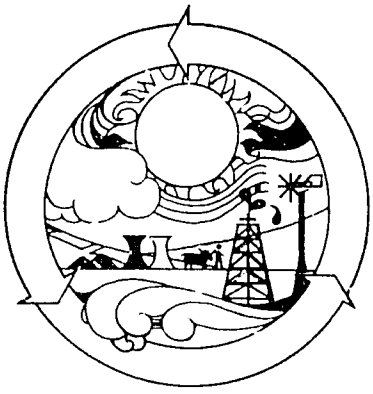
PN-AAT-964
ISN 42530

Energy for Rural Development
Program Report PR-80-3

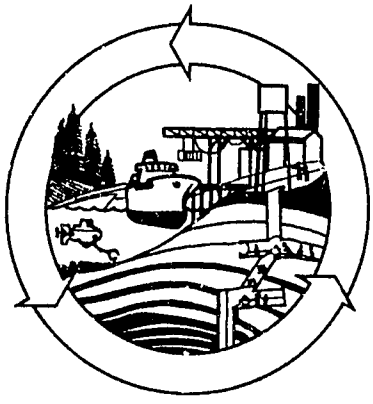


energy
systems

THINKING ABOUT ENERGY AND RURAL DEVELOPMENT: METHODOLOGICAL GUIDELINES FOR SOCIOECONOMIC ASSESSMENT

Charles C. Schlegel and James Tarrant

September 1980



materials
systems

Energy for Rural Development
Program Report PR-80-3

THINKING ABOUT ENERGY AND RURAL DEVELOPMENT

Charles C. Schlegel,
Research Fellow, Resource Systems Institute

James Tarrant
Research Intern, Resource Systems Institute

A preliminary report on research in progress as part of the inter-country Energy for Rural Development program, with support from the Agency for International Development

September 1980

INTRODUCTION

The rapid escalation of petroleum fuel prices and uncertainties of supply that have characterized the second half of the 1970s in most parts of the world have, among other things, stimulated a marked increase in energy research. In particular, the role of energy in national planning and development efforts has gained prominence, especially in poorer countries where the impact of the "energy crisis" has been most severe and where its implications for the future are particularly troubling.

Consideration of energy in national decision making is not, of course, entirely of recent origin. Energy imports and exports, mainly in the form of petroleum or petroleum products, have long had to be accommodated in balance of payments and other national economic accounts. Standard national accounting techniques have been employed in this task without any great difficulty. What seems to have changed most in recent years is focus. On one hand, the economic and political uncertainties associated with dependency on foreign supplies of oil and increasing energy demand resulting from changing living habits, industrialization, and growing scarcity of traditional fuels have given some urgency to the adoption of technologies capable of exploiting domestic energy potential, particularly in renewable energy resources. On the other hand, fuel price and supply constraints have raised the sensitivity of planners and policymakers to the implications of such constraints for development planning and strategy. Whereas previously, energy (or, more accurately, commercial fuels) could be treated as a commodity, the revised orientation has both broadened the scope of investigation to include a wide variety of actual and potential fuels, and, perhaps most significantly, forced attention on energy as it is inextricably embedded in a social, cultural, and environmental context. These factors have raised conceptual, methodological, and factual issues seldom considered before, and this has forced many to face problems they do not fully understand and are unequipped by training and experience to face.

This state of affairs provides the rationale for this monograph. We hope to provide a guide for energy planners and research administrators to a way of thinking through energy research problems and deciding on appropriate strategies for gathering and analyzing relevant information. The experienced social researcher will find little that is new in what follows, though perhaps from time to time the discussion will raise a useful point that he has overlooked or forgotten. Neither will the novice find explicit instruction on how to take a sample or administer an interview. Other references are widely available for this. The contribution of this monograph, we hope, will be that it fosters a systematic and holistic perspective: on the research process as a system of highly interrelated and interdependent parts, and on energy as a pervasive constituent of social organization.

A. What We Know About Energy And Rural Development

There are probably more kinds of energy studies than there are forms of energy. These and their methodological characteristics will be examined in more detail below, but we must note that the variation in methodologies used to analyze energy problems will undoubtedly affect what is now known about energy and rural development.

Most studies in this area have tended to look at the end uses to which energy is put, the nature and problems of existing fuel supplies, and the potential application of new energy technologies or improved traditional supply and use. A number of relationships can be discerned at this point. At the same time, it will be useful to show where the gaps in policy research remain.

Initially, it is worth noting that some nations and regions in Asia have been studied more than others. The most extensively (if not intensively) studied nation is India. Of course, its rural population is larger than those of all the other Asian developing nations combined (excluding China), but more importantly, it has a relatively larger and more elaborate data base to draw from and a larger pool of educated people and institutions to carry out these studies than most other Asian nations. The larger nations of Southeast Asia and Pakistan have a growing capacity to do energy and rural development studies but the poorer nations have generally been studied very little, though their rural development problems--energy included--may be even more pressing.

For convenience, the relationship between energy consumption and rural development will be looked at from the point of view of end uses. Earlier studies have examined this relationship from a variety of angles, but at some point all of them examine the rural tasks that energy serves.

Although rural development policy is rarely formulated on the basis of its impact on the household, but is frequently focused at the village level or above, rural energy studies have typically looked at household units and aggregated their results from that level. This section will follow suit.

Agriculture

Though nomadic systems still exist and fairly large regions of some countries have adopted large-scale mechanized agriculture, the small-scale subsistence farmer is still the norm in developing parts of Asia. Though the paradigm for the region seems to be the Indian farmer, it is doubtful whether a typical Indian farmer exists, much less one that is generalizable to all of Asia. Furthermore, because the literature on agricultural energy use is still too limited to permit numerically specific statements without endless qualifications, only general trends will be outlined here, without reference to specific countries. The latter are considered in other reports in this series.

People and bullocks dominate subsistence agricultural energy inputs in Asia. Tasks such as land preparation (clearing, plowing, dike and tank

building, and stumping) are all done by humans and draft animals with the help of simple tools. Likewise, planting, cultivating, harvesting and post-harvest tasks such as grain threshing, pounding, corticating, winnowing, and so on are done by people with some help from draft animals. Likewise, transport of crops from field to household and local markets is typically done by humans, with some help from beasts of burden.

In the subsistence farming system some inanimate energy is used in the crop growing stage. The principal source and one which is extremely large in energy terms, is the conversion of sunlight through photosynthesis into the potential energy form of vegetation, including crops, trees, and pasture (see Figure 1). The potential for intervention, from a policy point of view, is very limited. However, research continues into creating plant strains that have a greater-than-average photosynthetic efficiency (around 1-2% of incoming solar energy) but useful results will probably be years in coming.

Other applications of inanimate energy in the growing cycle are for irrigation and fertilizer. In the traditional subsistence system, most fertilizer is generated on the farm, where manure from draft animals and sometimes other domestic animals is used. Crop residues are usually either burnt in the field to restore potassium and other minerals to the soil or used as a mulch for soil conditioning. Their use as fuel is also widespread.

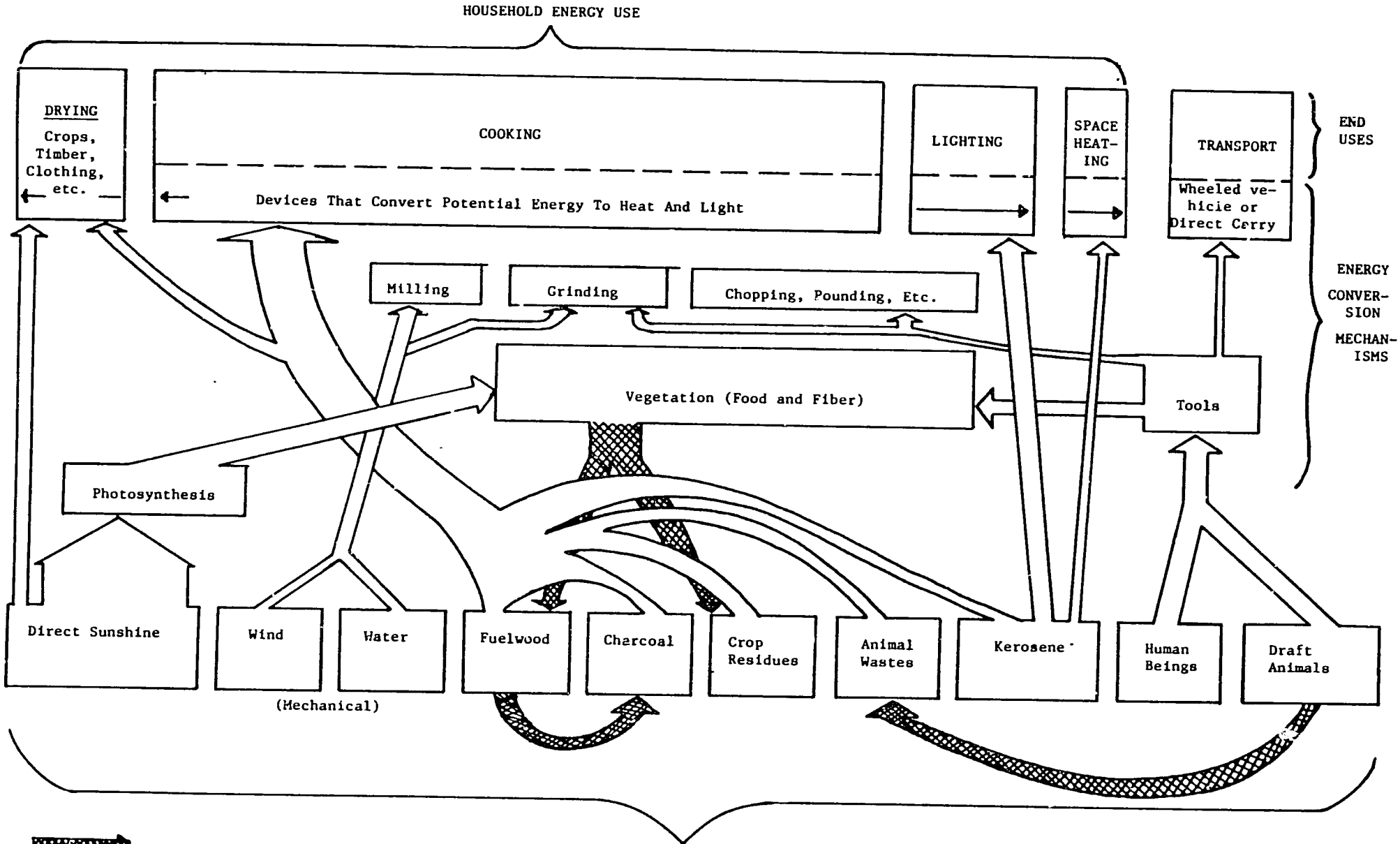
The amount of crop residues and manure available and used for agricultural purposes varies widely depending upon the number of draft animals, types of crops grown, alternative uses for these substances as fodder or fuel, and cultural preferences. Increasingly, subsistence farmers have access to commercial fertilizers manufactured by processes that are energy-intensive, especially of fossil fuels. Fertilizer may be a significant indirect use of energy in the growing cycle of some subsistence farms, but the range in amounts used is wide and dependent on many factors.

Most irrigation used in subsistence farming systems is from flowing streams and rivers, and rainfall; it employs the passive energy source of gravity. The flow is controlled, particularly in flood periods, through catchment tanks and step-down canals and ditches that are often wondrously intricate. A fillip to the flow or changes in the vertical drop may be given by use of water wheels, which are also passively powered. However, in some areas, especially the Middle East, human or draft animal powered waterlifts may be used to bring water from one level to another. A few large or relatively wealthy subsistence farmers have access to electric or diesel-powered irrigation pumps, but this is still rather limited in application. In other areas mechanical wind pumps are used to bring up groundwater for irrigation.

In summary, in this somewhat generalized view of the growing cycle of the agriculture system, perhaps 85-90 percent of the energy inputs are animate--derived from humans and draft animals. Necessarily, this is a very rough figure since it does not take into account the efficiency with which food is converted into work, the differences in tool technology, or the methodological problems of comparing direct work with indirect, embodied energy

Figure 1

A SIMPLE MODEL OF ENERGY FORMS AND FLOWS IN A TRADITIONAL SUBSISTENCE FARMING SYSTEM



Indicates intra-farm system creation of a principal energy form

Note: For purposes of simplicity no

(as in fertilizer), and gravity.

Household Energy Use

In a subsistence farming system the vast preponderance of fuel is used after the crops are harvested and in the household, and of this at least 60 percent is typically used for one task--cooking.

In a typical household the major end uses for energy are food preservation and storage, cooking, lighting, and space heating. The absolute amounts of energy used for these tasks in the aggregate and the relative importance of each task to aggregate household energy consumption vary according to culture, income level, the number of people living in the household, the conversion efficiency of stoves, lamps, and other energy-using devices, the availability of some fuels, the importance of cottage industry (especially food-processing), and other factors.

Cooking

Even in urban areas and in relatively high income households the preference is often to use traditional fuels for cooking. The four main traditional fuels are fuelwood, charcoal, crop residues, and cow dung. Even where all of these are equally available (a very rare situation), households usually prefer to use one kind of fuel (and stove) for particular kinds of cooking, often for cultural reasons. The policy implication of this is that the introduction of an improved stove that uses only one kind of fuel will not necessarily prove to be a satisfactory solution for cooking energy problems.

From the point of view of energy accounting, the traditional stoves that use these fuels typically have very low conversion efficiencies. For wood fuels these range from 5-10 percent of the heat potential of the fuel. Although it is likely that crop residues and dung are burned more completely, delivered energy, particularly in open firepits, is still very low. Charcoal is becoming an increasingly popular cooking fuel, particularly in towns and cities where the cost and inconvenience of using wood is greater. Charcoal is relatively clean, easier to handle, and more controllable than wood or dung, yet traditional methods of making charcoal, especially at the household level, are extremely wasteful of wood. Perhaps 90 percent of the wood's potential heat is lost with the traditional earth mound charcoal-making process. Thus, from the point of view of the consumer, the use of charcoal is a progressive step that enhances the quality of life, but from the point of view of the energy/ecological system, it is a regressive step that potentially downgrades the quality of the environment by accelerating the depletion of forest reserves.

Use of kerosene for cooking purposes is still relatively limited. Though kerosene distribution systems are now quite widespread in rural areas of most Asian developing nations and though the price to the consumer is often

greatly subsidized, its use for cooking has been limited for cultural reasons and because preferred, noncommercial traditional fuels have been more readily available. This situation is now changing in many countries, however.

The dynamics of fuel substitution for cooking in rural Asian households are increasingly complex. In many if not most rural areas, the combination of growing populations and the desire for more extensive subsistence and cash crop planting has led to more land being cleared, often at the expense of forests. As readily available woodfuels have become scarce, a greater proportion of them have become commercialized and in some cases unavailable with the result that the price of traditional fuels has climbed rapidly in many rural areas. At the same time, the rise in the international price of petroleum and the increased demand for kerosene because of the growing shortage of traditional fuel, has made it difficult for many nations to continue to heavily subsidize the price of kerosene to the consumer. As a result, some rural households are experiencing a ratcheting effect on cooking fuel prices as increases in the price of one fuel seem to lead to increases in the price of another. It is too early to say whether there is direct relationship between rises in the price of wood fuels and that of kerosene, since there are many indirect and separate forces working on the two markets. However, there does seem to be some relationship between the two.

It is the poorest households that feel the pinch earliest. In some households this may lead to less cooked food or more semi-cooked foods. In others it may lead to greater use of low quality fuels such as crop residues and cow dung with consequent impacts on fodder and fertilizer use.

Lighting

Other household tasks account for a smaller proportion of total household fuel uses. The next largest end use is lighting, which is usually obtained from kerosene lamps in a traditional subsistence household. Other fuels such as bottled gas, alcohol or fats are used much less. A sizeable proportion of poor households still must rely on the light given off from open pit fireplaces. Other lighting energy is supplied from resin torches and flashlights whose energy consumption is marginal. Most kerosene lamps are relatively energy-efficient, even more efficient than kerosene stoves. The limiting factors in the use of efficient kerosene lamps seem to be the price of both the lamp and the kerosene.

Only a small number of subsistence households have access to or use electricity for lighting. Most rural electrification projects benefit the well-to-do primarily. A number of studies seem to indicate that subsistence households place a relatively low priority on use of electricity for lighting as opposed to, say, its use for irrigation pumps, even when the latter will entail a greater charge to them than the former. In any event, the pace of grid extension in developing countries is extremely slow, the cost of hookups and monthly charges greater than the perceived benefits, and the reliability of the system often poor. All of these factors greatly limit the beneficial

impact of rural electrification beyond the area of irrigation.

Space Heating

In areas of high altitude or latitude, seasonal requirements for space heating are important. However, even in these areas, the increment of space-heating fuel use to total household fuel use is relatively modest. Moreover, space heating may often come from the same fire that is used for cooking. In other instances, building design and the use of heavy clothes may lower the effective space-heating requirement. For purely space-heating needs, charcoal brazier and kerosene heaters are most commonly used, but are much less common than the use of cooking fires for this purpose.

Food Preservation and Storage

Food preservation and storage is a small use of fuel. For household uses, foods may be preserved by being smoked over a cooking fire or spread out in the sun and dehydrated. The use of crop dryers is not common.

Fuel use for crop preservation seems to rise when cash crops are involved. Tea and tobacco curing, fish drying, copra making, and other processes in which the amounts processed are sizeable over a limited time period may require the use of some traditional fuels and kerosene. However, large-scale crop preservation is usually the responsibility of village or market entrepreneurs or cooperatives, rather than households.

Transportation

Transportation is a vital area of energy consumption. Though automotive transport is becoming increasingly common for inter-village and village-to-market transport of goods and people, it is still fairly uncommon in many rural areas.

Most personal and goods transport (e.g., of crops to market) is accomplished by people and animals, with the aid of an oxcart or its equivalent where terrain permits. Though a major element of most rural development strategies, road building remains a problem area, as is most apparent in terms of the kinds of roads to be built (seasonality and durability) and their purpose (farm to market, inter-village, etc.). There is disagreement as to costs and benefits of different road-building strategies and the environmental impact of road building and associated roadside development in fragile ecological zones.

Setting aside the energy cost of building roads, road-building projects influence the price of energy supplies to the village and indirectly the household, food crop preservation, mode of transportation technology and fuelwood and charcoal marketing. All of these have important implications for

the dynamics of the rural energy system that have not been adequately investigated.

B. Gaps in Energy Information for Policy-Making

While certain basic patterns of energy use are becoming clearer, the causes of many rural energy-related problems, such as deforestation, remain elusive. In addition, in most countries not enough is known about village or regional socioeconomic characteristics to assess the ability of rural development organizations to develop local energy supplies and improve their use.

Experience with rural development over the years indicates that policy interventions must anticipate their likely reception by rural populations if they are to succeed. The effect of traditional social structure, rural income distribution, and land tenure patterns on the viability of a project, and the interaction of related activities, (e.g., coordinating an irrigation project to encourage planting a second crop, with assurance of markets for both those crops) are instances requiring finely tuned rural development policies. It is unlikely that energy policy making for rural development will prove very different.

Nevertheless, only a few energy and rural development studies attempt to place household, village, or regional energy problems in the context of the appropriate social or ecological system. There is a tendency to resort directly to village energy surveys or to use national energy supply and consumption data to formulate rural energy policy. While energy consumption data are necessary, analyses of other sociological, environmental, and economic data are essential for designing village-based energy projects.

In most places, not enough attention is paid to discovering the economic, social and psychological factors that make one project succeed and another fail. Energy studies are no exception. Only after more than two decades of implementation are serious evaluations of India's biogas implementation program beginning, for example. Though rural energy problems are certainly urgent, new technologies should be tried out first as learning laboratories to discover whether and how they are likely to succeed in real life situations. Rather too much emphasis is placed instead on demonstration projects meant to persuade people to adopt a particular technology, perhaps prematurely.

The notion of a pilot project as a learning tool is certainly not new; indeed it is a principal component of the concept of "appropriate" technology. But it implies collection of both the hard scientific data that is normal procedure for a pilot project, and the on-site adaptations and sociological and economic information that attempt to assess the local elements that enable a project to succeed and be replicated in other areas.

As mentioned earlier many energy and rural development studies have

been done in some countries, while little research has been done in others. The coverage of those studies is equally unbalanced. A review of the literature indicates that in many countries energy studies are concentrated at either the aggregate, national level or the village-specific level. Relatively few studies have started out looking at the province or region as the principal unit of analysis, yet it is probably this level that is crucial to the policy making process. Indigenous energy resources, cultural and linguistic differences, and agricultural and ecological system differences can most usefully be incorporated into the formation of national energy planning at this level. Likewise, it is the regional administrator or provincial officer who must organize the institutional, labor, financial, and physical resources to implement much of rural energy policy--particularly that concerned with the development of new and renewable energy resources and better use of traditional energy resources.

There are a number of substantive gaps in our knowledge of energy and rural development in addition to the procedural gaps already mentioned. Some of these include:

- An adequate study of human and draft animal labor, especially from the point of view of tool technology and labor utilization as inanimate energy substitutes for human and animal power.

- A more systematic knowledge of the use and availability (by household, by season) of manure and crop residues. This is especially important given the popularity of biogas and improved stove technology with policymakers.

- Not enough is known of the kinds of cooking patterns and associated fuel and stove use, which seem to vary significantly even within regions.

- In the face of continued governmental encouragement of rural electrification, not much is known of consumer preferences for the application of electricity in their villages. If intermittent use of electricity for agriculture is considered more important, more data will be needed on the trade-offs of grid electricity versus autogeneration (whether by fossil fuels or renewable energy).

A general weakness in studies of energy in rural development is the lack of attention to appropriate utilization of new technologies. This lack is apparent in studies by research and development institutions; by local organizations responsible for assessing and evaluating energy-related needs and resource potentials; and by institutions that provide venture capital and other incentives to marketing technologies and practices.

C. Scope and Focus

This monograph is about methodology. We use the term in its broad sense of encompassing the entire research process, from formulation of the specific question or questions that will guide the investigation, to the final

stage of analysis and interpretation. We have not limited our attention to the formal procedures for gathering information, though this is probably the most commonly understood definition of methodology; neither have we attempted to anticipate and provide answers to specific methodological questions. Our objective is at once more limited and more ambitious. We take our primary audience to be planners, researchers, and research administrators working in the field of energy and rural development who may be nonspecialists in either energy analysis or research methodology. We hope to provide them with some useful suggestions and guidelines for thinking systematically about the purposes and strategies of energy-rural development research and arriving at solutions appropriate to their particular problems and circumstances.

We assume that the principal current need is for a clearer understanding of the social role of energy, how it influences and is influenced by the particular configuration of its social setting. The orientation of what follows is thus toward methodological techniques and perspectives which are appropriate to social science research. Further, we take a practical and applied approach, on the assumption that most policy and planning purposes require fairly broad and reliable generalizations achievable in a reasonable period and at reasonable cost.

FRAMEWORK FOR RESEARCH DESIGN

The basic framework of the present study is very simple. It focuses on four questions which are essential in planning and implementing any systematic research project with a substantial socioeconomic component:

1. What is the research problem?
2. What data are necessary?
3. How are the data acquired?
4. How can data be linked back to the initial question?

It is emphasized that this outline implies a sequence that is artificial and unrealistic. Conceptually, the process should always be an iterative one. The research questions will never be formulated without some regard for data requirements, methods of collection, and analytical procedures. And it would be foolish to attempt to specify data requirements in total disregard for the practical and conceptual problems of collection methods. Here, as throughout much of the following discussion, the purpose is to highlight and clarify the principal elements of research methodology; and in order to do this it is necessary to consider each major component somewhat independently. Moreover, in the nature of the research situation, some parts of the work really do have to be dealt with before others, and it is both convenient and heuristically desirable to discuss these parts in the same order as they occur. But the steps will overlap, or shade gradually from one to the other, or involve reference to other steps that have not yet been reached.

A. What is the Question?

The importance of this step can hardly be overemphasized, because it determines, in one way or another, everything that is to follow. The problem statement should be more than a simple declaration of what the research is to be about. Perhaps this ought to be called a statement of the research topic. A properly formulated problem statement should guide the research through its various stages. It should define the boundaries of the effort to be undertaken and thus, in a sense, specify what the research is not about.

In other words, the problem statement should specify and operationalize the topic description. For example, "Current Energy Demand in Rural Mongolia" is a fairly typical topic statement. It identifies the problem as the policymaker or macro-planner might formulate it. But before a research effort can be mounted, even before any preliminary estimation of time, labor, and resource requirements can be made, the statement must be translated into operational terms. What, for example, is meant by "rural"? Are all towns and villages excluded? Will the project attempt to gather data on all rural areas (however defined) throughout the country, or will fieldwork be confined to a single village, district, or region? Will the assessment of "energy demand" include rural industry, transport and communication, government services, and so on, or only farms and households? And how comprehensive and literal is the term "energy" intended to be? Does it mean that all magnitudes are to be expressed in Btu's, kilocalories, or some other energy unit? Is embodied energy included? Animal and human power? Obviously the answers to these questions will have an important bearing on the resource requirements and time frame of the effort, not to mention the techniques employed in obtaining the information.

The most serious consequence of ambiguity in formulating and expressing the problem statement is that it allows or actuallly encourages ambiguity at every other stage of research. Without a clear rationale, data collection often goes off in serveral directions, with no clear focus or coherence; almost invariably, the tendency in such cases is to gather more data than there is any reasonable use for. Data management and analysis are thereby made more difficult and time consuming. Most important, it becomes difficult to interpret the evidence and draw valid conclusions. Facts seldom speak for themselves; they have meaning only within a conceptual framework that relates one set of facts to another. If a question is not clear, it is hard to know how--or whether--it has been answered.

In short, failure to be precise in stating the research problem can only result in unnecessary expenditure of time and effort, an unwarranted volume of information that is difficult and costly to manage and analyze, and confusion and ambiguity in interpreting the results. At the very least it leads to inefficiency and can erode the credibility of the research team and its sponsoring organization.

B. What Data are Required for Addressing the Question?

Once the research problem has been properly formulated, data needs can be assessed in a fairly straightforward manner. The first question that should be asked in this context is whether some of the necessary data--or acceptable substitutes--might already be available.

Naturally, many factors will influence the suitability of existing information for the current problem. In particular, the unit of observation is likely to be important. Censuses, routine socioeconomic surveys, and similar large-scale data bases typically provide breakdowns to at least the first or second subnational level, but may have little direct value for a village study. On the other hand, village case studies have long been a common mode of social and economic research, and are usually documented in academic theses and dissertations, official reports, and other materials. In some cases, it may be possible to utilize this information for present purposes, or perhaps to borrow techniques for measurement and analysis. The selection, for an energy study, of villages or other units that have been well researched on other occasions and are known to be widely different on a number of major socioeconomic characteristics, might be a relatively economical means of exploring interactions between social organization and energy use.

Many problems will of course require that data be gathered from scratch. There are two basic difficulties with social data. First, there is often relatively little standardization in either conceptual or operational definition. And secondly, even when the variable has a fairly simple and clear-cut conceptual meaning, it may not be easily or directly measurable. "Quality of life," for example, is viewed by some researchers as consisting entirely of income, wealth, and material possessions; for others it may also include some notion of satisfaction and well-being. Clearly the data required to satisfy one definition will be different from those needed to satisfy the other, and the techniques appropriate for obtaining information on material possessions will be wholly inadequate for the assessment of happiness or satisfaction.

In part, these problems arise from weaknesses in social theory, but they probably stem primarily from the inherent complexity of social reality. In any event, there is little prospect that they will soon be resolved. One way of dealing with some of these difficulties is to use multiple or composite measures that tap different facets of the same underlying concept. The various level-of-living indices are examples of this procedure. Alternatively, or sometimes in conjunction, multivariate analysis techniques, such as multiple regression or factor analysis, can be used to take account of several distinct but related indicators simultaneously.

Though social variables may be more difficult to quantify in principle, much of the available energy literature suggests that the collection of data on consumption and production of fuel and energy is not as problem-free as might be expected. If the research question is phrased in energy rather than fuel terms, the problems of energy units and conversion factors come into

play: Should the common unit be Btu's, kilocalories, or kilograms of coal equivalent or coal replacement? What is an appropriate conversion factor when cooking fuel typically consists of variable combinations of wood and twigs, leaves, crop residues, bamboo, and assorted other combustible materials? What about the moisture content of fuelwood, which may vary considerably from day to day and even more from season to season? Each of these factors, and others as well, will of course influence the procedures and techniques used in the data gathering process, and the choice of one alternative over another will certainly affect the numerical results.

C. Data Acquisition

Perhaps because data gathering is often the largest and most expensive part of a research project, methodology in the minds of many is almost synonymous with methods or techniques of data collection. Certainly the time, effort, and expense typically required for this phase justify careful attention.

Here we identify three major data collection methods. Each of them has several subtypes and variants, and each has its own particular set of strengths and weaknesses. In what follows we shall attempt to indicate some of the prominent characteristics of each and the types of problems for which they may be appropriate, and to note their principal positive and negative features.

Sample surveys and case studies are probably the two most commonly used techniques for collecting field data in social science research. In their purest and most typical forms, surveys and case studies are polar opposites. The survey is designed to cover populations too large for every member or element to be observed, so some kind of sampling is necessary; and practical considerations set a comparatively low ceiling on the amount of data that can be obtained for each element. The case study is small in scale and emphasizes the collection of quantities of detailed information, though much of it may be in non-numeric form. Good survey technique stresses a neutral and non-obtrusive stance by the field investigator, while the case study ordinarily involves close contact and interaction between subjects and observer over a relatively lengthy period. Finally, the survey is normally used to study large systems in which substantial variation in structure and behavioral patterns are likely, whereas case studies generally focus on small systems--a village, neighborhood, or project area--in which face-to-face contact among members is at least possible, and where major structural and ecological conditions are similar for all members.

These are of course broad characterizations, subject to wide variation or combination in actual use. A third method, lying somewhere between the survey and the case study, and sharing some of the properties of each, might be called intermediate analysis. This term actually covers several rather indistinct subtypes that share a common focus on territorial units and a relatively extensive use of secondary data.

Sample Surveys

The popularity of this method is such that when a research project involves the collection of data in the field, a "survey" is often the first and sometimes the only method considered. The term is often used rather loosely, however. The present discussion will focus on the sample survey, in which a sample of individuals, households, villages, firms, or other units is drawn according to accepted statistical procedures in order to represent some larger population or universe. The process of collection involves interviewing, measuring, or otherwise making observations for each sampled unit.

The survey itself consists of three basic parts: First, delineating the population or universe to be sampled, and drawing the sample; second, developing the survey instrument; and third, identifying and locating the sample elements selected, and administering the instrument in the field.

Sampling is itself a highly specialized and technical subject, but the basic principles are covered in most statistics texts. The most serious practical difficulty is often to obtain a list or other source of information on membership of the complete population that will permit identification of the appropriate sample subjects. If a small and geographically concentrated population, such as all households in a village, is to be sampled, the procedure can be fairly simple: enumerators are instructed to take a predetermined route through the village and interview every fourth, seventh, or nth household. This assumes, of course, that every household can be readily identified and that multiple interviewers do not interfere with each other or violate the overall sampling scheme. If the population is widely dispersed or consists of elements not reliably identifiable by direct observation, this method will be inappropriate and some other procedure must be devised. The problem of obtaining a list of members of a population--a sampling frame--is one of the principal obstacles to the conduct of sample surveys. This seems to be the principal reason why "surveys" are often taken of conveniently located or easily identified households, firms, or villages. In some circumstances this practice may be justified, but findings cannot be regarded as representative in the strict sense of that term.

Because sample surveys are at best complicated, several cautions should be observed in developing the instrument.

a) Within the framework provided by the problem statement, keep the instrument as short as possible. Respondents may easily become bored, confused, or irritated in the course of a long interview, and data quality will suffer accordingly. Interviewers, too, can be affected in much the same way, and with similar results. The surest way to avoid unnecessary length is to keep an eye clearly on the research problem and its associated hypotheses. Resist suggestions to include peripheral or unrelated questions because "interviewers are in the field anyway, so the additional information is free." It seldom is.

b) Avoid open-ended questions whenever possible. Pre-coding will of course add to the difficulty of preparing the questionnaire schedule, but it will pay off in several ways: it will be easier to administer; it will facilitate consistency of interpretation; and perhaps most important of all, it will force the principal investigators to think seriously and carefully about what each item is intended to measure and how the data will be analyzed. Don't forget to provide coded categories for "not applicable" and "missing information."

c) Pretest the instrument in an area similar to but outside the survey area. This is the best way to identify ambiguous or unduly sensitive items.

d) Prepare the final schedule in such a way as to simplify the recording of data and later tabulation or keypunching and analysis. A "self-coding" format is usually easy to develop, and will result in substantial savings of time and effort. At the same time it will minimize the introduction of error that often occurs when data must be transferred from interview schedules to code sheets to punched cards or magnetic tape.

For the fieldwork involved in survey research, enumerators or interviewers are clearly the key element. It is critical, therefore, that they understand in general terms what the purpose of the research is, and specifically, what kind of response is expected for each item on the questionnaire. This means training, and training must consist of more than reading through the questionnaire a few times. It is a very good idea to select interviewers some time before field work is to begin, and involve them in the pretest of the instrument. This will provide fairly realistic field experience and will raise questions to be answered in more formal training sessions.

Field supervision and quality control are likewise very important. Supervisors should have been closely involved in the preparation of the interview schedule and have a clear understanding of what the survey is intended to produce and how each question contributes to that end.

Case Studies

A case study, as the name suggests, is generally an intensive study of a single case (a community, project, firm, etc.) or at most a very small number of cases. Emphasis is on direct observation and close and sustained interaction between the observer and the inhabitants or actors under study. As noted above, the focus of such a study is usually the group as a whole; conversation, interviews, and observation of individuals are simply means of collecting information about the organization and structure of a particular and unique entity. A case study may sometimes employ survey methods for the collection of statistical information, but this is ordinarily on quite a small scale and is often carried out by a single participant observer, perhaps with some minimal local assistance.

Given the size of the "sample," and the fact that cases are often chosen for study precisely because they are atypical (exceptionally poor or successful, possessing a community biogas system, etc.) no claims can properly be made about the generalizability of findings. Such research can be indicative or suggestive, of course, and can be the basis for hypotheses to be tested elsewhere.

The typical case study is largely the work of a single individual, with occasional assistance recruited locally, and everything depends on this researcher's judgment and interpretation. Though some standardization of procedure may be involved, particularly among anthropologists with formal training in participant observation techniques, this is generally more in the form of what to look for rather than how to collect data. Therefore no case study can ever truly replicate another in the same sense that a survey can be repeated in almost identical fashion from one place to the next. Much of the value of a good case study may stem from the insight that it gives into the workings of a system--how the various facets of its organization interact with one another, and how these may change over time. This insight or understanding will almost always be richer and more complete than that gained from other methods of research because it utilizes impressionistic and purely qualitative information in a way that these methods cannot. This is one of the case study's primary strengths, but at the same time one of its most serious weaknesses.

The case study approach may be relatively inexpensive, at least as compared with a sizeable survey. Usually only the principal investigator and a field assistant are directly engaged in the research, and few technical facilities are required. However, it is generally a full-time job that may extend over a period of many months for fieldwork alone. Moreover, successful case studies require a high degree of motivation on the part of the investigator, and exceptionally high levels of training and formal education. Such people are seldom available in abundance.

As noted above, case study sites are often selected because they are different. This appears to be a good criterion for deciding the role that they should play in an overall research program. In particular, project sites would seem appropriate locations, or areas identified in more extensive research as anomalous or atypical.

Intermediate Analysis

Primarily, "intermediate" refers to the middle position between the micro level which is normally the locus of the case study, and the macro level occupied by the large-scale sample survey. But intermediate also indicates that this approach adopts some of the features of both micro and macro studies. Specifically, the intermediate study may be as extensive in its geographical and population coverage as a large survey, but it takes as its units of observation civil or administrative subdivisions, ecological zones, or similar

entities, and treats them as having characteristics of their own, apart from the characteristics of their human inhabitants. In this sense, intermediate analysis is similar to the case study.

Several features of the intermediate perspective should be noted:

a) If the units are territorially-based, and all such units are included, both the total population and all territory of a country are covered. This would not apply if, say, villages and towns were chosen as the unit of observation.

b) The full complement of first- or second-order subnational unitswill typically divide the country up into a fairly large, but still manageable, number of parts. This allows enough cases for most statistical analysis, and permits a fairly fine-grained picture of the human and physical landscape to emerge.

c) Subnational boundaries are not always as arbitrary as is often assumed. If they were demarcated with ecological and/or socio-cultural features at least partly in mind, existingadministrative units may provide a fair reflection of thesedifferences. In other words, they may serve in some meaningful sense as "social" or "ecological" units.

d) Since such units typically have political or administrativeimportance, they provide a structure for much routine data collection and reporting. They are also familiar to planners and policymakers and are often the entities through which development programs are coordinated and implemented.

One of the major practical advantages of intermediate analysis is the availability of secondary data. Census reports provide breakdowns to various subnational levels, sometimes as far down as the village, on a wide range of demographic variables. Large socioeconomic surveys may provide additional information disaggregated at least to the larger units. Special surveys or routine reporting by branch offices of the various ministries will also generate useful data. Other sources may exist in the form of lists, directories, yearbooks, maps, transportation schedules, and so forth, which are compiled by private or semi-governmental bodies.

All this information is usually available, at least in principle, for further analysis. If it exists in published form, acquisition may be fairly easy; if not, locating and gaining access to it may be a formidable problem. In some countries in the Asia-Pacific region--Indonesia, Malaysia, and Thailand, for example--programs either exist or are in the process of development to build and maintain computerized data bases containing a broad array of statistical information at one or more subnational levels. These "territorial indicator" data files have great potential for intermediate analysis. Though secondary data is not the answer to all research needs, it is certainly a resource which deserves much more use and attention than it generally gets.

This discussion of data collection methods has necessarily been

selective--there are obviously more than three methods of gathering social data. For the sake of convenience, this presentation has probably invested each of the methods considered with a uniqueness and unitary character that it does not deserve. However, even if these three approaches were distinct and well-developed research procedures, in practice they are not and need not always be employed individually and exclusively. Many combinations are possible, and an examination of these possibilities in search of the one that best meets the data needs of a project with the greatest economy of scarce resources, should definitely be encouraged. The coordination of survey analysis and case studies has already been suggested. Group-level characteristics of districts or provinces may also provide valuable contextual or background information for surveys and perhaps also for case studies; and cluster sampling on the basis of intermediate units allows the incorporation of secondary or other group-level data into survey analysis. The basic objective, of course, is to plan research in such a way as to be able to build upon previous research and exploit information collected for other purposes as fully as possible.

D. Analysis

Though analysis is the final stage in the research framework presented here, it might better be viewed as the link connecting the evidence generated in preceding stages back to the initial problem statement. With very few legitimate exceptions, this is--or should be--what analysis is all about. It is not--or should not be--an end in itself. Crucial though analysis is, it is no more important than the collection of data, and it is decidedly less important than proper formulation of the research problem.

It seems often to be the case that analysis is regarded as the key by which the many mysteries contained in the data will be revealed. Of course analysis should tell us something that we didn't know before, or there would have been little point in doing the research in the first place. But these revelations will ordinarily be of the type that informs us about sizes or numbers or strengths and directions of relationships. Except in very unusual circumstances, analysis should reveal few real surprises. If it does, it probably means that too little thought was given to the specification of the problem, or that data were selected haphazardly.

It is useful to distinguish between two main categories of analysis according to their intended use. Descriptive analysis involves the systematic construction of a picture of what is "out there." It entails the use of summary statistics (averages, standard deviations, percentages, indices of distribution, etc.) or classifications (high, medium, and low) to indicate the position of one or more groups or areas with respect to the variables measured. This information is usually presented in graphs, charts, maps, and tables. Rural energy resource inventories are of this type. A project investigating the amount of variation in average commercial fuel consumption among provinces would similarly call for a decriptive analysis.

The second type--what might be called exploratory analysis--involves a

search for relationships among variables. Here a number of statistical procedures might be employed to determine the strength and shape of association: correlation, simple and multiple regression, cross-tabulation, analyis of variance, and so on. The aim of explanatory analysis is to explain or make predictions about one variable or set of variables on the basis of another set of variables.

As noted above, "descriptive" and "explanatory" are terms which refer to the purpose of the analysis, and therefore might more properly be applied to the study as a whole. Nevertheless, it is appropriate to discuss them here because they have important practical implications at the data analysis stage.

There is no reason to automatically favor one type of study over the other. Explanatory analysis is a "higher" form of endeavor in a philosophy of science sense, and presumably will often be the preferred choice for policymakers and planners who wish to know what variables have a significant relationship with welfare, energy consumption, or whatever the dependent variable might be. Nevertheless, if basic understanding about a phenomenon is poor, and there is little appreciation for the range and pattern of its distribution across a social system--both characteristics that seem largely applicable to the current stage of knowledge about energy in a rural setting--then considerable descriptive investigation may be warranted initially in order to allow the later formulation of sensible hypotheses and explanatory research designs. As for the policy relevance of explanatory research, it is well to bear in mind that few of the socioeconomic "determinants" of energy use, rural development, and similar variables are likely to be directly or immediately subject to policy control. A study may show, for instance, that total household energy consumption is largely a function of household size. A reasonable inference would be that a reduction in average family size would have the desirable effect of reducing overall energy use, but this is hardly a practical policy option, at least over the short term.

This example somewhat oversimplifies the situation, and should not be taken as a recommendation against explanatory research. An understanding of relationships among policy-related variables is essential, even when no obvious levers of control or influence emerge. The point is simply that purely descriptive research needs no apology; and despite its admittedly greater sophistication, explanatory research may in fact have fewer direct policy applications than is sometimes assumed.

DIMENSIONS OF METHODOLOGICAL CHOICE

A number of factors, or dimensions, will have broad applicability in planning and implementing rural energy research. They involve choices or decisions that will generally have a pervasive influence on the entire research operation. A certain decision made on one of these factors will often constrain or otherwise affect the choices available on another. Moreover, the kinds of questions that can be addressed by the research, as well as the ways in which empirical findings can be interpreted, may be significantly influenced

by these same decisions. Several of these factors, which we have called dimensions of methodological choice, are discussed below.

A. Generalizability

Most research, at least of the explanatory type, will presumably attempt to draw general conclusions from limited observations. There is such a close relationship between "policy" and "generalization" that the first almost implies the second.

In the context of empirical research there are only two ways of arriving at valid generalizations: either enumerate and observe the complete universe of interest, in which case "generalization" becomes redundant, or estimate characteristics of the universe by means of observations on a representative sample. If small units of observation are employed, and/or a very large universe is under study, the practical problems can be overwhelming. But in principle, neither of these criteria presents any great difficulty. Given sufficient time and resources, a complete census can be taken or a sample survey can be designed to be representative of all households in the country or any major portion of it. Practical considerations usually prevail, however, and the usual compromise is to do a survey covering the immediate vicinity of the research organization, a province, or a similar fairly small territorial or population unit.

What seem to require more careful attention are ways of widening the scope of research to make findings more broadly applicable, while at the same time keeping costs and other material requirements within reasonable limits. Intermediate analysis is one alternative to the large-scale survey. This method is not suitable for every problem, of course, but neither is the survey (though it appears that a great many problems are formulated with a survey in mind). Another possibility would be to establish a division of labor among several research organizations in which identical or nearly identical instruments and procedures could be employed in several fairly small-scale studies that would generate parallel data bases. These data could be analyzed separately or pooled for a larger single analysis. A variant of this approach would be for one organization to move systematically from one area to another over a period of time, administering the same instrument in each area.

Under certain conditions it may be possible to achieve formal generalizability by some of the multi-stage methods just suggested. In most cases, however, a degree of standardization and comparability of results is the most that can be expected. Even this, however, would be a significant achievement, and would go a long way toward promoting cumulativeness in our knowledge about energy and rural development.

Other opportunities also exist for the sharing among institutions of training materials, instructors, and possibly a pool of trained interviewers, and for the routine exchange of general information, research findings, and data. At a minimum, the traditional standards of academic research should

apply: know the relevant literature; employ standard procedures, concepts, and measurements to the extent that standards have been established and are applicable to the problem at hand; and make a serious effort to replicate, extend, or otherwise build on the work of others.

B. Units of Observation

This refers to the objects or "things" under study. In a sample survey, for example, either households or individual adults are usually sampled, and the data instrument asks for information about characteristics of each sample household or individual. Other commonly selected units of observation are firms (including farms); nucleated settlements such as towns, villages, or cities; districts, provinces, or other spatially-defined subdivisions; and larger units such as regions or ecological zones, that may or may not have formal boundaries. For most of these units some sort of sampling is usually a practical necessity. A complete enumeration of households or individuals, for instance, is seldom feasible for research purposes unless the universe, as defined, is quite small--say, the population of a small village or all firms in a certain industry.

For other units of observation, however, the numbers involved may not be so large as to make sampling or some other form of selection necessary. It may be quite feasible, for instance, to conduct a comparative study of all major civil or political subunits of a country, such as states or provinces, or of all villages in a specified region.

There are many hybrid situations in which characteristics of a group or collective are obtained by performing some mathematical operation on one or more characteristics of individual members or elements of the group, but in which the result is a group-level property which has no meaningful interpretation at the level of individual members. Rates and indices--of fertility, growth, suicide, inequality, and so forth--are examples. A fertility rate can be calculated only on the basis of information collected about women in their child-bearing years, but it makes no sense to speak of the fertility rate of a particular woman. Likewise, an index of inequality is applicable only to some group, though the basic data may be derived from individuals, households, or farms.

Though statistical aggregation or summarization is a very common procedure for obtaining information that applies to social groupings or territorial subdivisions, it is not the only way. These larger units may also have characteristics of their own that are not derivable from information about their their constituent elements. These are sometimes called "global" properties. The political structure of a country or state, for example, is a property that can be described only in terms of these units themselves. Size, distance, topography, the availability of physical resources, and similar variables are other global properties. The data required to describe these properties are obviously very different from those discussed above. Sample surveys would probably be an inappropriate method of gathering global

information. Direct observation may be adequate for some variables, but most commonly global data are obtained from key informant interviews or secondary sources such as maps, directories, and so on.

Not all units of observation are equal in terms of their applicability to a given research question. If household-level characteristics--income, membership size, land holdings, dietary habits and cooking practices--were presumed to be the primary source of variability in rural energy use, then clearly household information on these variables would be critical. If, on the other hand, supply factors were conceived to be most important, then perhaps group-level variables such as a district's biomass resource base, level of urbanization and market network development, transport facilities, principal cropping pattern, and so forth, would be of greater interest.

C. Comprehensiveness

Some research problems are by nature more comprehensive than others, in the sense that they relate to broader and more abstract concepts or segments of reality. In relative terms, an assessment of the volume of fuelwood consumed in an area, and the consequent impact on deforestation, is a relatively simple and straightforward problem involving few thorny conceptual issues or operational difficulties. The number of variables implied in the problem statement is small, data gathering procedures are more or less routine, and presumably there are few major intervening or confounding factors that need to be taken into account.

Another project, however, investigating the role of energy consumption in the promotion of rural welfare, is inherently more complex, and involves the measurement and manipulation of a substantially greater number of variables. "Energy consumption" presumably includes several varieties of fuels used to perform a range of rural tasks, and may imply laboratory analysis of samples to determine moisture content and calorific values for conversion into a common energy unit. "Rural welfare" is an even more ambiguous term, difficult to operationalize adequately and entailing, quite possibly, the collection of data on several indirect measures of the concept. Furthermore, the existence of known or suspected influences on rural welfare, apart from energy, means that there are a number of control variables that should be incorporated into the analysis in order to isolate the independent effects of energy consumption.

Thus in large measure the selection of the research topic will predetermine the scale of the effort to be mounted and the requirements of physical and human resources.

There is another aspect of comprehensiveness, however, that relates not to the complexity of the problem itself, but to the detail with which it is operationalized. In most rural settings, for example, a great variety of biomass fuels are typically used. A project investigating biomass consumption can choose to identify and enumerate the utilization of each separate variety, or it can concentrate on the major categories and lump the rest together as

"other." Tasks can be minutely differentiated and energy consumption for each can be measured, or somewhat broader classifications can be used.

The particular needs of the research must of course prevail; if great detail is needed, then the project must be prepared to bear the cost. There is often the temptation, however, to obtain more detailed data than is immediately necessary on the assumption that the extra information involves little additional cost, and it just might come in handy later. While the temptation is understandable, the reasoning is largely fallacious. Unfortunately, "leftover" data rarely get analyzed. And beyond a certain point the marginal costs of additional detail begin to escalate rapidly. More detail means more data; more data means more time, longer questionnaires, and/or more field enumerators; and more and better training and supervision are required. Costs go up, of course, while the threats to data quality and consistency increase. Moreover, a greater volume and variety of information means more data management problems and a more complex analysis scheme.

The moral of all this seems to be: When in doubt, simplify.

D. Units of Measurement

In an energy context, the question of units of measurement generally takes two forms: whether to account for energy use in terms of the weight and volume of fuels or in some common energy unit; and, if in energy units, which of several alternatives to choose.

The energy accounting approach is attractive because it allows, in principle, the charting of total energy flow into and out of the system under study. Assuming that the practical difficulties may be satisfactorily resolved, a model parallel to the economists' GNP or NNP could be developed to monitor and analyze changing levels and configurations among several categories of enegy production and use. Or net energy analysis--the calculation of the amount of energy available to the final consumer after all energy costs involved in its discovery, production, and delivery have been paid--could be used as a policy tool to help decide whether a given project or program would result in significant gain or loss, as assessed in available energy terms.

These approaches rest on an energy theory of value that is itself controversial. On a more common and practical level, the argument for assessing the consumption of a variety of fuel types in standard energy units is that it is the only effective way of determining the quantity of a given fuel necessary to perform the energy tasks currently being filled by another fuel. For example, the calculation of the amount of biogas which would have to be generated in a village in order to substitute entirely for present kerosene consumption would seem to require that both fuels be converted to a common unit of measurement.

On closer examination, the validity of the latter argument is questionable. If, for example, it were desirable to promote the substitution

of biogas for kerosene, the minimum relevant information would be (a) what are the current uses of kerosene? (b) what amounts are consumed for each use? (c) for which of these uses would biogas be technically and socially appropriate? (d) for these uses, how much biogas would be required? In assessing kerosene savings that would result from the successful introduction of biogas, (b) minus the residual amounts implied by (c) would provide the figure in, say, liters or gallons. To determine the amount of biogas capacity (probably as measured in cubic meters) that it would be necessary to develop, (d) alone would be required. (Biogas needs for cooking a standard rice meal, lighting with a commonly-used lamp type, etc., are available in the literature, so the actual computation of (d) should be a fairly straightforward matter.)

What is involved here is a shift in orientation toward end tasks and fuels rather than enegy per se. It allows the determination of both potential kerosene savings and needed biogas capacity, and in addition it expresses them in terms probably most familiar to energy planners and design engineers. At the same time, it avoids the extra step of converting both fuels to some standard unit. Indeed, for many wood species, crop residues, and other biomass fuels the appropriate conversion factors are not readily available, and in any case will vary considerably depending on the moisture content.

Occasions will arise, however, when it is necessary or desirable to express all physical quantities in standard energy units, and the researcher will need to choose from among several possibilities. There seems little compelling reason to select one alternative over the other. While experts may argue over the finer points of Btu's, kilocalories, oil and coal equivalents, and others, conversion formulas are in fact available for transforming any commonly used measure into any other. In most practical situations, convenience and consistency should probably be the primary considerations.

E. Precision

Everyone has read research reports in which findings of the following sort are reported: "Average per hectare yield of main season paddy rice, as reported by farmers sampled, was 27.65 quintals; this works out to a total main season production of 4,562,118 quintals for the district as a whole." This is an example of false precision: Given the probable error in the estimation of per hectare yield, it is absurd to report the value to two decimal places. And given the further probable error in estimating total harvested area in the district, simple extrapolation resulting in a figure implying accuracy to the last quintal is equally inappropriate.

Misplaced precision is a somewhat different phenomenon, though the end result may be equally absurd or misleading. Misplaced precision arises when some things are easier to measure, or measure accurately, than others. A property such as community cohesion may be inherently rather vague or loosely defined; instrumentation may be poorly developed, so that readings are accurate only within rather wide tolerances; or measurements may be available only for a sample of units, so that sampling error is automatically introduced. These and

other sources of error will always be present, though their relative importance may be very different in different circumstances.

Laboratory tests to determine calorific value may be highly accurate, certainly as compared with measurements of such social variables as community cohesion. However, if the properties of the thing being measured change substantially in real-world situations--as is the case with moisture content in fuelwood, for example--the precision of a given measurement may be largely irrelevant to the information needs of the research. Similarly, in research that employs information from sources with widely different standards of accuracy, the most precise measurements will in effect be "degraded" in their association with cruder data.

The implications for research on energy and its role in rural development should be obvious. In view of the fact that socioeconomic data are likely to be relatively coarse, there is little point in going to great expense or effort to measure the physical quantities of fuel or energy used with great accuracy. Analysis techniques involving stringent assumptions about statistical distributions, variances, and levels of measurement may also be unnecessary or inappropriate; rankings and rank-order correlations, contingency tables, and other methods which make fewer demands about data type and quality should probably be more widely used.

SUMMARY AND CONCLUSIONS

All available evidence suggests that the "energy problem" will intensify in the years ahead. The search for alternatives to fossil fuels, for means of achieving energy self-sufficiency, for ways of conserving existing reserves of non-renewable fuels and enlarging the stock of renewable ones, and for strategies to improve the lives of people through the provision of additional usable energy, will probably continue to accelerate. For all of this, research will be required.

In the preceding pages we have attempted to identify some of the major elements of methodological design and procedure of relevance to such research. The discussion has been for the most part general and discursive. Prescriptive and proscriptive suggestions have been confined largely to matters of approach and strategy rather than specific technique. Social research methodology is by no means an exact science, though certain of its technical elements are highly developed. In a very real sense, the most critical factors are a clear idea of what the problem is and what realistic possibilities exist for its solution; and good judgment in planning and implementing the work required.

With this in mind, the aim has been to present a simplified but fairly comprehensive overview of the research process, and to highlight some of the major issues on which decisions have to be made. Throughout, we have attempted to emphasize the importance of thinking about energy and rural development and the research problems it poses: What is already known from previous related research? What sources of available data can be exploited? What levels of

detail and precision are really necessary or justified? These and similar questions can only be answered in the particular, but the factors that should influence the answers and the range of available options are rather general.

We have also stressed the organic nature of research. Its major components are intimately interrelated. It is precisely for this reason that "methodology" has been used as a summary term for all these parts. At the same time this usage has hopefully underscored the important fact that methodology exists to facilitate the investigation of problems and the discovery of knowledge. It has no independent value and no other function.

Much of the substance of this monograph can be summarized as five cautionary principles:

1. Specificity: Delimit your problem carefully; don't try to cover everything in a single research project.

2. Cumulativeness: Build whenever possible on the knowledge and effort of others.

3. Consistency: Make it as easy as possible for others to build on your work and to arrive at comparable conclusions.

4. Economy: Give parsimony a high priority, in both scientific and material senses of the term.

5. Timeliness: Remember the user, who probably can't wait a year and a half for results.

CHARLES C. SCHLEGEL, Ph.D., is a Research Fellow at the Resource Systems Institute at the East-West Center. He received his advanced degrees in the Sociology of Development at Cornell University, with emphasis on methods of social research and Southeast Asian studies. He has had field research experience in Malaysia and Indonesia, as well as in the United States. His current interests include the social organization of agriculture, social indicators research, the relationship between energy and rural development, and subnational data systems.

JAMES J. TARRANT, M.A., International Studies, The John Hopkins University 1977. Currently, Summer Intern, Resource Systems Institute, East-West Center. He will begin position of Technical Advisor, Centre for Environmental Studies, Institute of Technology, Bandung, Indonesia, in October 1980. Previously Associate Fellow and other positions, Overseas Development Council, Washington D.C. (1976-1980); Peace Corps Volunteer in Ethiopia (1972-1974). Special interests include interaction of society and the human environment, village and urban energy-related activities, biomass fuels, petroleum issues in non-OPEC developing countries.