy months, they readily turned back to the old way of life, depending on kerosene lamps for their light supply.

In Pa Haen Village, Roi-et Province, the biogas digester was also left idle in May. When the survey team visited the site, a discussion was held between the villagers and the NEA representative and the accepted solution was to hire someone to take care of the digester. Each household agreed to pay 5 baht per month to the man in charge. This solution seems very practical because as indicated, daily duties became a burden which most villagers were either unwilling or unable to accept. On the other hand, paying 5 baht for electrification seemed to be a very reasonable solution. For the Micro-hydro projects in Chiang Mai discussed earlier the electricity tariff for the villagers was greater than 5 baht per month and this was accepted by the villagers. Therefore, this solution for operating the Biogas system seems very reasonable and realistic. An evaluation survey to be conducted next year will prove or disprove this statement.

The Concept of Participation and Self-reliance in Water Lifting Projects

Since the implementation of technology in the Water Lifting Component was done in conjunction with other projects, it was very difficult to judge whether participation and self-reliance were consequences of this project.

For participation, one needs to distinguish between participation in the implementation of water lifting activities exclusively or participation in general. In case of the windmill, implementation of the windmills was carried out by paid subcontracting firms. In the eyes of the villagers, the windmills were handed to them free of charge with no investment of any kind.

It was the District Agriculture officers who phased requests through appropriate channels and who acquired a technology which would help improve the potential for a successful experimental plot. The success of this project would benefit the villagers, but it would also indicate to the high ranking officers the ability of their subordinates to carry out successful projects. Since most government officers are very conscious of needing to provide successful development projects, the Windmill Water Lifting Project has certainly proved the point--especially since the project was located in a community where other development projects were located. Included in the development activities were the King's Biogas and Weir projects being anxiously watched to make sure of their success.

Similarly, in Sakon Nakhon the Photovoltaic Water Lifting Component became just one additional piece of equipment indicating development of the village. The water pump became another object of decoration whose actual function did not serve actual needs but became a luxury. There is no objection to villagers having luxurious lives if the basics are met. But a detailed evaluation survey can accurately answer the question whether actual needs were met. One fact becomes apparent, however. The villagers have become reliant on this simple way to obtain water and they start complaining when water from the tanks is not sufficient to supply everyone. While the villagers are not self-reliant on their energy supply they have become dependent on the new and inefficient technology.

In terms of participation, the photovoltaic cell at Ban Tha Yiem in Sakon Nakhon is very small and does not need participatory input from many individuals. As for maintenance, this project is under the management of the headman who takes care of everything efficiently. There are no complaints and the villagers are basically satisfied except for occasional minor complaints.

To put it briefly, it is difficult to state explicitly if the Water Lifting Component has promoted participatory development and self-reliance in supplying energy to the villages. The cases of Ban Sukon, Chumphuang District, Nakhon Ratchasima Province cannot be said to be implemented. Conflicts still have to be solved and solutions made. Any discussion of this project should be delayed.

D. LESSONS LEARNED

Weaknesses of the Baseline Surveys

Dissemination of information

Objectives of the baseline survey should be made clear to all in order that a proper sampling frame can be made. Since the contract for the project was made to Meta Systems Inc., Boston, most of the documents were in Boston and not widely distributed to concerned individuals. Secrecy was not the reason for the inadequate dissemination of information; carelessness or neglect seems to be the reason.

Coordination of the survey component with other components

The contract was not signed in early 1981 as expected due to difficulties with the Department of Technical and Economic Commission, Ministry of Foreign Affairs. Since baseline surveys required a large number of enumerators, plans were made to launch the baseline survey in April and May, 1981, when college students were available. Therefore, the baseline questionnaire survey was launched before other components, resulting in inadequate coordination among components. Most component leaders were not even aware of the survey, and thus did not contribute input to the survey.

Ironically, where the participatory concept was introduced into the project, participation of other component leaders in the survey component was at a minimum. The entire project would have become much more integrated and easier to coordinate if ample time had been given for coordination during the initial stage of the project prior to the baseline survey.

Length of the baseline survey

The baseline surveys attempted to collect all information which might be of relevance to the projects. It became clear later that much of the information collected was not relevant and it was too complicated for the enumerators to collect and record. Improvements in the data gathering process should definitely be made if a similar survey is to be carried out in the future.

Objectives of the survey

If the objectives of the survey had been made clear to everyone, and if joint planning had been done by all of those concerned, different strategies might have been planned and used. As has been mentioned earlier, a survey designed for the Energy Master Plan would definitely be different from a survey designed for implementation of energy technology.

For best results, a survey for the Energy Master Plan should be carried out. The questionnaire should contain relevant information on energy demand and supply only. The surveys for implementation of energy technology could be made later when a different set of questions would be asked. Transition surveys would be a more appropriate survey for this purpose. The results of the analysis of the baseline survey reported in earlier chapters clearly indicated the weaknesses of the baseline survey in data gathering.

Weaknesses of the Transition Surveys

Importance of the survey

Although transition surveys have been requested by certain energy technology components, in general, the component teams had no confidence in the social survey and did not pay enough attention to the information gathered. Most component leaders treated the socio-economic surveys as a chance to collect baseline information to be compared to evaluation surveys collected in the future. The case of the photovoltaic cell implementation in Nakhon Ratchasima is one case in point.

Time frame

Most transition surveys were carried out in the last year of the 5-year project due to delays in the Research and Development activities of other components. At this time it is too early to detect weaknesses of the transition survey. Weaknesses will be identified more easily when evaluation surveys are made.

Also, because of the delay in conducting transition surveys, especially when baseline surveys were not available, certain information was not available before implementation. The case of the Huai Pui Micro-hydro system indicates this very well:

1. As explained earlier, the Provincial Electricity Authority (PEA) states that rural electrification will soon be made available to 2 of the 7 villages and therefore those 2 villages should not have been included in the project.

2. The amount of water to be made available and the amount of electricity to be generated are not sufficient to electrify 7 villages. The exclusion of the 2 villages where electrification is being planned would have made management easier. Now villagers are confused and unhappy.

Strengths of the Baseline Surveys

Survey personnel

Data for the baseline surveys were collected by dedicated and well-trained enumerators, field supervisors, and component leaders. Data were collected under close supervision and the activities were a good learning experience for everyone concerned. Enumerators spent one month in a village collecting data with 3 techniques, i.e., participant observations, questionnaire enumerations, and physical measurements. Good enumerators and researchers were identified for future projects. The field supervisors and consultants also learned lessons from experiences gained from this survey.

The concept

The survey was carried out having the participatory and self-reliance concepts built into the survey techniques and into the questionnaires. The survey was not just a quantitative measurement. Qualitative data were also collected in the baseline survey. The concepts will prove to be useful later when implementation takes place.

Analysis

Experience gained from analysis of the survey data includes both computer analysis and questionnaire evaluation. It becomes clear which kind of questions should be omitted or improved in the future surveys.

Strengths of the Transition Surveys

Importance of Transition Survey

It becames clear to the survey team that good transition surveys are the heart of any research and development project. Prior to implementation, socio-economic conditions must be identified. Conflicts and factionalism in communities identified prior to implementation were important information needed for appropriate strategies to be carried out.

Participation Concept in Transition Surveys

A good transition survey will make implementation of technology easier and more meaningful. A transition survey is certainly a must in all research and development projects. In the Renewable Nonconventional Energy Project, the transition surveys carried out proved to be valuable in some of the cases while for others, the value has not yet been assessed.

The importance of the participation concept becomes very clear to researchers in transition surveys. Researchers learned from their experiences that villagers' participation at all stages of implementation were good indicators of successful research and development projects.

E. RECOMMENDATIONS

1. Surveys on rural energy should be carried out with the following precautions:

- Check that no similar surveys were carried out recently;
- The authority concerned (in this case the NEA and CLS) should see the importance of and give full support to the survey; and
- Terms of reference and proposals should be made available to all parties concerned.

2. The concepts used in the survey and the objectives of the survey should be agreed upon by all related components. Sufficient time must be made available for consultation meetings to discuss the relevance and strategies of the survey.

3. A baseline survey should be designed for the Energy Master Plan and a transition survey should be designed for the implementation of energy technology. However, since great efforts have already been put on the baseline survey, implementation of energy technology should be carried out in villages where baseline surveys were carried out already.

4. Attention should be given to the process of site selection and transition surveys. Though villagers should not be given high hopes for project implementation, enough details should be gathered to enable the component leaders to decide where to implement their project.

5. Most technology experts do not want to worry about social conditions, but this is one aspect which should not be neglected. Many experts implement their projects when requested either by the villagers through local administrative channels; through friends who are government officers; through political parties; or through their boss. Requests for specific technology may be made just to get development projects into the communities, since many officers are promoted for being able to help develop the community with material inputs. Therefore, careful consideration should be made in selecting a site.

6. Technology experts should try to work with local people. Many experts do not think that human relations are a necessary etiquette or part of their implementation skills. A short course in implementation technique plus public and human relations should be designed and introduced as an orientation to the job.

7. Special effort should be made not to duplicate work with the work of another agency. The implementation of the Micro-hydro System at Huay Pui should not have included villages which the Provincial Electricity Authority (PEA) had put in its plan. Certainly villagers would prefer the PEA to a NEA project, making cooperation weak and difficult to manage. Being a developing country, Thailand cannot afford to duplicate efforts by implementing two electrification projects in the same location.

8. Based on experiences in rural energy development, the East-West Center, Resource Systems Institute (RSI) together with the Chulalongkorn University Social Research Institute (CUSRI) developed a concept of "participatory action research" (PAR) for rural energy development. This is a technique in field research where dialogue is used between the implementing officers and/or researchers and the villagers to acquire information on available energy sources and to learn the demands of the community; attempts can then be made to reach a decision on the most appropriate type of energy technology required for that region or village.

Chapter 7

Conclusions

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CONCLUSIONS

1. The implementation of an alternative energy technology requires not only specific information of the locality but also a well formulated technique designed to actively involve the local villagers in the formation, implementation, operation and maintenance of the designed technology.

2. For implementation of a project to be successful, one must not walk into the community blindly. The baseline survey, when carried out prior to implementation, should serve as a background and guideline for future activities.

3. Baseline surveys need to be conducted on every component. Transition surveys carried out prior to implementation will lead to successful implementation if social problems identified by the survey are solved.

4. Evaluation surveys were not conducted for this study due to time limitations. They are good measures of social and economic changes in the community, they pinpoint problems of acceptance and provide technology diffusion information.

5. The results claimed in the analyses by the Village Survey Component can only be claimed as guidelines for use in the data analysis of other energy surveys.

6. The surveys conducted by this component have provided important baseline information regarding the rural areas of Thailand that will have many uses in the future. Be cautioned that these surveys cannot be considered as statistically representative of Thailand as a whole, but they are still extremely valuable within themselves as they represent provinces with specific energy resources.

7. The analysis of the structure of variables by factor analysis was not applicable for this set of data. We can view this analysis as an exercise in factor analysis application.

8. These results will be useful in choosing the statistical methods which should be used in future surveys. Thus, in turn, means that scaling and quantification of variables can be built into the questionnaire and will not need to be a separate function during coding or analysis.

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9. As far as the analyses of the data are concerned, certain primary conclusions were obtained from the analyses run (factor analysis, multiple regression, discriminant analysis and Pearson's correlation matrix);

- The decision to go further/nearer for fuel collection depended on the size of the household, how many household members were responsible for fuel collection and how many rais of land they had access to;

- Neither the use of firewood nor charcoal were indicated by household economic status. Traditional habits and familiarity determined the energy practice in each household;

- The amount of fuel used depended mainly on the needs of the household as identified by household size;

- Most people used fuel in traditional ways. Most did not apply or even think about methods of fuel conservation, methods of cooking or how to use fuel beneficially; and

- Kerosene consumption showed a relationship to household income and lighting equipment.

10. The energy components cannot always consider themselves as isolated units. The success or failure of a component might well rely on the implementation of other projects, such as a new road to carry produce to market, produce that was grown using an improved nonconventional energy technology. Each element relies on each other.

11. The value of the social scientist has been played down in many instances. However, in several cases, project failures or project marginal successes were due to social rather than technical failures.

Chapter 8

Recommendations

RECOMMENDATIONS

1. Special efforts should be made to equip the personnel (especially the technicians) involved in the projects with a good understanding of village life, concentrating on the community's ways of thinking, its behavior and, if possible, important village relationships. Project personnel will, in short, be public relations representatives of the Royal Thai Government and of their energy component, a responsibility which is viewed with as much importance as their technical expertise.

2. Research and Development is important, but without a solid implementation program the results will not pass the "practical application" test. Therefore, attention should be given to the implementation stage with close supervision by the technical specialists.

3. Technical specialists need to give more attention to the implementation stage of the project so that technical/construction difficulties do not cause a failure of project acceptance by the local community.

4. It is recommended that in the future, the Survey Component should proceed with every phase of the surveys (preliminary, baseline, transitional and evaluation) for every technical component in the project.

5. The evaluation surveys should be conducted over a long enough period of time to ensure an accurate assessment of each project.

6. Training on participatory implementation techniques should be offered and required for technicians working on rural energy development.

7. The training curriculum for implementation of nonconventional energy technology should consist of:

- General knowledge on different energy technologies;
- General knowledge on participatory techniques; and
- General knowledge on implementation stages or project cycle.

8. If training cannot be offered, energy implementation personnel should be made aware of the need to involve local people in every stage of implementation, especially the initial stages.

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9. Energy personnel should have a positive attitude toward the local people and should be able to work with the local people with an understanding of how to involve the villagers in the formation, implementation, operation and maintenance of the designed technology.

10. In Survey Data Analysis, if the volume of data is large and must be divided into two phases, it is necessary to design the two phases to be the same. Alternation of the questionnaire and alternation of the data frame will only make the computer analysis more complicated and more time consuming, especially if there is any lag time between data coding and data analysis.

11. Data should be prepared for statistical analysis before coding. Preparations such as scaling, arranging all answers to have the same direction of scaling, and quantification of variables requiring it, should be made prior to actual computer analysis.

12. The statistical tools that are to be applied in the analysis should be identified before formulating the questionnaire. In this way, only the necessary variables will be included and redundancy can be avoided.

13. Redundant and unnecessary variables should be minimized. It was found in this analysis that many of the variables were not applicable to Thailand.

14. The surveys should definitely be continued.

ANNEX

ANNEX

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Annex

Printout 1 Factor Analysis of Fuel Demand and Supply

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FILE: FIRST    FILE     D1                    VM/SP CONVERSATIONAL MONITOR SYSTEM

 325  0            ANALYSIS=GEN,MOTOR,HBOAT,REFRI,EIRON,STRAC,TRAC,
 326  0                     MILL,WHEEL,EPUMP,ENGINE,DIEF,EPAIN,EWIN,EORY,UNIT1,NOW,
 327  0                     PAST,FUTURE,WICK TO 10UR8,READ TO SECURE,CAPAC,COST,
 328  0                     LIGHT1,LIGHT2,FUE1,FUE2,FUE3,FUE4,FUE5,FUE6,
 329  0                     TFUEL1,TFUEL2,TFUEL3,/
 330  0            EXTRACTION=PC/
 331  0            ROTATION=VARIMAX/
PRECEDING TASK REQUIRED       47.03 SECONDS CPU TIME;      535.82 SECONDS ELAPSED.

 332  0          SPLIT FILE BY ID1
 333  0            FACTOR          VARIABLES=RS1 WS1 SS1 STOVE1 UNIT1 NOW PAST FUTURE
 334  C                            SOCIAL WORK MEAL MEAS1 MEAS2 LINEA3 MEM OFFFARM
 335  C                            TOTLAND FUMEM DIST1 CSUM1 CRAIN1 CHIN1/
 336  0            ANALYSIS=RS1 WS1 SS1 STOVE1 UNIT1 NOW PAST FUTURE
 337  0                     SOCIAL WORK MEAL MEAS1 MEAS2 LINEA3 MEM OFFFARM
 338  C                     TOTLAND FUMEM DIST1 CSUM1 CRAIN1 CHIN1/
 339  0            EXTRACTION=PC/
 340  0            ROTATION=VARIMAX/
THERE ARE  1002958 BYTES OF MEMORY AVAILABLE.
THE LARGEST CONTIGUOUS AREA HAS  1002968 BYTES.
THIS FACTOR ANALYSIS REQUIRES      42536 (       41.5K) BYTES OF MEMORY.
31 MAY 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-44       VS1 VMSP-1.0

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ANALYSIS NUMBER  1  LISTWISE DELETION OF CASES WITH MISSING VALUES
>WARNING 11281
>THERE ARE FEWER THAN 2 CASES OR A BAD CORRELATION MATRIX AND FACTOR IS
>SKIPPING TO THE NEXT ANALYSIS SUBCOMMAND.

31 MAY 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-44       VS1 VMSP-1.0

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ID1:  2
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ANALYSIS NUMBER  1  LISTWISE DELETION OF CASES WITH MISSING VALUES
>WARNING 11281
>THERE ARE FEWER THAN 2 CASES OR A BAD CORRELATION MATRIX AND FACTOR IS
>SKIPPING TO THE NEXT ANALYSIS SUBCOMMAND.

31 MAY 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-44       VS1 VMSP-1.0

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ID1:  3
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Printout 1 (continued)

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FILE: FACTOR   FUEL     A1                 VM/SP CONVERSATIONAL MONITOR SYSTEM

THERE ARE  1039360 BYTES OF MEMORY AVAILABLE.
THE LARGEST CONTIGUOUS AREA HAS  1039360 BYTES.
THIS FACTOR ANALYSIS REQUIRES      288556 (     281.8K) BYTES OF MEMORY.
14 JUN 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-VM      VS1-VMSP-1.0

FILE:
IDI:  1
- - - - - - - - - - - - - - - - - - - - - - - - - -  F A C T O R   A N A L Y S I S  - - - - - - - - - - - - - - - - - - - - - - -

ANALYSIS NUMBER  1  LISTWISE DELETION OF CASES WITH MISSING VALUES
>WARNING 11281
>THERE ARE FEWER THAN 2 CASES OR A BAD CORRELATION MATRIX AND FACTOR IS
>SKIPPING TO THE NEXT ANALYSIS SUBCOMMAND.

14 JUN 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-VM      VS1-VMSP-1.0

FILE:
IDI:  2
- - - - - - - - - - - - - - - - - - - - - - - - - -  F A C T O R   A N A L Y S I S  - - - - - - - - - - - - - - - - - - - - - - -

ANALYSIS NUMBER  1  LISTWISE DELETION OF CASES WITH MISSING VALUES
>WARNING 11281
>THERE ARE FEWER THAN 2 CASES OR A BAD CORRELATION MATRIX AND FACTOR IS
>SKIPPING TO THE NEXT ANALYSIS SUBCOMMAND.

14 JUN 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-VM      VS1-VMSP-1.0

FILE:
IDI:  3
- - - - - - - - - - - - - - - - - - - - - - - - - -  F A C T O R   A N A L Y S I S  - - - - - - - - - - - - - - - - - - - - - - -

ANALYSIS NUMBER  1  LISTWISE DELETION OF CASES WITH MISSING VALUES
>WARNING 11281
>THERE ARE FEWER THAN 2 CASES OR A BAD CORRELATION MATRIX AND FACTOR IS
>SKIPPING TO THE NEXT ANALYSIS SUBCOMMAND.

14 JUN 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-VM      VS1-VMSP-1.0

FILE:
IDI:  4
- - - - - - - - - - - - - - - - - - - - - - - - - -  F A C T O R   A N A L Y S I S  - - - - - - - - - - - - - - - - - - - - - - -

ANALYSIS NUMBER  1  LISTWISE DELETION OF CASES WITH MISSING VALUES
>WARNING 11281
>THERE ARE FEWER THAN 2 CASES OR A BAD CORRELATION MATRIX AND FACTOR IS
>SKIPPING TO THE NEXT ANALYSIS SUBCOMMAND.
```

Printout 2 Factor Analysis of Fuel Related Variables

```
REGRESSION CONTROL CARD SCAN CONTINUES.  **WARNING** - FURTHER DIAGNOSTICS MAY BE MISLEADING OR ERRONEOUS - INTERPRET WITH CARE.

31 MAY 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-AM       VS1-VMSP-1.0

PRECEDING TASK REQUIRED        0.43 SECONDS CPU TIME:       24.93 SECONDS ELAPSED.

 423  C            FACTOR          VARIABLES=MEM INCOME TOTLAND FUMEM MEAS1 LTMEA3
 424  C                            CSUM1 CRAIN1 CWIN1 DIST1/
 435  C             ANALYSIS=MEM INCOME TOTLAND FUMEM MEAS1 LTMEA3
 436  C                            CSUM1 CRAIN1 CWIN1 DIST1/
 437  C             EXTRACTION=PC/
 438  C             ROTATION=VARIMAX/
THERE ARE  1000440 BYTES OF MEMORY AVAILABLE.
THE LARGEST CONTIGUOUS AREA HAS  1000440 BYTES.
THIS FACTOR ANALYSIS REQUIRES        9800 (        9.6K) BYTES OF MEMORY.
31 MAY 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-AM       VS1-VMSP-1.0

FILE:
- - - - - - - - - - - - - - - - - - - - - - - - -  F A C T O R   A N A L Y S I S  - - - - - - -  - - - - - - - - - - - - - - -

ANALYSIS NUMBER  1  LISTWISE DELETION OF CASES WITH MISSING VALUES


EXTRACTION  1  FOR ANALYSIS  1, PRINCIPAL-COMPONENTS ANALYSIS (PC)


INITIAL STATISTICS:

VARIABLE       COMMUNALITY      FACTOR    EIGENVALUE    PCT OF VAR    CUM PCT

MEM              1.00000          1        2.37764        23.8          23.8
INCOME           1.00000          2        1.75906        17.6          41.4
TOTLAND          1.00000          3        1.11342        11.1          52.5
```

Printout 2 (continued)

```
FILE: NEW       FACTOR   B1                VM/SP CONVERSATIONAL MONITOR SYSTEM

FUMEM            1.00000        4        1.03092        10.3          63.3
MEAS1            1.00000        5         .94343         9.4          73.2
LIMEA3           1.00000        6         .84392         8.4          80.7
CSUM1            1.00000        7         .68885         6.9          87.6
CRAIN1           1.00000        8         .60722         6.1          93.6
CWIN1            1.00000        9         .45632         4.6          98.2
DIST1            1.00000       10         .17922         1.8         100.0
   PC EXTRACTED   4 FACTORS.

FACTOR MATRIX:

                FACTOR  1      FACTOR  2      FACTOR  3      FACTOR  4

MEM              .25323         .60748         .44377         .23030
INCOME          -.06083         .51330        -.59864         .01285
TOTLAND          .02703         .65767        -.28270         .18018
FUMEM            .35602         .39779         .54301         .38859
MEAS1            .06106         .37590         .04508         .19922
LIMEA3           .03404         .57572        -.12099        -.00994
CSUM1            .80309        -.02392         .00834         .05800
CRAIN1           .85141        -.19368        -.17255         .12912
CWIN1            .89362        -.16866        -.17893         .15002
DIST1           -.09503        -.01879         .34165         .97219

31 MAY 84   SPSS-X RELEASE 1.0 FOR IBM OS
            CHULALONGKORN COMPUTER CENTER   IBM-3031-AM       VS1--VMSP-1.0

FILE:
- - - - - - - - - - - - - - - - - - - - - - - - - - - -   F A C T O R   A N A L Y S I S   - - - - - - - - - - - - - -

FINAL STATISTICS:

VARIABLE      COMMUNALITY      FACTOR   EIGENVALUE   PCT OF VAR   CUM PCT

MEM              .63101          1        2.37764        23.8         23.8
INCOME           .61383          2        1.75906        17.6         41.4
TOTLAND          .54907          3        1.11342        11.1         52.5
FUMEM            .73078          4        1.03092        10.3         62.8
MEAS1            .18675
LIMEA3           .34734
CSUM1            .64895
CRAIN1           .80509
CWIN1            .88148
DIST1            .88682

VARIMAX   ROTATION  1  FOR EXTRACTION  1  IN ANALYSIS  1   KAISER NORMALIZATION.
  VARIMAX CONVERGED IN    6 ITERATIONS.
```

Printout 2 (continued)

```
FILE: NEW       FACTOR   B1                    VM/SP CONVERSATIONAL MONITOR SYSTEM


ROTATED FACTOR MATRIX:

                FACTOR  1      FACTOR  2      FACTOR  3      FACTOR  4

MFM              .05581         .28137         .71452         .19543
INCOME          -.02604         .73764        -.18932        -.13409
TOTLAND         -.00379         .72985         .08910         .09126
FUNFM            .11447        -.01908         .82289         .16908
MEAS1            .01245         .32566         .19107         .20094
LIMEAB          -.04165         .54113         .22647        -.03785
CSUM1            .76284        -.02438         .24159         .09984
CPAIN1           .89657        -.02824        -.01913         .01135
CWIN1            .93841        -.00815        -.00805         .02694
DIST1           -.04048        -.03064        -.03360         .03071


FACTOR TRANSFORMATION MATRIX:

                FACTOR  1      FACTOR  2      FACTOR  3      FACTOR  4

FACTOR  1        .95645         .01282         .29767        -.04761
FACTOR  2       -.15837         .83212         .52759         .02355
FACTOR  3       -.19855        -.52453         .74372         .36362
FACTOR  4        .13136         .17037        -.29287         .92986

31 MAY 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER   IBM-3031-AM       VSI: VMSP-1.7

PRECEDING TASK REQUIRED        5.67 SECONDS CPU TIME:     211.66 SECONDS ELAPSED.

 439  0          FINISH


  439 COMMAND LINES READ.
    1 ERRORS DETECTED.
   81 SECONDS CPU TIME.
 1000 SECONDS ELAPSED TIME.
      END OF JOB.
```

Printout 3 Correlation Matrix of Variables Related to Fuel Scarcity

FILE:- PEAP - GBPR - - - AI - - - - - - - - - - - - VM/SP CONVERSATIONAL MONITOR SYSTEM

MEAS1	-0.0153	0.0122	0.0292	1.0000	99.0000	0.0133	-0.0032	0.0151	0.0556	0.0470
	(534)	(534)	(534)	(0)	(0)	(534)	(534)	(534)	(534)	(534)
	P=0.724	P=0.779	P=0.501	P=*****	P=*****	P=0.759	P=0.940	P=0.731	P=0.133	P=0.285
MEAS2	0.0583	0.0227	0.0464	99.0000	1.0000	-0.1476	0.0517	0.1593	-0.0153	0.0779
	(361)	(361)	(361)	(0)	(0)	(361)	(361)	(361)	(361)	(359)
	P=0.269	P=0.672	P=0.444	P=*****	P=*****	P=0.305	P=0.327	P=0.002	P=0.777	P=0.141
OBTAIN	-0.0904	-0.0475	0.0229	0.0133	-0.1476	1.0000	0.0232	0.0513	-0.0553	0.0067
	(959)	(959)	(959)	(534)	(361)	(0)	(359)	(959)	(959)	(954)
	P=0.005	P=0.142	P=0.479	P=0.759	P=0.305	P=*****	P=0.275	P=0.113	P=0.105	P=0.053
DIST1	-0.0125	0.0020	0.0479	-0.0032	-0.0517	0.0232	1.0000	-0.0215	0.0664	0.0004
	(959)	(959)	(959)	(534)	(361)	(359)	(0)	(959)	(359)	(954)
	P=0.699	P=0.950	P=0.138	P=0.940	P=0.327	P=0.675	P=*****	P=0.505	P=0.131	P=0.995
UNIT1	0.0330	0.0651	0.0060	0.0191	-0.1592	0.0316	-0.2316	1.0000	-0.0353	0.0373
	(959)	(959)	(959)	(534)	(361)	(359)	(959)	(0)	(359)	(954)
	P=0.308	P=0.044	P=0.858	P=0.729	P=0.002	P=0.110	P=0.505	P=*****	P=0.002	P=0.255
ACTIVIT	-0.0927	-0.0834	-0.0263	0.0556	-0.3153	-0.3523	0.0444	-0.0763	1.0000	0.2315
	(959)	(959)	(959)	(534)	(361)	(359)	(959)	(959)	(0)	(954)
	P=0.005	P=0.010	P=0.416	P=0.199	P=0.772	P=0.195	P=0.151	P=0.002	P=*****	P=0.519
ALINCOME	-0.1385	-0.1270	-0.0871	0.0470	-0.0779	0.0363	0.0274	-0.0731	0.0310	1.0000
	(954)	(954)	(954)	(531)	(359)	(954)	(954)	(954)	(954)	(0)
	P=0.000	P=0.000	P=0.007	P=0.280	P=0.141	P=0.333	P=0.335	P=0.251	P=0.513	P=*****
CUMEM	0.1553	0.1396	0.0487	0.0472	0.1765	-0.0005	-0.0754	-0.0533	-0.0302	-0.0525
	(959)	(959)	(959)	(534)	(361)	(359)	(959)	(959)	(959)	(954)
	P=0.000	P=0.000	P=0.132	P=0.276	P=0.001	P=0.497	P=0.020	P=0.095	P=0.351	P=0.055

(COEFFICIENT / (CASES) / SIGNIFICANCE) (A VALUE OF 99.0000 IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED)
04 JUN 84 - SPSS-X RELEASE 1.0 FOR IBM OS
CHULALONGKORN COMPUTER CENTER IBM-3031-4M VSI- VMSP-1.0

FILE:

- - - - - - - - - - - - - P E A R S O N C O R R E L A T I O N C O E F F I C I E N T S - - - - - - - - - - - -

	CSUM1	CWIM1	CRAIN1	MEAS1	MEAS2	OBTAIN	DIST1	UNIT1	ACTIVIT	ALINCOME
MEM	0.0511	0.0100	0.0021	0.1693	0.3321	-0.0357	0.1043	-0.1463	0.1933	0.5616
	(959)	(959)	(959)	(534)	(361)	(359)	(959)	(959)	(359)	(954)
	P=0.059	P=0.621	P=0.948	P=0.000	P=0.000	P=0.334	P=0.001	P=0.000	P=0.000	P=0.000

(COEFFICIENT / (CASES) / SIGNIFICANCE) (A VALUE OF 99.0000 IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED)
04 JUN 84 SPSS-X RELEASE 1.0 FOR IBM OS
CHULALONGKORN COMPUTER CENTER IBM-3031-4M VSI- VMSP-1.0

FILE:

- - - - - - - - - - - - - P E A R S O N C O R R E L A T I O N C O E F F I C I E N T S - - - - - - - - - - - -

Printout 4 Multiple Regerssion of Fuel Scarcity

```
FILE: PEGPE     FILE     A1                    VM/SP CONVERSATIONAL MONITOR SYSTEM

VARIABLE(S) ENTERED ON STEP NUMBER  1..    MEN

MULTIPLE R            .10430          ANALYSIS OF VARIANCE
R SQUARE              .01088                          DF       SUM OF SQUARES       MEAN SQUARE
ADJUSTED R-SQUARE    -.00984          REGRESSION       1          1194.61914          1194.64814
STANDARD ERROR      10.65395          RESIDUAL       957        101525.70653           113.56663

                                      F =        10.52301        SIGNIF F = .0012

---------- VARIABLES IN THE EQUATION ----------                  ---------- VARIABLES NOT IN THE EQUATION ----------

VARIABLE              B        SE B       BETA          T   SIG T        VARIABLE     BETA IN   PARTIAL   MIN TOLER        T   SIG T

MEN                .51291      .15810     .10430      3.244   .0012      FUMEM        -.12378   -.11733     .33760   -3.654   .0003
(CONSTANT)        1.20458      .06764                 1.245   .2135      TOILAND       .05685    .05633     .33659    1.754   .0797
                                                                         RS1          2.952E-04   .00030     .99336     .009   .9927
                                                                         OBTAINL       .01510    .01515     .99689     .469   .6394
                                                                         COLLTIME     9.735E-03  .00333     .33915     .103   .7633

                                  * * * * * * * * * * * * * * * * * * * * * * * * * *

VARIABLE(S) ENTERED ON STEP NUMBER  2..    FUMEM

MULTIPLE R            .15654          ANALYSIS OF VARIANCE
R SQUARE              .02451                          DF       SUM OF SQUARES       MEAN SQUARE
ADJUSTED R SQUARE     .02246          REGRESSION       2          2691.23501          1345.61751
STANDARD ERROR      10.56584          RESIDUAL       956        101123.31073           112.05995

                                      F =        12.00301        SIGNIF F = .0000
14 JUN 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER   IBM-3031-49        MSL-VMSP-1.0

FILE:
                                  * * * * M U L T I P L E   R E G R E S S I O N * * * *
EQUATION NUMBER 1     DEPENDENT VARIABLE..   DISTI

---------- VARIABLES IN THE EQUATION ----------                  ---------- VARIABLES NOT IN THE EQUATION ----------

VARIABLE              B        SE B       BETA          T   SIG T        VARIABLE     BETA IN   PARTIAL   MIN TOLER        T   SIG T

MEN               .71535      .16657     .14546      4.295   .0000      TOILAND       .04887    .04753     .93100    1.470   .1419
FUMEM            -.94480      .25853    -.12378     -3.654   .0003      RS1          -3.618E-03 -.00355     .39240    -.113   .9103
(CONSTANT)       1.97846      .09850                 2.010   .0449      OBTAINL       .01734    .01757     .98431     .542   .5882
                                                                         COLLTIME      .02474    .02495     .97547     .769   .4427

FOR BLOCK NUMBER  1   PIN = 0.050 LIMITS REACHED.

                                  * * * * * * * * * * * * * * * * * * * * * * * * * *

BEGINNING BLOCK NUMBER  2.  METHOD:  ENTER
```

Printout 4 (continued)

```
FILE: REGRE     FILE     A1                VM/SP CONVERSATIONAL MONITOR SYSTEM

VARIABLE(S) ENTERED ON STEP NUMBER  3..    RS3
                                    4..    OBTAIN1
                                    5..    COLLTIME
                                    6..    TOTLAND

MULTIPLE R            .16695        ANALYSIS OF VARIANCE
R SQUARE              .02787                          DF       SUM OF SQUARES      MEAN SQUARE
ADJUSTED R SQUARE     .02174        REGRESSION         6          3363.35943        560.14243
STANDARD ERROR      10.58974        RESIDUAL         952        106739.53432        112.14254

                                    F =        4.54906        SIGNIF F =  .0001

----------------- VARIABLES IN THE EQUATION ----------------

VARIABLE              B          SE B        BETA          T   SIG T

MEN               .64937       .17406      .13205      3.731   .0002
FEMEM            -.95340       .26171     -.12691     -3.643   .0003
RS3              -.01965       .14035 -4.018E-03      -.139   .3025
OBTAIN1           .07556       .14693      .01652       .515   .3065
COLLTIME          .07591       .07067      .03147       .953   .3409
TOTLAND           .01485       .01309      .05103      1.517   .1297
(CONSTANT)       1.32079      1.35233                   .977   .3290
14 JUN 84   SPSS-X RELEASE 1.0 FOR IBM OS
            CHULALONGKORN COMPUTER CENTER   IBM-3031-44        VSI- VMSP-1.0

FILE:
                                    * * * *   M U L T I P L E   R E G R E S S I O N   * * * *
EQUATION NUMBER 1   DEPENDENT VARIABLE..  DIST1

FOR BLOCK NUMBER  2   ALL REQUESTED VARIABLES ENTERED.
14 JUN 84   SPSS-X RELEASE 1.0 FOR IBM OS
            CHULALONGKORN COMPUTER CENTER   IBM-3031-44        VSI- VMSP-1.0

PRECEDING TASK REQUIRED        5.18 SECONDS CPU TIME:      136.92 SECONDS ELAPSED.

 525  0          FINISH

  525 COMMAND LINES READ.
    0 ERRORS DETECTED.
   85 SECONDS CPU TIME.
  469 SECONDS ELAPSED TIME.
      END OF JOB.
```

Printout 5 Multiple Regression of Amount of Charcoal Consumption

```
26 JUN 84   SPSS-X RELEASE 1.0 FOR IBM OS
            CHULALONGKORN COMPUTER CENTER  IBM-3031-44        VS1-MVSP-1.3

FILE:

                                  * * * *  M U L T I P L E   R E G R E S S I O N   * * * *

VARIABLE LIST NUMBER 1   LISTWISE DELETION OF MISSING DATA

EQUATION NUMBER 1    DEPENDENT VARIABLE..  MEAS1

   DESCRIPTIVE STATISTICS ARE PRINTED ON PAGE  37

BEGINNING BLOCK NUMBER  1.  METHOD:  STEPWISE

VARIABLE(S) ENTERED ON STEP NUMBER  1..    MEM

MULTIPLE R            .16946          ANALYSIS OF VARIANCE
R SQUARE              .02872                          DF       SUM OF SQUARES     MEAN SQUARE
ADJUSTED R SQUARE     .02687          REGRESSION       1            32.06711        32.06711
STANDARD ERROR       1.43459          RESIDUAL       527          1394.59619         2.05804

                                      F =      15.58140        SIGNIF F =  .0001

------------------ VARIABLES IN THE EQUATION ------------------          ------------- VARIABLES NOT IN THE EQUATION -------------

VARIABLE              B        SE B        BETA          T  SIG T        VARIABLE     BETA IN  PARTIAL  MIN TOLER        T  SIG T

MEM                .10954     .02775      .16946      3.947  .0001        EUSEM      -3.347E-02  -.03329     .91812     -.375  .9405
(CONSTANT)        1.02653     .17119                  5.996  .0000        ADMICONE     .03087    .03072     .97460     .713  .4783
                                                                           OFFARM     9.506E-03  .00963     .99027     .220  .8259
                                                                           TOTLAND      .06543    .05351     .91812    1.452  .1464

FOR BLOCK NUMBER  1  PIN = 0.050 LIMITS REACHED
```


Best Available Document

Printout 5 (continued)

```
26 JUN 04    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER   IBM-3031-AM        VS1-VMSP-1.0

FILE:

                                    * * * *   M U L T I P L E   R E G R E S S I O N   * * * *

EQUATION NUMBER 1     DEPENDENT VARIABLE..  MEAS1

BEGINNING BLOCK NUMBER  2.  METHOD:  ENTER

VARIABLE(S) ENTERED ON STEP NUMBER  2..    OFFARM
                                    3..    FUMEM
                                    4..    TOTLAND
                                    5..    ADINCOME

MULTIPLE R            .18161          ANALYSIS OF VARIANCE
R SQUARE              .03298                          DF       SUM OF SQUARES       MEAN SQUARE
ADJUSTED R SQUARE     .02374          REGRESSION       5            36.83371            7.36674
STANDARD ERROR       1.43690          RESIDUAL       523          1071.03259            2.06667

                                      F =        3.56771        SIGNIF F =  .0035

------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE                B         SE B        BETA          T  SIG T

MEM                .09670       .03340       .14960      3.101  .0018
OFFARM       -8.18958E-03       .02886     -.01825      -.284  .7767
FUMEM         1.85654E-04       .05126   1.6338E-04     .004  .9971
TOTLAND       2.74100E-03   2.16238E-03      .05966      1.268  .2055
ADINCOME      8.61587E-03       .02041      .02841       .423  .4724
(CONSTANT)        1.00134       .17847                   5.604  .0000

FOR BLOCK NUMBER  2   ALL REQUESTED VARIABLES ENTERED.
```

Printout 6 Multiple Regression I: Amount of Firewood Consumption

```
26 JUN 84   SPSS-X RELEASE 1.0 FOR IBM OS
            CHULALONGKORN COMPUTER CENTER  IBM-3081-4M       VSI-VMSP-1.0

FILE:

                                  * * * *  M U L T I P L E   R E G R E S S I O N  * * * *

VARIABLE LIST NUMBER 2   LISTWISE DELETION OF MISSING DATA

EQUATION NUMBER 2    DEPENDENT VARIABLE..  MEAS2

   DESCRIPTIVE STATISTICS ARE PRINTED ON PAGE  38

BEGINNING BLOCK NUMBER  1.  METHOD:  STEPWISE

VARIABLE(S) ENTERED ON STEP NUMBER  1..    MEM

MULTIPLE R            .32230          ANALYSIS OF VARIANCE
R SQUARE              .10388                          DF        SUM OF SQUARES     MEAN SQUARE
ADJUSTED R SQUARE     .10136          REGRESSION       1           137.53922        137.53922
STANDARD ERROR       1.82562          RESIDUAL       355          1136.53177          3.33287

                                      F =       41.26790       SIGNIF F = .0000

----------------- VARIABLES IN THE EQUATION -----------------          ------------- VARIABLES NOT IN THE EQUATION -------------

VARIABLE              B        SE B       BETA          T  SIG T        VARIABLE     BETA IN  PARTIAL   MIN TOLER        T  SIG T

MEM              .29277      .04557     .32230      6.424  .0000        FUMEM         .05295   .05123     .93730     .955  .3368
(CONSTANT)      1.40542      .27729                 5.069  .0000        ADINCOME     -.06253  -.05635     .99991   -1.067  .2861
                                                                        OFFARM       -.05214  -.03535     .99930   -1.339  .1995
                                                                        TOTLAND       .15634   .15713     .90599    2.999  .0029

                                  * * * * * * * * * * * * * * * * * * * * * * * * * * *

VARIABLE(S) ENTERED ON STEP NUMBER  2..    TOTLAND

MULTIPLE R            .35499          ANALYSIS OF VARIANCE
R SQUARE              .12602                          DF        SUM OF SQUARES     MEAN SQUARE
ADJUSTED R SQUARE     .12110          REGRESSION       2           166.85549        83.42774
STANDARD ERROR       1.80546          RESIDUAL       355          1137.13551         3.25963

                                      F =       25.59196       SIGNIF F = .0000
```

Printout 6 (continued)

```
26 JUN 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER   IBM-3031-MS        VS1-VMSP-1.1

FILE:

                                   * * * *   M U L T I P L E   R E G R E S S I O N   * * * *

EQUATION NUMBER 2    DEPENDENT VARIABLE..  MEAS2

------------------ VARIABLES IN THE EQUATION ------------------          ------------- VARIABLES NOT IN THE EQUATION -------------

VARIABLE                B         SE B        BETA          T  SIG T          VARIABLE     BETA IN  PARTIAL   MIN TOLER         T  SIG T

MEM                  .26920      .04735      .27434      5.262  .1000          FUMEM        .05311   .03201     .77063      .933  .3278
TOTLAND              .01905  6.3530E-03      .15634      2.999  .0329          ADINCOME    -.05574  -.03955     .90393    -1.122  .2524
(CONSTANT)          1.35999      .27454                  4.952  .1000          OFFARM      -.03413  -.03521     .99194     -.532  .4953

FOR BLOCK NUMBER  1   PIN = 0.050 LIMITS REACHED.

                                   * * * * * * * * * * * * * * * * * * * * * * * * * *

BEGINNING BLOCK NUMBER  2.  METHOD:  ENTER

VARIABLE(S) ENTERED ON STEP NUMBER  3..    ADINCOME
                                    4..    FUMEM
                                    5..    OFFARM

MULTIPLE R              .35226          ANALYSIS OF VARIANCE
R SQUARE                .13123                                DF       SUM OF SQUARES       MEAN SQUARES
ADJUSTED R SQUARE      .11889           REGRESSION             5           173.75362           34.75072
STANDARD ERROR         1.80772          RESIDUAL             552          1153.23737            3.26785

                                        F =    10.63409    SIGNIF F =  .0000

------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE                B         SE B        BETA          T  SIG T

MEM                  .23135      .05145      .25436      4.491  .1000
TOTLAND              .01873  6.4195E-03      .15371      2.918  .0037
ADINCOME            -.04750      .06054     -.05300      -.784  .4333
FUMEM                .06418      .06978      .05031       .920  .3584
OFFARM     -9.59308E-04         .09302 -7.011E-04      -.010  .9918
(CONSTANT)          1.38890      .29081                  4.776  .1000

FOR BLOCK NUMBER  2   ALL REQUESTED VARIABLES ENTERED.
```

Printout 7 Multiple Regression II: Amount of Firewood Consumption

```
26 JUN 84   SPSS-X RELEASE 1.0 FOR IBM OS
            CHULALONGKORN COMPUTER CENTER  IBM-3031-44      VS1-VMSP-1.0

FILE:

                                  * * * *  M U L T I P L E   R E G R E S S I O N   * * * *

EQUATION NUMBER 1    DEPENDENT VARIABLE..  MEAS1


------------------ VARIABLES IN THE EQUATION ------------------          ------------- VARIABLES NOT IN THE EQUATION -------------

VARIABLE              B        SE B       BETA        T  SIG T          VARIABLE     BETA IN  PARTIAL   MIN TOLER        T  SIG T

HOUR             .29712      .07523      .17207    3.949  .0001          DIST1       -.02076  -.02113      .91596     -.637  .5255
MEM              .08079      .02797      .12586    2.889  .0040          COLLTIME  4.910E-03   .00503      .93576      .115  .9074
(CONSTANT)       .57370      .20272                2.830  .0048          COOK     -1.164E-02  -.00111      .82335     -.026  .9795

FOR BLOCK NUMBER  1   PIN = 0.050 LIMITS REACHED.


                                  * * * * * * * * * * * * * * * * * * * * * * * * * * * *

BEGINNING BLOCK NUMBER  2.  METHOD:  ENTER

VARIABLE(S) ENTERED ON STEP NUMBER  3..    COLLTIME
                                    4..    DIST1
                                    5..    COOK


MULTIPLE R            .23839          ANALYSIS OF VARIANCE
R SQUARE              .05683                          DF       SUM OF SQUARES      MEAN SQUARE
ADJUSTED R SQUARE     .04720          REGRESSION       5            63.64139         12.72828
STANDARD ERROR       1.41433          RESIDUAL       523          1355.13335          2.90034

                                      F =        5.36105       SIGNIF F =  .0000


------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE              B        SE B       BETA        T  SIG T

HOUR             .29604      .08053      .17144    3.676  .0003
MEM              .08279      .02837      .12898    2.918  .0037
COLLTIME    2.24519E-03      .02103  4.514E-03     .107  .9150
DIST1      -2.45756E-03  5.1032E-03    -.02066    -.484  .6289
COOK       -3.03475E-03      .17200 -8.040E-04    -.018  .9859
(CONSTANT)       .58024      .36205                1.603  .1096


FOR BLOCK NUMBER  2   ALL REQUESTED VARIABLES ENTERED.
```

Printout 8 Multiple Regression III: Amount of Firewood Consumption

```
26 JUN 84   SPSS-X RELEASE 1.0 FOR IBM OS
            CHULALONGKORN COMPUTER CENTER  IBM-3031-AM       VS1-VMS[illegible]-1.0

FILE:

                                    * * * *  M U L T I P L E   R E G R E S S I O N   * * * *

EQUATION NUMBER 2    DEPENDENT VARIABLE..  MEAS2

BEGINNING BLOCK NUMBER  2.  METHOD:  ENTER

VARIABLE(S) ENTERED ON STEP NUMBER  2..    DIST1
                                    3..    COLLTIME
                                    4..    HOUR
                                    5..    COOK

MULTIPLE R            .32735          ANALYSIS OF VARIANCE
R SQUARE              .10716                              DF       SUM OF SQUARES       MEAN SQUARE
ADJUSTED R SQUARE     .09458          REGRESSION           5           142.25593          28.45119
STANDARD ERROR       1.82731          RESIDUAL           359          1135.36173           3.33903

                                      F =        8.52115       SIGNIF F =  .0000

----------------- VARIABLES IN THE EQUATION ----------------

VARIABLE                B         SE B        BETA          T  SIG T

MEM                  .29347       .04622      .32351      6.350  .0000
DIST1               -.01754       .01737     -.05108     -1.010  .3131
COLLTIME      7.20747E-03        .01763      .02074       .409  .6830
HOUR                 .01438       .12980  6.381E-03       .112  .9112
COOK                -.06537       .19612     -.01925      -.333  .7391
(CONSTANT)          1.53693       .48374                  3.177  .0016

FOR BLOCK NUMBER  2   ALL REQUESTED VARIABLES ENTERED.
```

Printout 9 Multiple Regression of Kerosene Consumption for Lighting

```
VARIABLE(S) ENTERED ON STEP NUMBER  4..    ACTIV

MULTIPLE R            .34432          ANALYSIS OF VARIANCE
R SQUARE              .11855                          DF       SUM OF SQUARES      MEAN SQUARE
ADJUSTED R SQUARE     .11087          REGRESSION       4          16743.93915       4185.95979
STANDARD ERROR      16.45275          RESIDUAL       453         124633.35870        271.21976

                                      F =       15.43333        SIGNIF F =  .0000
21 JUN 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-44       VS1-VMSP-1.3

FILE:
                                      * * * *  M U L T I P L E   R E G R E S S I O N   * * * *
EQUATION NUMBER 1     DEPENDENT VARIABLE..  KAROS

---------------- VARIABLES IN THE EQUATION - -- ------------          ------------ VARIABLES NOT IN THE EQUATION ------------

VARIABLE              B        SE B       BETA         T  SIG T        VARIABLE     BETA IN  PARTIAL  MIN TOLER         T  SIG T

ADINCOME        1.27533      .26480     .22178     4.817  .0000        MEN          .07633   .17022     .37395     1.531  .0935
JAR             2.88847      .83521     .16240     3.583  .0004        UNIT       7.911E-03  .00925     .90444      .177  .8597
PUM            12.08535     4.00442     .13727     3.018  .0027        OFFARM      -.14800  -.13214     .39032    -2.197  .0285
ACTIV          -2.07324      .75521    -.11831    -2.607  .0094        WICK         .13334   .13775     .39097     2.975  .0031
(CONSTANT)     12.16115     1.90396                6.387  .0000        HOUR1        .08169   .13563     .89252     1.339  .0565
                                                                        HOUR2        .06043   .05273     .63914     1.115  .2649
                                                                        HOUR3        .08125   .07115     .54227     1.527  .1275
                                                                        ELJO         .03251   .13353     .39151      .719  .4725
                                                                        HOUR6        .01999   .03341     .99050      .637  .5524
                                                                        INCAN        .02076   .01954     .77650      .513  .6759
                                                                        HOUR7        .01674   .01727     .96297      .373  .7113

                                      * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

Printout 9 (continued)

```
FILE: ARDBAMI? REGRESS  A1                VM/SP CONVERSATIONAL MONITOR SYSTEM

                                                                HOUR3        .12008   .12456     .99966     2.535  .0373
                                                                FLUO       1.565E-03  .03161     .98679     .035   .9724
                                                                HOUR6       -.01587  -.01629     .97725    -.353   .7253
                                                                INCAN        .04060   .03959     .83935     .329   .6375
                                                                HOUR7        .02186   .02231     .94166     .673   .5357
21 JUN 84   SPSS-X RELEASE 1.0 FOR IBM OS                                                                    PAGE  62
            CHULALONGKORN-COMPUTER-CENTER--IBM-3031-4M--------VS1-VMSP-1.3

FILE:
                                  * * * *   M U L T I P L E   R E G R E S S I O N   * * * *
EQUATION NUMBER 1    DEPENDENT VARIABLE..  KARDS

VARIABLE(S) ENTERED ON STEP NUMBER  2..    JAR

MULTIPLE R            .30130          ANALYSIS OF VARIANCE
R SQUARE              .09078                          DF      SUM OF SQUARES      MEAN SQUARE
ADJUSTED R SQUARE     .08684          REGRESSION       2        12821.64723       6410.83364
STANDARD ERROR       16.53985         RESIDUAL       461       123412.03056        278.55104

                                      F =       23.01493       SIGNIF F =  .0000

------------------ VARIABLES IN THE EQUATION ------------------          ------------- VARIABLES NOT IN THE EQUATION -------------

VARIABLE            B        SE B       BETA          T   SIG T          VARIABLE    BETA IN  PARTIAL  MIN TOLER          T   SIG T

ADINCOME        1.38943      .25964     .24152      5.355  .0000          ACTIV       -.10445  -.13633     .93467    -2.996  .0029
JAR             2.54279      .80212     .14296      3.170  .0016          MEM          .07751   .07833     .90893     1.685  .0924
(CONSTANT)     11.65515     1.91773                 6.079  .0000          UNIT      -4.762E-03  -.00403     .96931     -.087  .9148
                                                                           OFFARM       -.15922  -.13392     .41573    -2.969  .0033
                                                                           HISK         .11921   .12343     .94463     2.645  .0084
                                                                           HOUR1        .07084   .07327     .95227     1.575  .1158
                                                                           HOUR2        .06738   .05753     .64928     1.237  .2167
                                                                           PUM          .12527   .13723     .91334     2.731  .0065
                                                                           HOUR3        .11337   .11872     .96734     2.556  .0135
                                                                           FLUO       3.005E-04  .00031     .95763      .007  .9945
                                                                           HOUR6       -.01623  -.01692     .94844     -.351  .7196
                                                                           INCAN        .04618   .04423     .81391      .953  .3428
                                                                           HOUR7        .02166   .02225     .91478      .477  .5334
21 JUN 84   SPSS-X RELEASE 1.0 FOR IBM OS                                                                    PAGE  63
            CHULALONGKORN COMPUTER CENTER  IBM-3031-4M       VS1-VMSP-1.3

FILE:
                                  * * * *   M U L T I P L E   R E G R E S S I O N   * * * *
EQUATION NUMBER 1    DEPENDENT VARIABLE..  KARDS

VARIABLE(S) ENTERED ON STEP NUMBER  3..    PUM

MULTIPLE R            .32481          ANALYSIS OF VARIANCE
R SQUARE              .10550                          DF      SUM OF SQUARES      MEAN SQUARE
ADJUSTED R SQUARE     .09967          REGRESSION       3        14903.29931       4966.76643
STANDARD ERROR       16.57220         RESIDUAL       460       123333.33853        274.63783

                                      F =       18.09479       SIGNIF F =  .0000
```

Printout 9 (continued)

```
FILE: ARDBAMID REGRESS  A1                    VM/SP CONVERSATIONAL MONITOR SYSTEM

FOR BLOCK NUMBER  1   PIN = 0.050 LIMITS REACHED.
21 JUN 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-AM        VSI-VMSP-1.3

FILE:
                                        * * * *   M U L T I P L E   R E G R E S S I O N   * * * *
EQUATION NUMBER 1   DEPENDENT VARIABLE..  KAPOS

BEGINNING BLOCK NUMBER  2.  METHOD:  ENTER

VARIABLE(S) ENTERED ON STEP NUMBER  7..    UNIT
                                    8..    MEM
                                    9..    FLUD
                                   10..    HOUR3
                                   11..    HOUR2
                                   12..    HOUR1
                                   13..    INCAN
                                   14..    HOUR6

MULTIPLE R            .40384          ANALYSIS OF VARIANCE
R SQUARE              .16309                              DF       SUM OF SQUARES       MEAN SQUARE
ADJUSTED R SQUARE     .13700          REGRESSION          14         23333.35724        1645.27623
STANDARD ERROR      16.22502          RESIDUAL           443        113177.33363         263.25129

                                      F =        6.24393        SIGNIF F =  .0000

------------------ VARIABLES IN THE EQUATION ------------------          ------------- VARIABLES NOT IN THE EQUATION -------------

VARIABLE              B         SE B        BETA          T   SIG T       VARIABLE     BETA IN  PARTIAL  MIN TOLER          T  SIG T

ADINCOME        1.99713       .40694      .34715      4.908  .3300       HOUR7       -1.13655  -.03331  5.641E-03     -1.334  .3479
JAP             2.55503       .98671      .14765      2.589  .1399
PUM             5.59437      4.01782      .16354      1.139  .2559
ACTIV          -2.36316       .82289     -.13405     -2.872  .1343
HICK           10.13236      4.29212      .13269      2.360  .1187
OFFAPM         -1.85613      .63116     -.21960     -2.941  .1334
UNIT            -.04618       .20291     -.01105      -.228  .1301
MEM              .63352       .37944      .07624      1.670  .1356
FLUD            5.11257      8.36937      .08443       .634  .5267
HOUR3           2.93033      2.05319      .07671      1.427  .1541
HOUR2            .16537       .28579      .03181       .578  .5533
HOUR1            .10221       .53826      .01050       .190  .3495
INCAN           8.49631      5.00195      .09828      1.699  .1301
HOUR6          -2.81132      4.44428     -.08605      -.633  .5273
(CONSTANT)      9.20291      2.58623                  3.172  .1315


FOR BLOCK NUMBER  2   TOLERANCE = 0.010 LIMITS REACHED.
21 JUN 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-AM        VSI-VMSP-1.3

PRECEDING TASK REQUIRED        7.83 SECONDS CPU TIME;      137.59 SECONDS ELAPSED.
```

Printout 10 Multiple Regression of Number of Kerosene Lighting Equipments Used

```
FILE:
                                        * * * *  M U L T I P L E   R E G R E S S I
VARIABLE LIST NUMBER 1   LISTWISE DELETION OF MISSING DATA

            MEAN  STD DEV  LABEL

ACTIV       .763     .997
KARDS     19.552   17.455
ADINCOME   1.629    3.036
OFFARM     .604    2.356
WICK       .041     .220
JAR       2.216     .982
PUM        .041     .198

N OF CASES =   464

CORRELATION:

              ACTIV      KARDS   ADINCOME     OFFARM       WICK        JAR

ACTIV         1.000     -.032       .150       .079       .118       .211
KARDS         -.032     1.000       .266       .129       .125       .185
ADINCOME       .150      .266      1.000       .758       .124       .174
OFFARM         .079      .129       .758      1.000       .109       .096
WICK           .118      .125       .124       .107      1.000      -.136
JAR            .211      .185       .174       .096      -.136      1.000
PUM            .137      .197       .248       .123       .158       .155

21 JUN 84   SPSS-X RELEASE 1.0 FOR IBM OS
            CHULALONGKORN COMPUTER CENTER  IBM-3031-44       VS1-VMSP-1.1
```

Printout 10 (continued)

```
FILE: ARM22     REGRESS  V1                    VM/SP CONVERSATIONAL MONITOR SYSTEM


FILE:
                                        * * * *   M U L T I P L E   R E G R E S S I
VARIABLE LIST NUMBER 1    LISTWISE DELETION OF MISSING DATA
EQUATION NUMBER 1     DEPENDENT VARIABLE..  KARDS
   DESCRIPTIVE STATISTICS ARE PRINTED ON PAGE  59

BEGINNING BLOCK NUMBER  1.  METHOD:  STEPWISE


VARIABLE(S) ENTERED ON STEP NUMBER  1..    ADINCOME

MULTIPLE R              .25639          ANALYSIS OF VARIANCE
R SQUARE                .07096                                DF       SUM OF SQUARES
ADJUSTED R SQUARE       .06895          REGRESSION             1          12322.63433
STANDARD ERROR        16.85251          RESIDUAL             463         131211.23363

                                        F =        35.28327        SIGNIF F =  .0000

------------------ VARIABLES IN THE EQUATION ------------------                -------

VARIABLE                B          SE B        BETA          T   SIG T          VARIABL

ADINCOME            1.53249        .25797      .26639      5.940   .0000         ACTIV
(CONSTANT)         17.05565        .88839                 19.205   .0000         DEPARM
                                                                                 WICK
                                                                                 JAR
                                                                                 PUM

                                        * * * * * * * * * * * * * * * * * * * * * *


VARIABLE(S) ENTERED ON STEP NUMBER  2..    JAR

MULTIPLE R              .30130          ANALYSIS OF VARIANCE
R SQUARE                .09078                                DF       SUM OF SQUARES
ADJUSTED R SQUARE       .08684          REGRESSION             2          12321.6[illegible]
STANDARD ERROR        16.63985          RESIDUAL             461         123412.0[illegible]

                                        F =        23.01633        SIGNIF F =  .0000
21 JUN 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER   IBM-3081-44       V01-M00-1.0

FILE:
                                        * * * *   M U L T I P L E   R E G R E S S I
EQUATION NUMBER 1     DEPENDENT VARIABLE..  KARDS

------------------ VARIABLES IN THE EQUATION ------------------                -------

VARIABLE                B          SE B        BETA          T   SIG T          VARIABL

ADINCOME            1.38940        .25944      .24152      5.355   .0000         ACTIV
JAR                 2.54279        .80212      .14296      3.170   .0016         DEPARM
(CONSTANT)         11.65515       1.91723                  6.079   .0000         WICK
                                                                                 PUM
```

Printout 10 (continued)

```
FILE: ARM22     REGRESS  V1                    VM/SP CONVERSATIONAL MONITOR SYSTEM

                                    * * * * * * * * * * * * * * * * * * * * *

VARIABLE(S) ENTERED ON STEP NUMBER  3..   PUM

MULTIPLE R            .32481          ANALYSIS OF VARIANCE
R SQUARE              .10550                              DF       SUM OF SQUARES
ADJUSTED R SQUARE     .09967          REGRESSION           1          14333.20931
STANDARD ERROR      16.57220          RESIDUAL           453         125133.33353

                                      F =       14.00479       SIGNIF F =  .0000

------------------ VARIABLES IN THE EQUATION ------------------              -------

VARIABLE                B         SE B        BETA          T   SIG T          VARIABL

ADINCOME             1.21329      .26545      .21090      4.571   .0000         ACTIV
JAR                  2.49164      .79669      .14009      3.128   .0019         OFFARM
PUM                 11.02893     4.00089      .12527      2.751   .0063         HICK
(CONSTANT)          11.60375     1.90380                  6.095   .0000
21 JUN 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-44       VS1-VMSP-1.3

FILE:
                                    * * * *  M U L T I P L E   R E G R E S S I
EQUATION NUMBER 1     DEPENDENT VARIABLE..  KAPOS

VARIABLE(S) ENTERED ON STEP NUMBER  4..    ACTIV

MULTIPLE R            .34432          ANALYSIS OF VARIANCE
R SQUARE              .11855                              DF       SUM OF SQUARES
ADJUSTED R SQUARE     .11087          REGRESSION           4          15763.33315
STANDARD ERROR      16.45875          RESIDUAL           453         123933.95870

                                      F =       15.43393       SIGNIF F =  .0000

------------------ VARIABLES IN THE EQUATION ------------------              -------

VARIABLE                B         SE B        BETA          T   SIG T          VARIABL

ADINCOME             1.27583      .25488      .23178      4.917   .0000         OFFARM
JAR                  2.88847      .80621      .16240      3.583   .0004         HICK
PUM                 12.08535     4.00442      .13727      3.018   .0027
ACTIV               -2.07324      .79521     -.11831     -2.607   .0094
(CONSTANT)          12.16115     1.90396                  6.387   .0000

                                    * * * * * * * * * * * * * * * * * * * * *

VARIABLE(S) ENTERED ON STEP NUMBER  5..    HICK

MULTIPLE R            .35781          ANALYSIS OF VARIANCE
R SQUARE              .13528                              DF       SUM OF SQUARES
```

Printout 10 (continued)

```
FILE: ARM22     REGRESS  V1                    VM/SP CONVERSATIONAL MONITOR SYSTEM

ADJUSTED R SQUARE     .12584          REGRESSION          5          13135.13337
STANDARD ERROR      16.32954          RESIDUAL          453         133127.51393

                                      F =       14.33332        SIGNIF F =  .0000
21 JUN 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-MM        VS1-VMSP-1.3

FILE:
                                      * * * *  M U L T I P L E   R E G R E S S I
EQUATION NUMBER 1     DEPENDENT VARIABLE..  KAROS

------------------ VARIABLES IN THE EQUATION ------------------                 -------

VARIABLE                B          SE B        BETA          T  SIG T          VARIABL

ADINCOME             1.17446       .25484      .20415      4.435  .0000         OFFARM
JAR                  3.33547       .81329      .18753      4.101  .0000
PUM                 11.86081      3.97129      .13472      2.987  .0030
ACTIV               -2.39069       .79567     -.13643     -3.005  .0028
WICK                10.18167      3.42075      .13334      2.976  .0031
(CONSTANT)          11.17043      1.91690                  5.827  .0000

                                      * * * * * * * * * * * * * * * * * * * * * *

VARIABLE(S) ENTERED ON STEP NUMBER  6..     OFFARM

MULTIPLE R            .38085          ANALYSIS OF VARIANCE
R SQUARE              .14504                                DF       SUM OF SQUARES
ADJUSTED R SQUARE     .13392          REGRESSION            6          21435.17999
STANDARD ERROR      16.25484          RESIDUAL            452         123763.51746

                                      F =       12.92170        SIGNIF F =  .0000

------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE                B          SE B        BETA          T  SIG T

ADINCOME             1.85975       .39935      .32328      4.657  .0000
JAR                  3.26034       .81033      .18331      4.023  .0001
PUM                 10.96695      3.97244      .12457      2.761  .0060
ACTIV               -2.45840       .79259     -.14029     -3.102  .0020
WICK                10.35536      3.40594      .13562      3.041  .0025
OFFARM              -1.28939       .56440     -.15255     -2.285  .0229
(CONSTANT)          11.08057      1.90852                  5.806  .0000

FOR BLOCK NUMBER  1   POUT = 0.100 LIMITS REACHED.
21 JUN 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3031-MM        VS1-VMSP-1.3

FILE:
                                      * * * *  M U L T I P L E   R E G R E S S I
EQUATION NUMBER 1     DEPENDENT VARIABLE..  KAROS
```

Printout 11 Discriminant Analysis on Differentration between Firewood and Charcoal Households

```
23 JUL 84   SPSS-X RELEASE 1.0 FOR IBM OS
            CHULALONGKORN COMPUTER CENTER   IBM-3031-41      VS1-MVSP-1.3

FILE:

- - - - - - - - - - - - - - - - - - - - - - - - D I S C R I M I N A N T   A N A L Y S I S - - - - - - - - - - - - - - - - - - - - - - - -

DI GROUPS DEFINED BY RS3

          959 (UNWEIGHTED) CASES WERE PROCESSED.
           71 OF THESE WERE EXCLUDED FROM THE ANALYSIS.
              63 HAD MISSING OR OUT-OF-RANGE GROUP CODES.
          888 (UNWEIGHTED) CASES WILL BE USED IN THE ANALYSIS.


NUMBER OF CASES BY GROUP

                 NUMBER OF CASES
  RS3        UNWEIGHTED      WEIGHTED  LABEL

        1          588         588.0
        2          300         300.0

    TOTAL          888         888.0


COVARIANCE MATRIX FOR GROUP          1,

            MEM            FUMEM          ETYPE1         SANITARY       PROPERTY       TOTLAND        ADINCOME       OFFFARM

 MEM        5.071550
 FUMEM      .9718910       1.803947
 ETYPE1    -.98564130-01  -.20343540-01   4.893967
 SANITARY   .3146751       .1115438       .52416080-01   .3362955
 PROPERTY   1.244828      -.4489332      .87218530-01   1.326820       10.53355
 TOTLAND    20.06242       2.543179      -6.897193       4.326271       36.31333       994.3421
 ADINCOME   .9739660      -.2983313       1.739209       .5391396       4.233504       43.39015       19.66339
 OFFFARM    4832.959      -1235.771       17173.66       3337.108       11935.95       125516.8       11363.9       .10531043+10
 ACTIV      .2965442      -.93183759-01   .89860320-01   .53106290-01   .4323929      -2.746850       .24833709-01  -1471.642
 OBTAINI    .2314432      -.47294560-01  -.97544301-01   .2318372       1.014455       12.04446       .4375520       3354.528
 AVAIL     -.2123388      -.32956110-01   .61456271-01   .71351570-03  -.1933302      -3.163315      -.2733777      -746.4554
 STORE1     .2625943      -.10627090-01   .21484578      .1366223       .6073393      -.2561509       .1457334       385.3140
 DIST1      3.533706      -1.134739      -.88887134      -.5393619      2.432014       25.04477       .6315358      -1953.97
 COLLTIME   .1525513       .9265436      -.84412301-01   -.31025940-01  -1.736374      -4.351554      -1.122367      -5323.960
```

Printout 11 (continued)

23 JUL 84 SPSS-X RELEASE 1.0 FOR IBM OS
CHULALONGKORN COMPUTER CENTER IBM-3031-M1 VS1-VMSP-1.3

	ACTIV	OBTAINI	AVAIL	STORE1	DIST1	COLLTIME
ACTIV	1.030592					
OBTAINI	-.2818783	4.574094				
AVAIL	.58979130-01	-.6220067	.6097736			
STORE1	.2059475	-.2769067	.16676520-01	.7360330		
DIST1	.9877041	.3601560	-.3635905	.3535259	141.3555	
COLLTIME	-.2147058	-.1856750	.50548160-01	-.1745645	-.7542341	8.569506

COVARIANCE MATRIX FOR GROUP 2,

	MEM	FUMEM	ETYPE1	SANITARY	PROPERTY	TOTLAND	ADINCOME	OFFFARM
MEM	3.996611							
FUMEM	1.163434	2.217113						
ETYPE1	-.3830992	-.1144370	5.447614					
SANITARY	-.56945370-01	-.33467110-01	.1108919	.7504905				
PROPERTY	.5807358	-.1431429	.27559530-01	1.311973	3.034543			
TOTLAND	7.065463	1.600279	-5.524225	-.3339744	.2322742	147.0599		
ADINCOME	.1496481	-.80122210-01	.6911524	.5566042	3.515593	-2.041992	4.597357	
OFFFARM	847.6063	1656.133	8303.775	3345.600	12336.29	-27377.15	15215.36	.15364703E09
ACTIV	.30323300-02	.32831460-01	-.23667780-01	-.31727080-01	-.1739347	-.5944370	-.93752500-01	-124.3358
OBTAINI	-1.093378	-.86783300-01	.4967559	.3341472	3.425294	-6.042441	1.253309	7019.949
AVAIL	.1338695	.60256430-01	.22887400-01	-.1411260	-.6332642	1.308205	-.2376369	-1238.931
STORE1	-.15206240-01	-.20791530-01	-.23957640-01	-.33205130-02	.13335120-01	.30958750-01	.13533570-02	125.5912
DIST1	-.4749610	-.7375764	-1.366377	-.1238350	-1.335532	6.510279	-.3583345	-5775.417
COLLTIME	.3696321	.1372352	-.54113710-01	-.3558640	-4.042231	2.178841	-2.334150	-13455.15

	ACTIV	OBTAINI	AVAIL	STORE1	DIST1	COLLTIME
ACTIV	.5304236					
OBTAINI	.84548830-01	6.634692				
AVAIL	.49049050-02	-1.212074	.4755741			
STORE1	-.25641030-03	-.38361200-01	.22887400-01	.42332000-01		
DIST1	.4846377	.73046150-01	-.1537570	.33051280-02	35.10033	
COLLTIME	.2356968	-2.248450	.4485942	-.31917500-01	-1.233149	28.35952

Printout 11 (continued)

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23 JUL 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER   IBM-3031-4M        VS1-VMSP-1.0
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SUMMARY TABLE

STEP	ACTION ENTERED	ACTION REMOVED	VARS IN	WILKS' LAMBDA	SIG.	MINIMUM D SQUARED	SIG.	BETWEEN GROUPS	LABEL
1	ACTIV		1	0.993527	0.0000	.58737	1.1000	1	2
2	TOTLAND		2	0.784424	0.0000	1.2253	1.1000	1	2
3	COLLTIME		3	0.742446	0.0000	1.5472	1.1000	1	2
4	OBTAIN1		4	0.715701	0.0000	1.7717	1.1000	1	2
5	STORE1		5	0.704368	0.0000	1.9723	1.1000	1	2
6	SANITARY		6	0.697904	0.0000	1.9316	1.1000	1	2
7	FUMEM		7	0.693090	0.0000	1.9753	1.1000	1	2
8	MEM		8	0.691079	0.0000	1.9937	1.1000	1	2
9	PROPERTY		9	0.683507	0.0000	2.0095	1.1000	1	2

CLASSIFICATION FUNCTION COEFFICIENTS
(FISHER'S LINEAR DISCRIMINANT FUNCTIONS)

RGB =	1	2
MEM	.9951200	1.072179
FUMEM	.4531794	.5579930
SANITARY	1.376394	1.657592
PROPERTY	.2377153	.1320395
TOTLAND	.2841469D-02	-.2989493D-01
ACTIV	1.040380	.2540472
OBTAIN1	.9249960	1.110441
STORE1	.1989480	-.2937366
COLLTIME	.1899678	.3350356
(CONSTANT)	-9.403052	-10.54680

CANONICAL DISCRIMINANT FUNCTIONS

FUNCTION	EIGENVALUE	PERCENT OF VARIANCE	CUMULATIVE PERCENT	CANONICAL CORRELATION	AFTER FUNCTION	WILKS' LAMBDA	CHI-SQUARED	D.F.	SIGNIFICANCE
1*	0.45031	100.00	100.00	0.5572192	0	0.6395047	327.72	9	0.0

* MARKS THE 1 CANONICAL DISCRIMINANT FUNCTION(S) TO BE USED IN THE REMAINING ANALYSIS.

Printout 11 (continued)

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23 JUL 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER  IBM-3081-M2        VS1-VMSP-1.1


STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS

                FUNC   1

MEM            -0.11799
FMEM           -0.10301
SANITARY       -0.19249
PROPERTY        0.10076
TOTLAND         0.61462
ACTIV           0.51508
OBTAIN1        -0.30228
STORE1          0.24918
COLLTIME       -0.39985


STRUCTURE MATRIX:

POOLED WITHIN-GROUPS CORRELATIONS BETWEEN CANONICAL DISCRIMINANT FUNCTIONS AND DISCRIMINATING VARIABLES
VARIABLES ARE ORDERED BY THE FUNCTION WITH LARGEST CORRELATION AND THE MAGNITUDE OF THAT CORRELATION.

                FUNC   1

ACTIV           0.54106
TOTLAND         0.51744
COLLTIME       -0.42167
STORE1          0.38428
PROPERTY        0.30101
OBTAIN1        -0.28027
ADINCOME        0.19469
FMEM           -0.19041
AVAIL           0.11310
DIST1           0.10327
MEM             0.09074
SANITARY       -0.07773
OFFFARM         0.04476
ETYPE1         -0.03443


CANONICAL DISCRIMINANT FUNCTIONS EVALUATED AT GROUP MEANS (GROUP CENTROIDS)

   GROUP        FUNC   1

       1         0.47873
       2        -0.93842
```

Printout 11 (continued)

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             CHULALONGKORN COMPUTER CENTER  IBM-3081-V4        VS1-VMSP-1.1

FILE:

- - - - - - - - - - - - - - - - - - - - - - -  D I S C R I M I N A N T   A N A L Y S I S  - - - - - - - - - - - - - - - - - - - - - -

11 GROUPS DEFINED BY RS3


ANALYSIS NUMBER        1

STEPWISE VARIABLE SELECTION

     SELECTION RULE:  MAXIMIZE MINIMUM MAHALANOBIS DISTANCE (D SQUARED) BETWEEN GROUPS
     MAXIMUM NUMBER OF STEPS....................        30
     MINIMUM TOLERANCE LEVEL.................... 0.00100
     MINIMUM F TO ENTER.........................  1.0000
     MAXIMUM F TO REMOVE........................  1.0000

CANONICAL DISCRIMINANT FUNCTIONS

     MAXIMUM NUMBER OF FUNCTIONS................         1
     MINIMUM CUMULATIVE PERCENT OF VARIANCE...   100.00
     MAXIMUM SIGNIFICANCE OF WILKS' LAMBDA....  1.0000


PRIOR PROBABILITY FOR EACH GROUP IS 0.50000

------------------- VARIABLES NOT IN THE ANALYSIS AFTER STEP   0 -------------------

                          MINIMUM
VARIABLE    TOLERANCE    TOLERANCE      F TO ENTER        D SQUARED        BETWEEN GROUPS

MEM         1.0000000    1.0000000        3.2850          .15536650-01        1        2
FUMEM       1.0000000    1.0000000       14.466           .72321260-01        1        2
CTYPE1      1.0000000    1.0000000        1.1716          .33375040-02        1        2
SMILTAFY    1.0000000    1.0000000        2.4109          .12136160-01        1        2
PROPERTY    1.0000000    1.0000000       36.149           .1819752            1        2
TOTLAND     1.0000000    1.0000000      106.82            .5377562            1        2
ADINCOME    1.0000000    1.0000000       14.649           .07744910-01        1        2
DEFFARM     1.0000000    1.0000000        .52646
ACTIV       1.0000000    1.0000000      114.80            .5773603            1        2
OBTAIN1     1.0000000    1.0000000       31.339           .1577619            1        2
AVAIL       1.0000000    1.0000000        6.3173          .03181870-01        1        2
STORE1      1.0000000    1.0000000       58.917           .2965877            1        2
DIST1       1.0000000    1.0000000       10.302           .51351650-01        1        2
COLLTIME    1.0000000    1.0000000       70.941           .3571202            1        2
```

Printout 12 Plotting of All Graphs

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23 JUL 84    SPSS-X RELEASE 1.0 FOR IBM OS
             CHULALONGKORN COMPUTER CENTER   IBM-3031-A       VS1-VMSP-1.1

                                   ALL-GROUPS STACKED HISTOGRAM

                                -- CANONICAL DISCRIMINANT FUNCTION 1 --
             80 +                                                                  +
                .                                                                  .
F               .                                                                  .
R            60 +                                                                  +
E               .                                                                  .
Q               .                                                                  .
U               .                                                                  .
E            40 +                                                                  +
N               .                                                                  .
C               .                                                                  .
Y               .                                                                  .
             20 +                                                                  +
                .                                                                  .
                .                                                                  .
               .2         2       2 22222222222222222222222222222222222222222222 2 .
              OUT.........+.........+.........+.........+.........+.........+.........+.........OUT
                         -3        -2        -1         0         1         2         3
GROUP CENTROIDS                                2                   1

CLASSIFICATION RESULTS -

                          NO. OF     PREDICTED GROUP MEMBERSHIP
   ACTUAL GROUP           CASES          1          2
------------------------  ------   --------   --------

GROUP        1             592        448        144
                                     75.7%      24.3%

GROUP        2             367         89        278
                                     24.3%      75.7%

PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED:   75.70%

CLASSIFICATION PROCESSING SUMMARY

       959 CASES WERE PROCESSED.
         0 CASES WERE EXCLUDED FOR MISSING OR OUT-OF-RANGE GROUP CODES.
         0 CASES HAD AT LEAST ONE MISSING DISCRIMINATING VARIABLE.
       959 CASES WERE USED FOR PRINTED OUTPUT.
```

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