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Rural Energy Surveys in the Third World

A Critical Review of Issues and Methods

Michael Howes

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RURAL ENERGY SURVEYS IN THE THIRD WORLD

A Critical Review of Issues and Methods

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FOREWORD

The purpose of this study is to summarize and improve research methods used in rural energy surveys in developing countries. It also provides an annotated bibliography of relevant literature. A number of energy surveys have now been carried out in different rural areas of the Third World. They have improved the understanding of rural energy use and supply but available information is far from providing a coherent and complete picture. Also, when this study was conceived, no authoritative review of the existing literature, with focus on methodological aspects, had ever been undertaken. This publication represents a major contribution to filling this gap in relation to English language literature. An attempt has been made to include surveys undertaken in Asia (except for India) and Africa. Most studies in Latin America are not covered for language reasons. A companion piece on India will be published shortly in this Manuscript Series. It is hoped that the information and analysis presented in this report will be of benefit to future efforts to investigate and understand more fully rural energy situations in developing countries.

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Martin Greeley and Stephen Joseph must also be thanked for their helpful comments on earlier drafts, as must numerous other friends and colleagues from the Institute of Development Studies and the Science Policy Research Unit.

The assistance and patience of my secretary, Joan Gibson, and the help of Marion Huxley and Joan Thomas in typing and re-typing successive drafts of the manuscript, are also most gratefully acknowledged.

All of those mentioned have played an important part in helping to bring this work to fruition, the author alone remains responsible for any limitations and inadequacies. It should be stressed that the ideas which it contains do not necessarily represent the views either of the IDRC or any other organization.

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CHAPTER 1: THE METHODS OF RURAL ENERGY SURVEYS

A large number of rural energy surveys have been completed in the last decade. The primary objective of this book is to review the questions that they have asked, and to evaluate the methods which have been employed in the search for answers. This is largely a matter of determining how energy is consumed in the rural areas of the Third World.

Secondly, it intends to raise a series of additional matters which have generally not been dealt with by the main stream of energy work, to show why it is important that these should also be considered, and to discuss the methods which are available for their investigation. This will involve consideration both of the measurement of energy supply, and of the economic and social contexts within which the use of energy takes place.

The final objective is to ask how these various elements may be examined in relation to each other. This is approached through a discussion of the strategic choices which researchers must make in the allocation of their time and an examination of the various types of research 'package' which may be assembled.

Each of these broad areas will be viewed from a social science perspective, and with the intention of showing what this group of disciplines collectively has to offer by way of a contribution to an improved understanding of rural energy matters. It should, however, be emphasized at the outset that this work is not conceived as being exclusively relevant to social scientists. Recognizing that many of those who must conduct surveys, or promote and interpret them in some policy-making capacity, will have other disciplinary backgrounds, it seeks rather to lay out basic concepts and methods in a manner that will be readily accessible to a wider readership.

Important contributions to the subject are already available from the FAO,[1] the US National Academy of Sciences,[2] the East-West Center,[3] and a number of other sources. These will often be drawn upon quite extensively for detailed treatments of specific points of methodology in particular. The exercise to be undertaken here should therefore be seen as an attempt to complement these earlier works by exploring methods in the specific context proved by the existing body of survey work; and by taking a broader view than is customary of the way in which the various elements of a rural energy survey may be explored in relation to one another.[4]

By way of identification of the various aspects of the study it is to be noted that the consumption of energy is explored in Chapter II; supply in Chapter III; social and economic dimensions in Chapter III; social and economic dimensions in Chapter IV; and the packaging of research in Chapter V. A brief overview of the content and underlying rationale of each of the subject areas form the final part of this introduction. Before turning in more detail to what is intended, a little time will be devoted to the question of how to establish the parameters regarding the subject matter, and some related matters to be excluded from this investigation.

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[1]FAO: Wool Fuel Surveys, Rome 1983.

[2]US National Academy of Sciences. Proceedings: International Workshop on Energy Survey Methodologies for Developing Countries, Energy Survey Methodologies, Jekyll Island, Georgia, 1980. Board Energy Survey Methodologies, Jekyll Island, Georgia, 1980. Board on Science and Technology for International Development Commission on International Relations, National Academy of Sciences, National Research Council, National Academy Press, Washington, D.C., 1980.

[3]ISLAM, M.N. MORSE, R. and Soesatro, M.N. Rural Energy to Meet Development Needs: Asian Village Approaches. Westview Press, 1984. p. 22.

[4]FAO: (op. cit). Provides excellent guidelines on how to investigate particular dimensions of rural situations, but little or no guidance as to how, say, ecological and social considerations might be incorporated within an individual piece of research.

An initial impression of the diversity of problems and approaches which are to be encompassed is essential, in order to establish clearly at the outset the sense in which, and the extent to which, useful generalization will be possible.

THE SCOPE OF THE ENQUIRY

'Rural energy survey' has, in practice, nearly alway meant 'rural fuel survey'; and fuel, in turn, has largely been treated as if it were synonymous with certain types of biomass. Furthermore, surveys have tended by and large not to look either at animate energy, or at the so-called commercial fuels such as kerosene or charcoal that are used mainly in urban areas; and which generally comprise a small proportion of total rural consumption.

There are clearly senses in which such ommissions are undesirable. At present, biomass is used mainly to provide heat for domestic and small-scale industrial purposes, and is, for the best part, quite distinct from animate energy, which is mainly employed as a source of lifting and motive power in the agricultural and transport sector. This distintion is, however, being broken down by new technologies such as gasifiers, which will place differnt types of end use into direct competition with each other for the same energy source; it is already the case that end uses compete in a rather less obvious way with each other for the allocation of land. Similarly, with regard to 'commercial' fuels, it is clearly of significnce to inquire into the implications of possible substitution with biomass use.

While recognizing the validity of thes arguments for a more inclusive concept, the conventional understanding of energy as biomass will be retained here, on the essentially pragmatic grounds that the field to be investigated is a broad one; that it needs to be extended further into areas which relate more closely to the core of existing concerns than either animate or 'commercial' fuels; and that ultimately a line has to be drawn somewhere.

In addition to leaving out certain types of energy, the present work also excludes certain types of rural energy study. Most notably, it has little or nothing to say about either the substantive issues raised, or the methodological problems posed by the significant body of literature addressing itself to possible new energy sources or conversion devices. Such studies undoubtly have an important part to play within the overall context of rural energy policy making, and indeed have often been carried out in combination with the kinds of survey which are

to be discussed here.[5] Nevertheless, they can only properly come into their own in the event that more fundamental quotas about fuel availability and supply have been answered.

No reference will be made to the very substantial body of rural energy survey work which has been carried out in India. This is important enough to warrant independent consideration, and a separate account has therefore been prepared.[6] Leaving out India serves to limit further not only the geographical, but also the substantive scope of what is to be attempted, since this part of the literature is characterized by data collection exercises conducted upon a far more extensive scale than will generally be encountered elsewhere, with one or two important exceptions. The studies conducted by the Ministry of Energy and the Beijer Institute in Kenya,[7] the University of Ife and the United Nations University in Nigeria,[8] however, remain so atypical of the non-Indian work in general that they too are not included here.[9]

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[5]See M. Best. The Scarcity of Domestic Energy: A Study in Three Villages. Working Paper no. 27, Southern Africa Labour and Development Research Unit, Cape Town, South Africa, November, 1979. p. 1.

[6]See A. Desai. Rural Energy Surveys in India, National Council of Applied Economic Research, New Delhi, November 1982, to be published in IDRC Manuscript Series.

[7]Ministry of Energy/Beijer Fuelwood Cycle Study: Energy Development in Kenya, Problems and Opportunities. n.d. Mimeo.

[8]G.J.A. OJO et al, (eds). Rural Energy in South-Western Nigeria: A Preliminary Report (UNU, 1979).

[9]Where individual items from these larger studies serve to illuminate themes explored here, they have been used. See for example, J. Ensminger, Energy Use Among the Galole Orma, 1981. p.3. Mimeo.

Lastly, the exercise is confined to sources available in English. This means that, with a significant number of exceptions, the examples cited have tended to be drawn from countries where English is widely spoken and used; but it is hoped that the conclusions to be derived from this sub-set of the overall literature will be more general in their application.

These various devices have been adopted to narrow the scope of the enquiry, but a considerable diversity of problems remain to be explored. In the first place, the mainstream of rural energy surveys divides into two major sub-sections. On the one hand, there are a series of studies which take as their part point of departure an explicit concern with fuel shortage, its causes, and possible ecological and other consequences. The primary cosideration here is to provide information which will help to throw light on the problem of how to go about ensuring sufficient supplies of fuel to satisfy existing needs, at the same time guarding against the 'mining' of resources in particular, and all of the consequences which might follow from this.[10] On the other hand, there is the body of work prompted by the increase in oil prices in the early 1970s, and the accordant concern to establish a data base on existing patterns of energy use in the rural areas, as a first step towards the more extensive use of the available resources in the future.

An emphasis on one or other of these problems will affect the way in which the researcher goes about choosing the locations in which data is collected. It may well also influence the way in which boundaries are drawn around research locations.

Where shortage is not a problem, it is likely that fuel supply will be organized on a highly localized basis and that investigations can safely be conducted on the assumption that communities are discrete entities. But where shortages do arise, this is very likely to be caused, or at least accompanied, by states of affairs where numbers of rural communities are placed in competition either with urban consumers, or consumers from other rural communities, for fuel. Here a rather different drawing of boundaries, and perhaps also a partly differnet agenda of questions may be appropriate.

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[10]These concerns may be traced back to the seminal ideas of Eric Eckholm. The Other Energy Crisis: Firewood. Worldwatch Paper, Worldwatch Institute, Washington, D.C. 1975. p. 19.

Superimposed upon this first set, are a further series of differences deriving both from ecological diversity and the various stages of development at which particular communities or societies may be found. These will naturally be reflected in varying patterns of supply or consumption, which in turn may lead to varying constraints and possibilities as far as the methods of data collection to be employed are concerned. Finally, surveys will naturally also differ, both with regard to the resources which they have directly at their disposal as well as to the quality of data which is available from other sources.

All of this points to the conclusion that no methodological blueprint can ever be devised which can be applied to all rural energy investigations. In spite of this, however, generalization still remains possible in at least three senses.

In the first place, although the emphasis to be given to specific topics may vary from case to case, and although research locations may be selected according to rather different criteria, the basic checklist of questions from which an enquiry will initially proceed will be quite similar, in most instances. Irrespective of whether one is dealing with a situation of shortage or of relative abundance, it will always be important to distinguish between the various end uses to which energy is put, to explore consumption in relation to the level of fuel off-take which can be sustained by a particular enviroment; and to arrive at least at some preliminary understanding of the institutional factors which are likely to influence the feasibility of alternative forms of intervention.

Also, many of the techniques developed in relation to the needs of one particular piece of research may be quite widely transferable, with only minor modifications, to other situations. This will apply to quite wide ranges of methods for measuring energy consumption or supply under different land utilization regimes; as well as to the investigation of more complicated social phenomena.

Finally, in so far as a range of methods will normally be available for the investigaton of any particular phenomenom, the considerations which researchers will need to take into account in choosing between alternatives, will also be broadly similar from one instance to another. This will also apply to the way in which choices are made between overall research strategies. A strong basis for generalization does therefore exist, although this must inevitably fall short of the point where a researcher can simply be presented with methods and strategies 'off the shelf'.

SUMMARY OF CHAPTER CONTENTS

The first part of the introductory chapter defines the scope of the enquiry, and broadly what it can and cannot be expected to achieve. The final part of this introduction is devoted to a step by step outline of what follows.

The second chapter deals with fuel consumption, a subject which has been at the centre of nearly all rural energy surveys, and an exclusive concern of many. However, in spite of the amount of attention which consumption has received, it is suggested that the way in which it has been approached often reveals serious limitations. There is a tendency to not devote sufficient attention to the identification and differentiation of the types of uses to which fuel is put. This leads to certain problems in the estimation of present levels of use, and to more fundamental difficulties in the prediction of future levels of consumption, given that the requirements of different sectors will be subject to quite distinct determinants. The major section of the chapter attempts to indicate how this limitation can be overcome. The need to take account of the repetitive variations which can arise in fuel consumption through shorter and longer periods of time is also emphasized.

Chapter III turns to the factors affecting the supply of biomass fuels. There is, as was noted earlier, a substantial literature dealing with new ways of supplying and converting renewable energy sources. A substantial body of work is also available on the capacity of existing forest land resources to produce commercially transactable timber for construction and related purposes.[11] Very little, however, has been written about the supply of the fuel materials which are most commonly used in the rural Third World, and a major part of the chapter seeks to redress this imbalance by exploring some of the isolated attempts which have been made to determine fuel supplies. It focuses on methods of assessing productivity under three distinctive types of land use/fuel extraction regimes which are characteristic of the rural Third World, and shows how the maximum level of off-take at which supplies can be sustained in the long run can be calculated.

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[11] FAO: Tropical Forest Resources by Jean Paul Lanly. FAO Forestry Paper no. 30/UN 3216. 1301-78-04 Technical Report 4. p.19.

These procedures are equally relevant to situations where fuel is short, and where there is the potential for increasing consumption above present levels without mining the fuel resource. There is a demonstration further on, in the chapter of how situations of shortage may also be explored through the identification of the symptoms which arise when consumption overtakes supply. Rather, more attention has been devoted to this aspect of the fuel problem than to the assessment of supply itself but this sub-set of the literature is shown to be problematic both in the sense that shortages can arise for reasons quite independent of fuel consumption, and because symptoms are open to serious misinterpretation if not reviewed in a comprehensive manner. The chapter then concludes with an extended case study that provides a good illustration of how a series of symptoms can be studied in interaction with each other.

Chapter IV sets out to explore the broader economic and social contexts within which fuel use and supply take place, which, like supply, have been neglected by the majority of energy surveys. The inadequacy of aggregate or average levels of consumption as a means of identifying fuel needs are pointed out, and a number of different ways of classifying households are investigated in terms of the light they can throw on this particular problem. It is also argued that classification and an understanding of relations between different groups and classes, provides an essential pre-condition for identifying the political interests which will often be critical in determining whether or not it will be possible for specific forms of intervention to achieve their intended effects.

In the second section, a corresponding attempt is made to disaggregate the household, and to show how changes in fuel supply can interact with the existing sexual division of labour to have a particularly adverse effect upon the welfare of women. In very much the same way that the introduction of changes that may mainly prove beneficial to the less well-off members of society may be blocked by more powerful interest groups, it is suggested that the needs of women fail to be addressed as a result of the mechanisms of male control. In both instance, it may be that what appeared originally as an energy problem, amenable to solution by purely technical means, is in fact a more general problem of inequality and of the social structures within which this arises; and that conditions can only be expected to improve if that sturcture itself is transformed. It is argued that such important negative conclusions can help to define more precisely the circumstances under which simple technical and institutional solutions are capable of making a contribution.

The reader's attention is next directed towards the forces transforming rural society, and to the influence which these can exercise, in more or less direct ways, upon the supply of fuel.

Particular emphasis is given to urbanization, and the effect which this can have upon the availability of fuel in surrounding rural areas. The less obvious impact of trade in changing land use patterns, and hence the supply of fuel, as well as in transforming rural social relations, including those governing access to fuel, is also pointed out. This section serves, once again, to emphasize the dangers of conventional approaches which regard energy in isolation from the social contexts within which it is used, and which in so doing, can lead to quite misleading conclusions concerning the appropriate forms of remedial action.

The final chapter approaches the discussion on strategies for rural energy surveys by taking stock of the substantive issues arising earlier in relation to consumption, supply and social context; and by asking how these different aspects of the fuel problem can be integrated within overall research approaches. The resolution of these issues is shown to involve decisions about the type and number of locations within which enquires will be carried out, and the trade-offs which inevitably have to be made in choosing between the substantive and geographical scope of an investigation. The other major element which needs to be taken into account, is the methods which are to be used and a range of possible approaches redescribed and evaluated in relation to the specific types of issues which they might be used to explore.

The discussion proceeds to identify three characteristic forms of research package arising in response to the logistical problems described earlier in the chapter. These are the extensive sample survey (which depends largely on the questionnaire); the single community study (or the type characteristically undertaken by the anthropologist); and the purposely selected, multi-community approach (which combines elements of both of the others, and has proved by far the most popular with those carrying out rural energy surveys to date). The chapter concludes with an elaboration of some important general principles which will need to be borne in mind in the design and execution of any rural energy survey.

There then follows an annotated bibliography which deals, in turn, with a number of examples of energy surveys, with more general works of survey methodology, and with relevant items from the broader rural energy literature.

CHAPTER II: UNDERSTANDING FUEL CONSUMPTION

Rural energy studies have been concerned primarily with determining levels of fuel consumption, and it is therefore appropriate that this form the subject of the first part of the book. The problem of measurement is dealt with directly in the third section of this chapter, following preliminary discussions of the different categories of fuel users and uses, and the factors responsible for variations of consumption through shorter and longer periods of time.

It should be emphasized at the outset that it is crude fuel and not energy consumption which is to be explored. No attempt will be made to indicate how actual biomass fuel weights or volumes can be standardized to allow for variations in moisture contents; no consideration will be given to the relationship between weight or volume and actual calorific values; and no attention will be paid to the efficiency with which energy is actually converted, or to levels of final or useful energy consumption. It is not intended to imply that these relationships are unimportant. They are excluded on the grounds that they raise issues of a largely technical nature which have already been dealt with quite adequately elsewhere.[1] Ideally, the types of field-based enquiry which form the subject of this book should be carried out in concert with more systematic laboratory-based investigations. Whether this is possible or not, it is always important that the dangers of aggregating together measures of materials with varying moisture contents, calorific values and conversion efficiencies should be recognized.

1. USERS AND USES OF FUELS

In all but the simplest societies, a number of different types of fuel-using institutions will arise. Fuel may be consumed by households in the course of producing goods or services for their own consumption, or by small scale industrial enterprises whose output will be sold. Between these two categories there is the likelihood of encountering instances where fuel is used in the course of activities taking place within the household, but where the final consumer will not be a household member. Furthermore, instances may arise of biomass fuel consumption in larger-scale industrial enterprises or in other institutions such as schools, hospitals and prisons.

Energy surveys have frequently failed to recognize the significance of these different categories. Sometimes the existence of entire sectors is overlooked with the result that total

levels of demand cannot be determined, and their influence on the availability of fuel to others cannot be explored. On other occasions, distinct types of consumption are treated as though they were identical, even though they may be subject to quite different determinants and future growth paths. Given these difficulties, the first objective will be to distinguish clearly between different types of consumption, so that the full range of relevant institutions may be taken into account by the next generation of surveys. A second objective will be to differentiate between the specific end uses arising within these broader categories, so that surveys will be able to provide an adequate basis upon which to assess the likely impact of alternative possible forms of intervention; most of which will only respond to a part of the existing range of fuel needs.

a) Domestic energy consumption

The consumption of fuel by households for their own subsistence purposes accounts for the major portion of total rural consumption in nearly all Third World countries, almost irrespective of the level of development which has been attained.[2] The prominence attached to it by most surveys is therefore not surprising, and it is appropriate that we should consider it first.

Assuming, for the time being, that there is no overlap between the consumption of energy in the course of production for subsistence, and for other purposes, the major problem encountered with regard to this particularly category is how to identify the quantities of energy from different sources which are allocated to specific end uses. In addition, there will also be the need to consider the secondary question of how to account for variations in household size and composition in attempting to arrive at standardized consumption figures.

(1) Distinguishing End-uses

The literature reveals a large number of domestic end uses for fuel. (See Figure 2.1.) In addition to attempting to deal individually with each of the categories listed, it may also sometimes be desirable to distinguish between the fuel requirements of different types of cooking operation, particualry where there are marked variations of an ethnic, class or seasonal nature.[3] Other major end uses of energy present little difficulty where a single fuel is employed exclusively for a particular end use. But where a single fuel has more than one end use, or where a particular end use is satisfied by two or more fuels, then most surveys seem unable to proceed very far with the business of disaggregation. Faced with situations of this kind, typical responses have been simply to identify which fuels where employed for which end uses, without establishing the respective quantities involved; or to calculate the percentage of

Figure 2.1: A CHECKLIST OF POSSIBLE DOMESTIC END USES OF FUEL

A. COOKING AND RELATED

1. Domestic food preparation
2. Preparation of tea and beverages
3. Parboiling paddy
4. Drying food for storage
5. Preparing animal foods

B. OTHER REGULAR FORMS OF CONSUMPTION

1. Boiling water for washing
2. Boiling/washing clothes
3. Weaving
4. Drying
5. Fumigation
6. Space heating
7. Lighting: domestic
   : to protect animals from wolves and predators

C. OCCASIONAL FORMS OF CONSUMPTION

1. Food preparation for ceremonial purposes

households using a given energy source in different ways. This is better than not attempting to disaggregate by end use at all, but where breakdowns either cannot or have not been attempted, it is very difficult to think through the consequences of possible interventions with any clarity.

For this reason, it is worth noting one of the rather isolated attmepts which have been made to overcome this problem. This is described by Bialy,[4] who was able to persuade users to take fuel from separate piles for different purposes, so that the amounts allocated to separate end uses within a given period of time could be determined. Such processes, of course, will only be successful where there is a high degree of user collaboration, and where close supervision is possible. These considerations tend to limit the scale on which the method can be applied, but it does appear workable where a small number of principle uses of a particular type of fuel can be identified.

With regard to the problems of disaggregation, these seem to become easier at higher levels of development. Without stating exactly how results were obtained, it is apparent from Chira's work in Thailand that it proved possible here to determine the precise allocation of different end uses.[5] A clue as to how this might have been achieved may be distilled from work carrier out by Bariloche in Argentina, which suggests that at higher levels of household income there is a clear tendency for fuel conversion devices to proliferate, and thus for sources and end uses to become more readily distinguishable from each other.[6]

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[4] J. Bialy. Firewood use in a Sri Lankan village. University of Edinburgh, School of Engineering Science, Occasional Papers on Appropriate Technology, 1979. p.5.

[5] S. Chiratrattananon in M.N. Islam et al (eds.) Rural Energy to Meet Development Needs: Asian Village Approaches. Westview Press, 1984. p. 272.

[6] Instituto De Economia Energetica. A Regional Energy System. The Entre Rios Province Report No. 1. Bariloche Foundation, 1982. p. 173.

(ii) Household Size and Composition

Even where these problems can be satisfactorily resolved, there still remains the question of how allowance is to be made for family size and composition, which must be held constant if estimates of the energy consumption of relatively large populations are to be made on the basis of a small number of actual observations or interviews. This problem recedes to some extent as the number of observations grow, but even here it will still be useful for purposes of future projection to obtain weighted per capita rather than unstandardized household figures.

Most surveys fail to take any account of this factor, but those which do suggest that a number of difficulties have to be resolved. In the first place, there are problems of a semantic kind. The Fleurets report the virtual impossibility of communicating to Tanzanian villagers the distinction between household members resident at any particular point in time, and those absent for shorter or longer periods, since the latter tend to be regarded as present by virtue of the fact that they have not finally left in the sense of marrying and forming households of their own.[7] In a similar fashion, Digernes describes how informants would frequently omit to mention permanent servants in response to questions on household membership, although they would take all their meals as a part of the unit and therefore needed to be considered where per capita food or fuel consumption figures were required.[8]

In addition to the problems of who should be included when attempts are made to determine the normal size of the consumption unit over a period of time, difficulties can also arise in determining who is present or absent on a particular day. These become particularly important when physicial measures of fuel use are recorded for short periods, and then used as a basis for generalization. The Fleurets again mention this as a difficulty which they encountered in Tanzania, and Newcombe in New Guinea reports what appeared to be a total lack of consistency as

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[7] P. and A. Fleuret; Fuelwood Use in a Peasant Community: A Tanzanian Case Study in the Journal of Developing Areas 12 April, 1978. p. 317.

[8] T.H. Digernes; Wood for Fuel - Energy Crisis Implying Desertification. The Case of Bara, The Sudan. Thesis for Comd. Degree, University of Bergen, Norway, 1977. p. 59-60.

regards who might be eating where, on any specific occasion.[9] Where unpredictability is the norm, however, then this will affect the cook as much as the researcher, and the actual amounts of food eaten used may actually remain fairly constant around the requirements of the maximum number likely to be present at any time.[10] A number of writers have also noted that the close association which exists between fuel consumption and household size becomes much less pronounced as the number of persons grows, and the incremental fuel requirement for each additional person becomes smaller.[11] Rather more care, therefore, may be required in establishing the size of smaller households.

Weighting a household according to its age and sex structure can again prove a somewhat complicated matter and many surveys prefer simply to overlook it. As with the question of size, this may be of relatively little consequence where the units sampled are both large in number, and broadly representative of the wider population from which they are drawn. But precision becomes of increasing importance where, as in the majority of surveys, these conditions do not obtain.

There is no ideal way of weighting households according to their composition which can hold good for all societies at all points in time. A number of indices are however available which, although subject to certain limitations, at least give a better picture than that which could be

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[9]K. Newcombe and T. Bayes. Energy in a Simbu Village, Part I only. Report No. 5. Papua New Guinea Ecology Programme, UNESCO/UNEP, Man and the Biosphere, Integrated Ecological Studies of Human Settlements, Lae and its Hinterland, 1981. p. 16. Mimeo.

[10]See S. Siwatibau. Rural Energy in Fiji: a Survey of Domestic Rural Energy Use and Potential. A Report to the Fijian government with assistance from the International Development Centre, IDRC, Ottawa, Canada, 1981. This means that excess food is often prepared which then has to be thrown away. This would not of course be expected to happen where food was in less abundant supply.

[11]See eg. Islam et al. (op. cit.) p. 192.

obtained using only unadjusted figures. Some of the best known include those devised by the League of Nations, FAO/WHO, and Lusk.[12] These are summarized in Figure 2.1 below.

In applying any of these alternative indices, three things must be borne in mind. First of all, they refer to average levels of caloric intake in the form of food, and as such only provide a proxy for fuel consumption which may be more accurate under some circumstances than others. Secondly, they take no account of the economics of scale in fuel consumption discussed above. Finally, like figures relating to family size, they are of no use whatsover, unless it is possible to clearly identify the amount of fuel consumed by a household in the course of producing goods and services for self consumption.

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[12]See Bialy (op. cit). p. 18-22 and A.L. Epstein (ed). The Craft of Social Anthropology. Pergamon Press, 1979. p. 160.

Figure 2.2: COEFFICIENT FOR CALCULATING STANDARDIZED HOUSEHOLD SIZE

1. LUSK'S COEFFICIENT

Household Members	Consumption Unit
Males above 14 years	1.00
Females above 14 years	0.83
Males and Females 10 - 12 years	0.83
Males and Females 6 - 9 years	0.70
Males and Females 1 - 5 years	0.50
Males and Females 0 - 1 years	-

2. LEAGUE OF NATIONS COEFFICIENT

Age (Years)	Coefficient		
	Male	Both sexes	Female
0 - 2		0.2	
2 and 3		0.3	
4 and 5		0.4	
6 and 7		0.5	
10 and 11		0.6	
12 and 13		0.8	
14 - 59	1.0		0.8
60+		0.8	

3. FAO/WHO COEFFICIENT

Age (Years)	Coefficient		
	Male	Both sexes	Female
1		0.4	
1 - 3		0.6	
4 - 6		0.8	
7 - 9		0.9	
10 - 12	1.1		1.0
13 - 15	1.0		0.9
16 - 19	1.0		0.8
20 - 39	1.0		0.8
40 - 49	1.0		0.7
50 - 59	0.9		0.7
60 - 69	0.8		0.6
70+	0.7		0.5

(b) Other Forms of Household Energy Consumption

Apart from the household members who eat together and draw from a common source of fuel, there may be other people who are supplied with food on a more occasional basis. These will include guests whose presence is likely to exercise an influence upon levels of fuel consumption. Given that most households probably entertain, and are entertained by others with approximately the same frequency, this is unlikely to create any difficulties in assessing overall levels of fuel use where informants are asked about their average consumption. Similarly, where data is collected from large numbers of households, the effect of entertaining will almost certainly prove negligible and can safely be disregarded. Much more care in determining the number of persons present, however, as opposed to the number of household persons, will be required where the number of recordings made are very small, and where data relates only to short periods of time.

The situation becomes rather more complicated in cases where hired labour is provided with cooked food as part payment. Hiring labour is likely to be confined to specific times of the year, making the issue of when a survey should be carried out, more important where it occurs. In addition, only a relatively small number of households are likely to be affected, but the effect in those instances is likely to be rather large, making it important that they should neither be over or under-represented in any sample which might be selected for investigaton. This problem is not addressed in any of the surveys which have been reviewed, and it is therefore difficult to form any clear impression of how significant it might be. It seems likely that it will be of very little importance in some societies, but in others this may not be the case. Given this uncertainty, researchers may find it useful to conduct preliminary enquiries as to the extent and frequency of such practices, before arriving at any final decisions regarding survey design.

An additional category, the use of fuel in home industries producing goods for barter or sale, seems likely to be of much more widespread and substantial significance. These industries may involve the production of sweets and snacks, the processing of other types of food such as fish, the preparation of alcohol, the curing of tobacco, the processing of other agricultural materials such as copra, and the firing of clay to make bricks or pottery.

It is difficult to imagine an area of the rural Third World where at least some of these things are not going on. Their general neglect in the literature may be taken to imply that they

are of little or no significance in fuel consumption terms, but such a conclusion would not be borne out by the findings of the relatively small number of researchers who have given the matter some attention. Siwatabau reports from Fiji, for example, that households may be using about 30% of their total fuel consumption for copra drying.[13] Weatherly has found that in one of the more developed villages which he studied in Indonesia, stemwood consumption by home industries is equal to more than half the amount used by households for their subsistence;[14] and in a survey in Upper Volta, Ernst has discovered that on one day out of three, more than half of the households in her survey use more fuel to produce goods for market than for their own requirements.[15]

These examples suggest that where home industries have not been explicitly taken into account, the ommission is potentially quite a serious one. If the fuel used for these purposes is simply overlooked, the likelihood is that aggregate consumption will be substantially underestimated. But what probably happens more frequently, is that this type of consumption simply gets lumped together with the fuel which a household uses to satisfy its own immediate needs. Such a procedure is unsatisfactory on at least four counts.

Firstly, the incidence of such activities will not be spread evenly across a population. Many will be the preserve of specific occupational or income groups, and many will be localized around specific sources of raw material such as fish or clay. In order to get an accurate picture of aggregate consumption it will be important to ensure that different types of house-hold or area are neither over nor under-represented in a survey, and this will scarcely be possible where no distinction is drawn between different types of end uses.

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[13] See Siwatabau (op.cit). p. 32.

[14] W.P. Weatherly. Environmental Assessment of the Rural Electrification I Project in Indonesia, prepared for the US Agency for International Development, Jakarta, Indonesia, 1980. p. 80. Mimeo.

[15] F. Ernst. Fuel Consumption Among Rural Families in Upper Volta, West Africa. Voluntary Paper, Eight World Forestry Congress, Jakarta, 1978. p. 2-3.

Secondly, the determinants of purely domestic and other forms of household fuel consumption will be quite different, and these are likely to prove highly significant to any attempt to assess future levels of demand. If it is assumed that there is no change in the efficiency with which energy is converted, then the size of the domestic requirement largely becomes a function of future levels of population. Additional types of household consumption, on the other hand, will be determined by future access to markets, the level of the demand for the goods produced, and any economies of scale in the production process which may arise where the level of output per home industrial unit grows.

A third reason for distinguishing home industrial from other forms of domestic fuel consumption is that where output is sold, the additional income generated may well make it possible and desirable to purchase fuel. The presence of a home industrial sector may well be associated with the commercialization of biomass fuels, and with the consequences for overall levels of fuel availability which can follow from this.[16] Finally, where fuel is purchased rather than collected, users may become more prepared to contemplate cash expenditures on more efficient conversion devices than would previously have been the case.[17]

It is thus apparent that home industrial fuel consumption warrants independent attention. This may create some practical difficulties,[18] but these should prove no greater than those posed by the need to distinguish between different, purely domestic end uses; and the solutions proposed in relation to these should once again apply here. Alternatively, where such activities

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[16]For a discussion of this issue see Chapter III, part 3.

[17]A. Barnett et al. Rural Energy Needs and the Assessment of Technical Solutions, in - A. Barnett, R.M. Bell and K. Hoffman - Rural Energy and the Third World. A Review of Social Science Research and Technology Policy Problems, Pergamon Press, 1982. p. 6-7.

[18]M.N. Islam. Study of the Problems and Prospects of Biogas Technology as a Mechanism for Rural Development Study in a Pilot Area of Bangladesh (Resources Survey for the Assessment of Alternative Energy Technology) Prepared for the IDRC, Ottawa, Canada, 1980. p. 48.

are confined either to certain households or to certain periods of time, it may be possible to devise other forms of enquiry which will be sufficient to determine the approximate magnitude of present home industrial consumption levels. Households of similar size and composition that produce goods for sale can be compared with those that do not, for example; or the days on which a household of the first type produces goods for sale can be compared with the days when it does not.

(c) Small scale industry

Small scale industry represents a higher stage of development than household industry and may be distinguished from it in a number of ways. Labour is now hired rather than being provided by household members. Fuel and other means of production are all purchased, reflecting a growing division of labour in society, although the types of energy employed still tend to be those locally available and used for domestic purposes. Also, the scale on which production is carried out tends to increase; and it tends to become more continuous and less dependent upon the pattern of other activities. Finally, individual production processes become more distinct from each other, with multiple uses of energy conversion equipment being replaced by single ones. The purchase of fuel and the increased scale of production both mean that it is even more important that attention should be paid to this type of production than was the case with domestic industry. The more continous nature of the production process and the tendency for processes to separate out make it easier to study than its predecessor; but at the same time, also easier to overlook where the initial focus is upon domestic energy consumption.

The types of activity involved are not dissimilar from those of domestic industry, although the range tends to be somewhat wider. Like home industry small-scale industry has only been considered in a small minority of energy surveys, and this makes it difficult to give any comprehensive indication of its significance. However, in the case of Nepal, a relatively underdeveloped country where rural industries have been subjected to detailed investigation, the findings indicate that a very substantial range of activities, and by implication, a substantial volume of energy consumption, can be involved.[19] These are summarized in the chart below.

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[19] D. Donovan. Woodfuel Utilization by Small-scale Industry in Nepal. Progress Report No. 2. March 1980. Kathmandu, Nepal. p. 76-82. Mimeo.

Figure 2.3: CATEGORIES OF SMALL-SCALE WOOD FUEL USING INDUSTRIES IN NEPAL

Food production: bread and cakes; cheese; clarified butter; beaten rice; cooking fats; mustard oil; sugar.

Herbs and spices: cardamom; ginger; tumeric; various medicinal herbs.

Drinks and beverages: alcohol; soft drinks; tea.

Other agricultural processing: tobacco; tanning.

Wood processing: harcoal; matches; paper; timber seasoning.

Metal working: blacksmiths jewellery; other metal crafts.

Services: hotels; restaurants; guest houses.

Others: bricks and tiles; potteries; dyes; lime extraction; soap.

(Source: Donovan p. 76-82).

The failure to consider such activities is important for the same reasons discussed in relation to home industry. They will often be responsible for a considerable amount of energy consumption in themselves, and by altering the way in which fuels such as wood are extracted, may well have a long term impact upon the availability and consumption of fuel for purely domestic purposes, which is quite disproportionate to the actual quantities involved. Furthermore, because production is centralized, and on a relatively large scale, fuel conserving technologies may well be easier to introduce here than in the domestic sector and provide a more effective means for reducing overall levels of consumption.

Sometimes small industries will be omitted from individual surveys because it is felt that they are best studied separately.[20] This is not an unreasonable position to adopt, given that the methods of data collection must inevitably be somewhat different from those used in relation to domestic consumption, and it may be justified in countries where their development is particularly extensive. Nevertheless, it is important not to lose sight of the possible linkages between domestic and industrial fuel consumption.

The methods contemplated for measuring industrial consumption will essentially be the same as those employed for home industry. (See Donovan, already mentioned above for more details). These methods can also be employed in the case of the non-commercial rural establishments such as schools, hospitals, and prisons which tend to appear upon the scene at more advanced stages in the development process. They are only of interest here in so far as they have contributed to growing concentrations of population in urban areas, the greater portion of which frequently continue to rely on biomass fuels for their domestic consumption purposes.

2. VARIATIONS IN FUEL CONSUMPTION THROUGH TIME

Apart from identifying the different kinds of fuel user and end uses, the researcher has to form some impression of how use is likely to vary through time before planning methods of investigation. Such variations are likely to be of particular significance in relation to domestic and home consumption, possibly rather less so in other instances. For the time being, attention will be confined to changes of a cyclical or repetitive nature. These will be considered at three different distinct levels: the short run or day to day; the seasonal; and the annual.

(a) Short run variations

The example cited earlier from Ernst's work in Upper Volta,[21] suggests that day to day variations in fuel consumption can be quite considerable, and although the subject receives

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[20] See Chapter III Part 3, and Chapter IV Part 2 (c).

[21] See Note 15 above.

relatively little attention in the literature, this impression tends to be supported by a small number of other available sources. Perhaps the clearest illustration of the phenomenon is provided by Blaty in his study of a Sri Lankan village, the results of which are presented in Table 2:1 below. Similar variations are reported by Best from Southern Africa,[22] clearly demonstrating the pitfalls of conclusions based upon single measures, and pointing out at the same time the dangers of imprecisely phrased questions about levels of consumption.

Table 2:1: MEASUREMENTS OF FIREWOOD CONSUMPTION FOR COOKING IN A SRI LANKAN VILLAGE

Household	No. of days recorded	Lowest daily consumption	Higest daily consumption	Coefficient of variation
A	5	2.0	6.8	48
B	4	5.1	8.5	18
C	9	6.1	10.5	14
D	6	7.4	14.5	23
E	6	11.9	14.2	8
F	6	7.6	10.6	13

[22] M. Best. The Scarcity of Domestic Energy: A Study in Three Villages. Working Paper no. 27. Southern Africa Labour and Development Research Unit, Cape Town, South Africa, November, 1979. p.7.

The possible reasons for day by day variation in fuel consumption identified in the literature are summarised in Figure 2.4. Given all of these potential sources of variation, it is clearly important that the researcher should make preliminary enquiries in order to ascertian which may or may not be operative under specific circumstances, and then devise monitoring procedures accordingly.

(b) Seasonal variations

Seasonal variations tend to be more adequately dealt with in the literature. They make their effect felt upon fuel consumption in a number of different ways.

There can often be a very marked seasonal dimension to the availability of fuel, particularly where it is crop residues rather than work products that constitute the primary source. In Upper Volta, Ernst detected a very clear pattern where wood was used for fuel for approximately half of the year, and millet stalks for the other half, following the harvest.[23] At the same time, she was able to demonstrate how an earlier survey, conducted during the wood burning period, and incorrectly assume that wood was used throughout the year, had in the process arrived at entirely inaccurate conclusions regarding the implications of fuel use for deforestation.

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[23] Ernst; (op cit).

FIGURE 2.4: POSSIBLE CAUSES OF SHORT RUN VARIATIONS IN DOMESTIC FUEL CONSUMPTION

A. AMOUNT REQUIRED

1. Activities undertaken (see Figure 2.1)

2. Number of guests entertained, and household members being entertained or eating elsewhere.

3. Numbers of hired labourers fed, and household members being fed as hired labourers elsewhere.

B. USER BEHAVIOUR

1. Who is using the fuel (some users are more economical than others)

2. The amount of time the user has at her/his disposal (when time is short fuel consumption may rise)

C. OTHER FACTORS

1. Weather conditions (particularly wind where fires are relatively unsheltered; also temperature)

The seasonal nature of the availability of residues, and the implications of this for other forms of fuel consumption is also brought out very clearly by Islam's work in Bangladesh. In the dry season when rice straw and other residues are in relatively abundant supply, firewood only accounts for about thirty per cent of fuel consumption by weight; whereas in the wet season, when

these residues have generally been used up, firewood supplies approximately eighty per cent of all consumption.[24]

This use of residues as well as a wide variety of different biomass fuels, would appear to be typical of poorer societies where fuel shortages are experienced most acutely, and seems likely to be a particular feature of the fuel consumption patterns of the poorer households who must make do with what leftovers are available from the consumption of others. The seasonal dimension is therefore likely to be particularly pronounced under such circumstances, and of sufficient importance to be taken into account.

Availability of fuel will also be a function of the ease with which it may be gathered and transported. This too varies seasonally in ways that can influence both levels and types of consumption, as well as the suitability of the means by which these variables might be assessed. A number of writers have pointed out that the quantities of fuel collected in the wet season may be relatively small as a result of the difficulty and potential danger of carrying loads over slippery paths.[25]

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[24] Islam; (op cit). p.46 Another factor related to the extent of wood use is the availability of twigs and leaves which appears, for some reason which is not explained, to also be much greater in the dry, than in the wet season.

[25] See Cline-Cole. Firewood in a Rural Settlement in Sierra Leone (A Crisis of Policy Issues?) in L'Energies dans les communautés rurales des pays du Tiers Monde. Colloque International de l'Université des Nations Unies. Travaux et documents de géographie tropicale No. 43, Centre d'Etudes de Géographie Tropicale, Centre National de la Recherche Scientifique, Unversité des Nations Unies, 1981, p. 68, and Fleuret (op cit) p. 9. This may result either in fewer trips being made, and/or a reduction in the average size of bundles carried.

There may also be a tendency for less fuel to be gathered during the rains because this will generally be the time when most work has to be carried out in the fields. Alternatively, people may opt for inferior fuels, which can be obtained more easily.[26] Yet again, where fuel is purchased rather than collected for self consumption, there is likely to be an increase in price owing to the greater availability of employment opportunities, and the accordant increase in wages which fuel gatherers might command if they were engaged in these other activities.[27]

Much will depend here upon whether the type or types of fuel used store well. Best, for example, points out that the brushwood commonly used in Southern Africa can only be kept for relatively short periods before deteriorating.[28] This presumably means either that collection has to continue at normal levels under unfavourable circumstances, or that consumption has to be reduced. The availability of storage facilities may also be an important factor, since where these can be used, and where fuels do preserve well, regular patterns of consumption can be maintained throughout the year on the strength of stockpiling during periods when conditions are favourable for collection. Where such facilities do not exist, it may be, on occasion, necessary to use wood that is damp and this feature must be taken into account in calculating consumption.

In addition to variations related to the availability of fuel, consumption will also vary seasonally according to need. The effect will be most pronounced where winter temperatures are low and energy is required for space heating. In the mountain locations in Southern Africa for example, Best found that winter consumption ranged from just under to just over half its summer levels as a result of this factor.[29]

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[26]S.L. Skar. Fuel Availability, Nutrition and Women's Work in High Land Peru: Three Case Studies from Constrasting Andean Communities. Employment Policy Research Programme, World Employment Programme Research Working Paper (WEP 10/WP 23) Geneva: International Labour Organization, 1982. p. 51.

[27]Digernes (op cit) p. 73

[28]Best (op. cit.) p. 24

[29]Best (op cit). p. 86-88.

Needs can also vary seasonally in a number of other ways. Fuel may be used to heat water in the winter when in the summer it can simply be placed in the sun.[30] Foods requiring little or no cooking may be consumed at certain times of the year but not at others;[31] and festivals associated with high levels of food and energy consumption may be concentrated within a certain period of time.[32] Fuel-using home or small-scale industries may be subject to marked seasonal peaks and troughs of activity in response to periods of heavy labour demand in agriculture;[33] and variations may also arise according to the availability of the agricultural raw materials to be processed.

(c) **Annual variations**

This discussion of the ways in which fuel consumption can vary through time, must also include the longer term, year by year changes which arise largely as a result of fluctuations in climatic conditions within normal limits. It is difficult to determine from the rural energy survey literature, which rarely covers more than a single year, quite how significant such variations might be; nevertheless, the implicit assumption always seems to be made that the year during which data was collected was in some sense 'average' or 'representive'.

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[30] Cline-Cole (op cit). p. 58

[31] e.g. the Galole Orma in Kenya survived in one season from the milk produced by their animals which does not need to be heated; but at other times cook millet.

[32] Cline-Cole (op cit). p. 68.

[33] Donovan (op cit). p. 47-9.

FIGURE 2.5 POSSIBLE CAUSES OF SEASONAL AND ANNUAL VARIATIONS IN DOMESTIC FUEL CONSUMPTION

I. SEASONAL

A. Amount required

1. Fuel consuming activities undertaken

2. Number, and distribution through time, of ceremonies

3. Diet

4. Temperature and need for surface heating

B. Availability

1. Time when crops with residue which are used as fuel are harvested

2. Weather (particularly rain) and ease with which fuel can be gathered and

3. Agriculture and other activities, and time available to collect and conserve fuel

4. Problems with storing fuel (storability and access to storage facilities)

II. ANNUAL

1. Weather (influencing year of crops providing residue for fuel)

2. Market prices (influencing area put down to fuel providing crops)

Two exceptions to this general rule have been found, but neither proves particularly helpful. Nkonoki actually collected data over a period of two years, but then presented all of his results in an aggregated way making it impossible to determine what difference, if any, might have been apparent between the two periods.[34] Alla-el-Din, on the other hand, presented figures estimating the quantities of residue produced per standard unit of land over a period of several years, but in the absence of any clear indication of how these were arrived at, they are not particularly revealing.[35]

Where crop residues are used

It would seem likely that substantial year by year fluctuations should arise, and these should be roughly in proportion to variations in crop yields themselves. In addition to fluctuations in the production of residues of a given kind from a given unit of land, differences in availability could arise through changes in the total amount of land put down to each crop. These would most likely be experienced where a transition towards agricultural production for the market was underway, and as farmers came to respond increasingly to price signals in deciding how to allocate their land between different uses.

As far as fuelwood is concerned, it seems likely that some cyclical variations may also occur, but no reference to these has been found in the literature reviewed. Clearly, this is an area where further invetigation might be useful.

3. APPROCHES TO THE ASSESSMENT OF FUEL CONSUMPTION

Earlier sections have shown that it is important, when exploring rural fuel consumption, to distinguish between various types of user and end use, and to allow for cyclical variations taking place in consumption over shorter and longer periods of time. Having looked at these factors individually, an investigation of their joint implications for the way in which an overall assessment of energy consumption might be carried out seems appropriate.

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[34] S. Nkonoki. the Poor Man's Energy Crisis. A Report of the Tanzanian Rural Energy Consumption Survey, Dar-es-Salaam, 1983. pp. 10, 11 and 48.

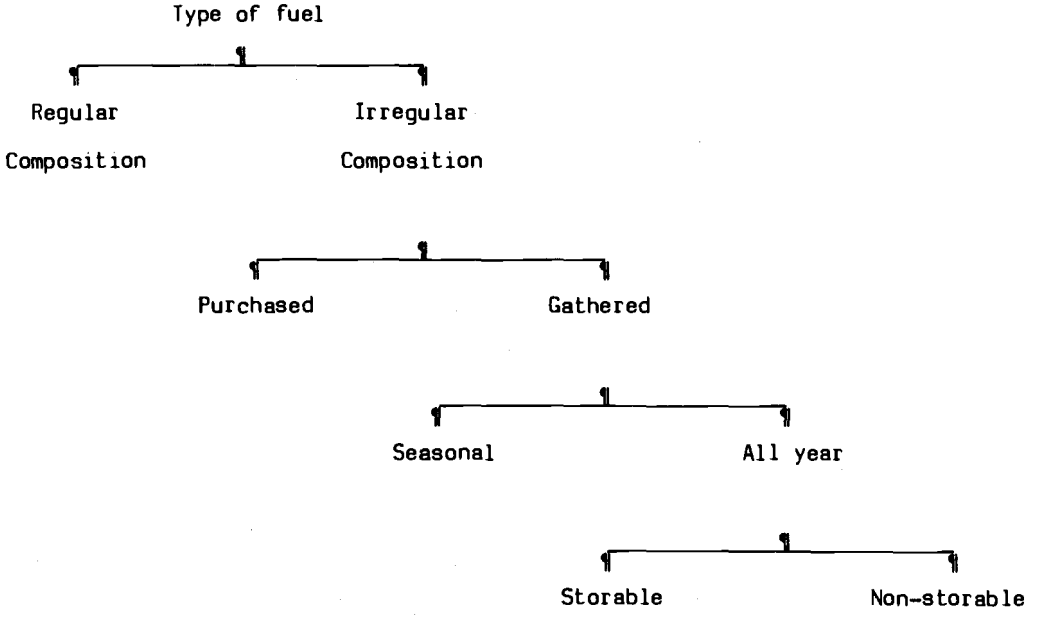
[35] M.N. Alla-El-Din. Rural Energy in Egypt: A Survey of Domestic Needs and Resources, 1982. Table 6. Mimeo.

A range of different methods will be reviewed, and it is important to re-emphasize at the outset that none is inherently superior to any other. Appropriateness will nearly always be a function of the precise nature of the situation to be investigated as well as the resources which are available for carrying out a particular piece of research.

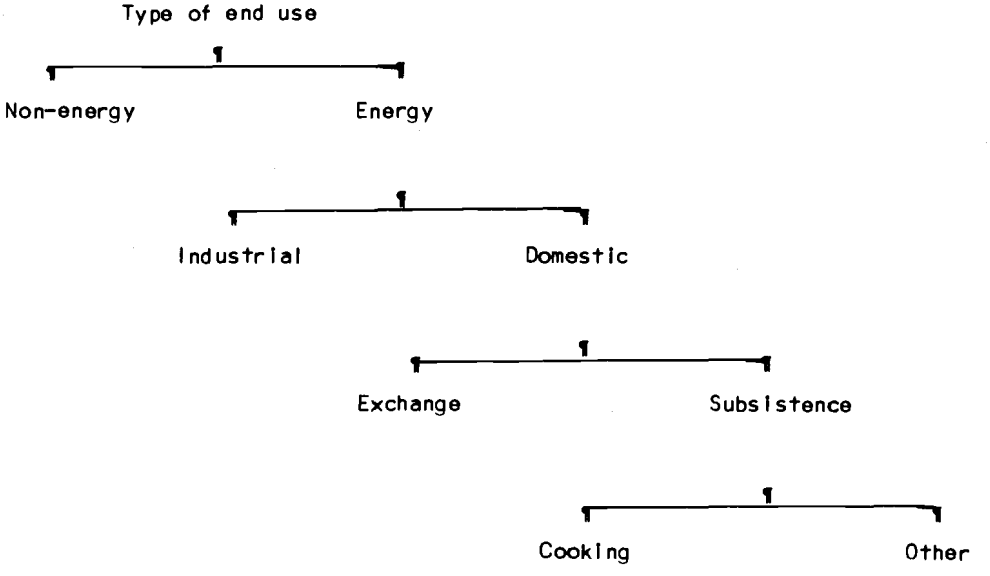
The discussion of alternative approaches starts with a review of the respective methods of 'user recall' and 'physical measurement' as a means of determining levels of energy consumption, and proceed from there to look in more detail at the ranges of possibilities incorporated by the latter. The next step is to weigh the pros and cons of investigations conducted on single days with those extending over longer, continuous periods; of single and repeat visits to individual locations within a single year; and of single and multiple year studies. But before a potential researcher can begin to review these questions, it will first of all be necessary to establish an outline of the types of fuel which are used, the kinds of end use to which these are put, and the way in which the relationship between fuels and uses unfolds through time.

(a) Fuels, uses, and the unfolding of their relationship through time

A list of the individual fuels used within the research area should first of all be compiled, and each fuel should then be located within the two typologies outlined below (the full significance of which will only become apparent when alternative methods are considered):



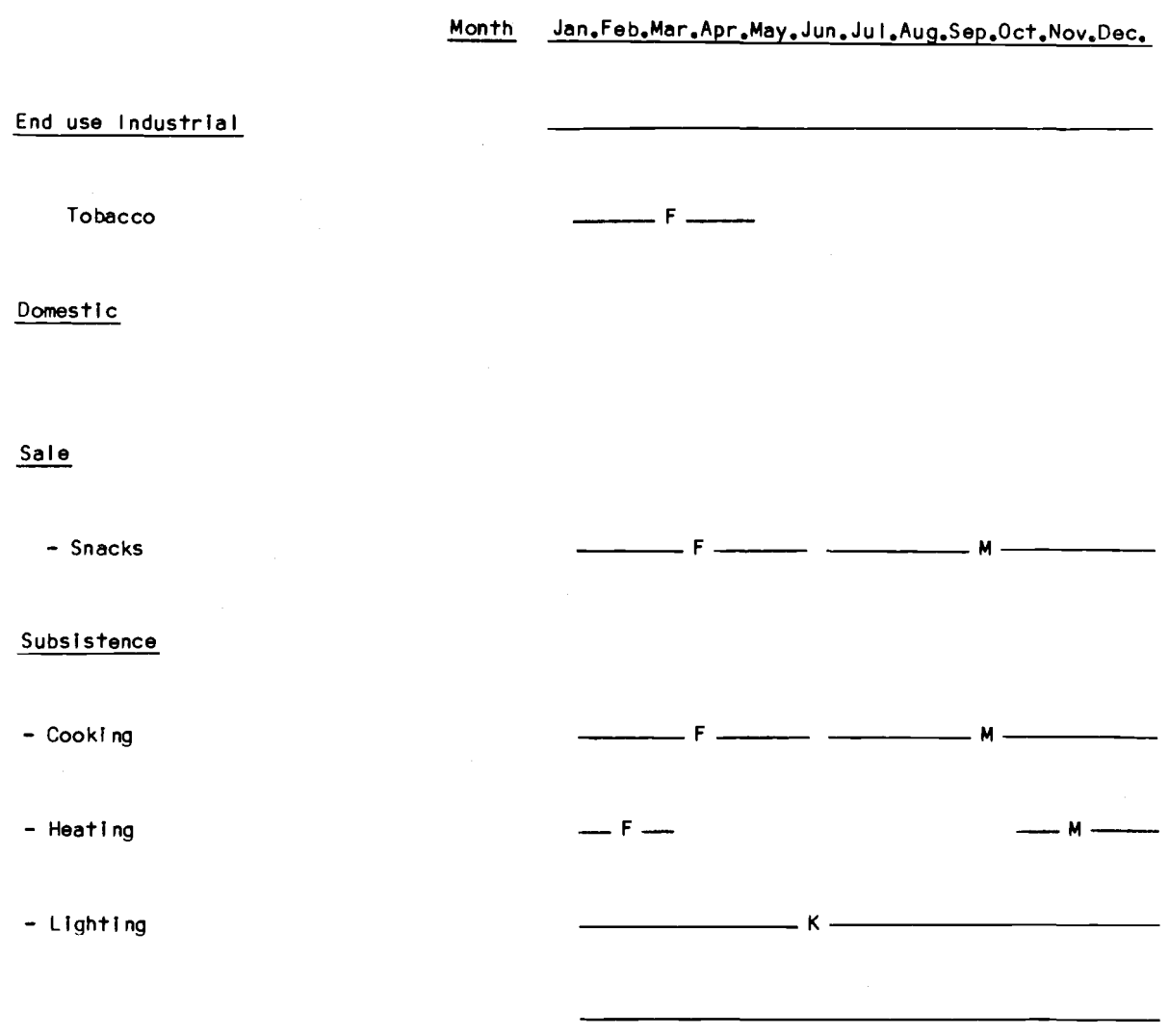
'Regular composition' refers to fuels of uniform quality such as petroleum or kerosene, where quality varies little, if at all. 'Irregular composition' is taken to mean fuels such as wood where volume is very difficult to determine accurately, and where volume to weight and volume to energy content ratios are not constant. All fuels of the former category will tend to be purchased, whereas those of the latter may be either purchased or gathered. Gathered fuels may be available only seasonally (such as various types of crop residue) or throughout the year (tree products); the latter subdivided into those which are storable (such as logs) and those which deteriorate after only short periods of time (such as brushwood).



Non-energy end uses of energy materials might include dung for fertilizer or straw for fodder. Energy uses subdivide into small scale industrial and domestic uses. The latter then subdivide further into consumption of energy for exchange as in home industry, and consumption for susbistence which may be in turn broken down into cooking and other uses which tend to occur on a less regular basis.

Having established the types of fuel available, and the end uses to which they may be put, the two aspects may then be brought together in the manner illustrated hypothetically in Figure 2.3 below, showing end uses satisfied by different fuels at different times of the year.

FIGURE 2.6 POSSIBLE SEASONAL DISTRIBUTION OF FUEL USING ACTIVITIES AND FUELS USED



Key: Firewood; Millet sticks; Kerosene

This chart is a demonstration of what might happen at the preliminary stage of organizing a survey, where it would be necessary to rely upon the limited secondary sources of data available, and the results of a small number of preliminary interviews using memory recall to establish, in very broad terms, which fuels and uses were of greater and lesser importance. Under these

circumstances, a chart of the type presented here might aim either to include all of the relevant categories elicited, or merely those which seem likely to be of particular significance (an early decision having been taken to eliminate others for simplicity's sake). At this stage, the researcher would be in a position to make informed decisions about which of the possible methods available should be used.

b) Methods of assessment

(i) The choice between recall and physical measures of consumption: broad considerations

The major advantage memory recall holds over physical measurement as a means of collecting data on consumption, lies in the fact that each item of data takes much less time to collect. More interviews can therefore be carried out, or more information obtained from each informant within a given amount of time. Situations may arise where it may be particularly important to contact a large number of people, because it is expected that there are considerable and significant variations in the fuel consumption habits of a population under investigation. These may arise within communities, between rich and poor, or between members of different ethnic groups with different food habits and consumption preferences. Similarly, there may be occasions when it may be important to distinguish between communities of different kinds; those at high altitude where fuel is required for space heating and those where it is not; those where a particular fuel consuming production system (e.g. tobacco curing) exists and those where it does not; those which are close or well connected by communication networks to urban centres and therefore more likely to engage in production for exchange, and those that are not; and so forth. In these instances, the recall methods may be justified on the grounds that they enable the larger number of observations required to be made in the time available.

The obvious drawback to information obtained in this way is that it is almost certain to be less accurate than where physical measures of consumption are made.[36] The extent to which recall accuracy falls short can vary considerbly from one set of circumstances to another, and this should be considered before any final decision is made.

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[36] 'Almost' because the evidence available from cross-checks is only suggestive of such differences, and cannot yet be regarded as providing conclusive proof. (See the discussion in the final section of this chapter).

The circumstances most suited to the use of the recall method are outlined in figure 2.7. To the extent that the situation under investigation does not correspond to these conditions, there is a strong case for employing at least some physical measurement.

FIGURE 2.7 CIRCUMSTANCES FAVOURABLE TO THE USE OF RECALL METHODS FOR DETERMINIG FUEL CONSUMPTION

1. Fuel regular in composition
2. Fuel measured in standard understood by all users
3. Fuel is purchased
4. Consumption levels vary little through time
5. Types of fuel used vary little through time
6. Storage is possible

(ii) Alternative forms of physical measurement

The most common form of physical measurement involves the recording of fuel taken from stores for specific end uses, or during short periods of time. This may be done in terms of volume or weight, although the latter is generally regarded as superior. There are, in addition, alternative approaches to measurement which have not yet been discussed. Illustrations of three approaches described in the literature are summarized in Figure 2.4 below, together with brief comments on their strengths and weaknesses.

None of the alternatives is without its disadvantages and which at best in practice will depend in large measure upon the degree to which users understand or sympathize with the objectives of the research, and are prepared to offer their cooperation.

In addition to these direct methods of measuring fuel consumption, certain researchers have also attempted to assess it less directly through measurement of the quantity of fuels collected

FIGURE 2.8

ALTERNATIVE APPROACHES TO THE PHYSICAL MEASUREMENT OF FUEL CONSUMPTION UNDER FIELD CONDITIONS

Author	Approach adopted	Comment
Fleuret	Household members asked to lay out wood for measurement, equivalent to that used in the previous day for the morning and afternoon/evening fires.	Quick and simple, but relying upon memory which may be far from perfect (although probably superior to purely verbal recall).
Ernst	A bundle of fuel was set aside each day and weighed. Household members instructed to only use fuel from that source. Bundle reweighed at end of each day to determine consumption.	More time consuming and potentially more accurate, although danger that other fuel will be used, or that others will use fuel from selected household's bundle.
Best	Households requested to lay out fuel equivalent to approximately three days use. Remainder weighed at end three days, or meal at which fuel finished recorded in event of this taking less than three days.	Possible to cover a greater number of households than Ernst, but with a greater risk of things going wrong.

or added to stores.[38] Where firewood is involved, this will entail either weighing or determining the volume of bundles or loads as they are carried from places where they have been gathered to the places where they will be used, in order to arrive at an average. This can then be multiplied by the number of trips made within a given period of time to arrive at a total consumption figure.

This approach tends to take rather less time than the more direct measurements of consumption but there are also a number of disadvantages associated with it. To begin with, there is a high risk that at least some of the fuel collected will not actually be used by the household in question or for the purposes of which the researcher is aware. Furthermore, there are likely to be quite substantial variations in bundle size according to who is collecting fuel, from where and at what time of year which means that a large number of measurements may be required to obtain a reasonably accurate average. Finally, the researcher has little alternative other than to rely upon user recall as a means of determining the number of bundles transported within a particular period of time; and this may be unreliable where collection does not follow any regular pattern but varies according to seasonal and other factors.

This problem will not arise to the same extent where people are poor, lack storage facilities, and are therefore obliged to collect regularly. Neither will it present serious difficulties where the fuel used is of a type which cannot be stored for extended periods. This method, however, has its limitations and can really only be recommended where it can be used in conjunction with other means of measurement, against which the results obtained can be checked.

The situation is rather different where crop residues are used as fuel. Unlike wood, which will tend to be 'harvested' in relatively small quantities on a recurring basis throughtout most of the year, these will generally be added to stores in large quantities within very short periods, probably two or three times during the annual cycle. This makes it relatively easy to assess the total amount entering fuel stores. The area devoted to the crop or crops in question can generally be ascertained, and crop cutting experiments then used to determine approximate yields. Alternatively, it may be possible to establish the ration between the weight of the residue and the weight of the main crop obtained, calculating the former on the basis of the latter where this has been established by some independent means.

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[38] e.g. Nkonoki (op cit). p. 50-51.

Calculations of consumption levels can then be made by establishing the period of time over which a residue is used as fuel and by making allowance for any non-fuel end uses. Once again, it has to recognized that there is considerable scope for inaccuracies to creep in, and that it would probably not be advisable to use such methods in isolation.

(iii) The deployment of research resources through time

The general discussion of the advantages and disadvantages of using recall and physical measurement methods and of the various forms which the latter might take, now needs to be extended to account for the decisions which researchers must make with regard to the way in which the resources at their disposal are allocated through time. Specific choices have to be made between making measurements of consumption on single days or in continuous blocks; between enquiries conducted on a 'once-off' basis and those which are repeated on one or more additional occasions during the course of the year; and between single and multiple year investigations.

We saw earlier how very substantial day to day variations can arise in domestic levels of fuel consumption. Wherever this is the case, it is clearly advisable that recordings should be repeated over a series of several days, so that an impression of the range of consumption levels can be established and the reasons for them ascertained. Sometimes, however, even where it is recognized that large variations are likely to arise, there may simply not be time for repeat measurements to be made. Under these circumstances, it is clearly not adequate to merely assume that recordings taken on a particular day will be average or representative. It is desirable that the researcher should at least ask whether the amounts used on different days and for different activities would be greater or smaller, and by how much. Alternatively, having first determined the amount used on a particular day or for a particular purpose, a researcher could weigh a similar amount, and then ask the user to indicate, by adding or substracting fuel from the pile, how much might be used on other occasions or for other uses.

Turning to longer term seasonal changes, a rather different set of problems arise, although the types of choices to be made remain broadly the same. Where there are significant variations, a strong case will exist for one or more repeat visits to an area to be made, and for physical measurements to be repeated. Where it is not possible, the remaining alternatives to explore

might include electing a time of year where conditions seem likely to be close to the average,[39] or at the very least, making sure that differences are investigated. Where resources for research are limited, for example, it makes good sense to ask how much wood is used per week, and then to follow this up with a question about periodic variations, but little or no sense to ask the first of the two questions, or something similar to it, in isolation from the second.[40]

It goes without saying that if it is difficult to find the resources to carry out repeat measurements of consumption within a particular year, it will clearly be even more difficult to carry out a proper longitudinal study spanning a number of years. While each study might have much to commend them, it therefore has to be accepted that they will rarely prove possible to carry out in practice. Researchers, however, should take into account the fact that such variations are highly likely to arise, and should seek to determine by means of user recall, how significant these might be. Other sets of time series data might be available such as per hectare crop yields for a district, and these could be used as a proxy indicator for residue supply.[41] Where time series data are difficult to obtain some impression of change may be obtained by selecting communities which are already experiencing fuel scarcity and/or are located close to urban centres, and comparing them with others where these conditions do not yet obtain.

(iv) The use of cross-checks

In any discussion of the respective merits of different methods of assessment under different circumstances, it should be remembered that however judiciously methods are chosen, there will nearly always be very substantial scope for error. For this reason, building cross

[39]The Fleurets, (op cit), for example working in a community with marked seasonal variations in temperature and hence in fuel use for heating, got around the problem by selecting a month where temperatures were close to the annual average.

[40]Digernes (op cit). p. 15.

[41]Apart from allowing the researcher to assess the range within which fuel consumption behaviour might vary as a result of variations in climate and biomass productivity, they also provide the opportunity to observe trends in consumption which could help to clarify whether shortages were arising and whom they were affecting.

checks into the process of data collection which will help to establish the degrees of confidence with which particular results can be regarded as a step in the right direction. Such checks are few and far between in the existing literature but those that are described provide a useful indication of what might be attempted.

The first illustration is drawn from Best, who compared the results of physical measurements of fuel consumption with those obtained through the informant's memory recall.[42] He found that there are substantial differences between the two, and that estimates always tended to be higher than actual measurements. No reason is given for this discrepancy, and the physical measures may have yielded an atypically low figure as a result of the people taking part in the experiment being more careful than usual in their use of fuel. Nevertheless, it is not difficult to see how the observed differences can be explored further, in relation to particular fuels and particular types of users as a basis for making more informed decisions about the choice of methods for further, and probably more extensive enquiries in the area in question.

The second example is provided by Bajracharya, who compared the consumption figures obtained by annual recall from a small sub-sample of his oveall survey, with recall figures collected weekly throughout the course of a year.[43] The sum of the latter generally exceeded the former, but the difference on average was only eleven per cent, suggesting that long term recall would be a reasonably satisfactory means of obtaining aggregate consumption data in the area in question.

The third and final illustration is provided by the Fleurets, who compared physical measures of consumption with similar measures of fuel collected and added to stores within a particular period of time; confirming in the process that their findings were reasonably accurate.[44]

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[42]Best (op. cit.), pp. 7 and 76.

[43]D. Bajracharya. Implications of Fuel and Food Needs for Deforestation. An Energy Study in a Hill Village Panchayat of Eastern Nepal. D. Phil. thesis, History and Social studies of Science, University of Sussex, 1981.

[44]Fleuret (op cit) p. 320.

It is not difficult to think of other possible checks, and a number indeed have already been mentioned in the course of the earlier discussion. They represent a sensible safety precaution and a useful decision-making device in a field of enquiry where methods are as yet not very well developed, and where considerable practical difficulties in obtaining accurate data will always exist.

The discussion so far has been primarily concerned with the way in which research resources should be allocated among different ways of measuring fuel consumption. Ultimately, however, this set of decisions will rest upon a wider set, concerning the distribution of time between the range of fuel related issues, which are to be considered in the chapters which follow. It is these which will dictate whether more or less substantial periods should be devoted to questions specifically concerned with consumption, and this naturally will also exert an influence upon the way in which these enquiries should be carried out.

CHAPTER III: ASSESSING THE SUPPLY OF FUEL

Fuel surveys may be carried out for a variety of reasons, but it is unlikely that they can serve any useful purpose if attention is confined only to levels of consumption. Of equal and complimentary importance will be the capacity of land devoted to the production of biomass resources to supply fuel. This is a subject which has largely been neglected in rural energy surveys, and which has been by-passed in the more general literature on biomass resources, where attention has largely been confined to the supply of marketable timber.

The first major part of this chapter explores how supply can be measured under three distinctive types of land use pattern commonly found in the rural Third World. This in turn leads to a discussion of the symptoms which may arise where consumption exceeds the level of permanently sustainable supply, and of how these may be interpreted. A brief concluding statement provides the opportunity to take stock of some of the more general methodological issues that arise.

1. BIOMASS PODUCTIVITY UNDER DIFFERENT SYSTEMS OF FUEL EXTRACTION

Biomass fuels may be obtained in a variety of ways according to the land use patterns characteristic of particular societies. Three basic types of situation will be considered here: shifting cultivation where fuel becomes available during the course of periodic land clearance; extraction on a continuing basis from forest of other types of land which are not for agricultural purposes; and the use of residues derived from land primarily devoted to agriculture.

These do not exhaust all of the possibilities which may exist at different places at different points of time. But they do cover a range of experience wide enough to raise most of the problems of measurement arising in the course of attempts to assess biological productivity, and the capacity of environments to support different levels of fuel requirement.

It should also be pointed out that the approach to be adopted departs from reality in implying that actual societies will normally be associated with only one of these alternative land use and fuel extraction systems. Reality is likely to prove more complex, with systems overlapping or being combined in particular instances; but it is for individual researchers to determine the relative importance of the elements with which they are confronted, and to devise their strategies accordingly.

Irrespective of which type of land use system is to be investigated, a number of common steps will have to be taken in order to determine the level of fuel supply available to different communities. These are summarised in figure 3.1. The methods to be used will, however, vary to some extent from one system from another.

(a) Shifting cultivation

Systems of shifting cultivation are common throughout large areas of Africa, and may also be found to a lesser extent in Asia and Latin America. A typical example is provided by

Adejuwon's work in the rain forest belt of Nigeria.[1] Farm plots here are typically half an acre or less in size, and are cropped for a period of one or two years; then left to lie fallow for a further period which is normally between five and ten years in duration, but which can sometimes extend for as long as fifteen years. Fuelwood is extracted as a by-product of this system. When a plot falls due for cultivation, the farmer first clears the ground of unwanted elements such as herbs and shrubs, and then cuts down and removes trees which will be used as fuel, before fire is applied once or twice to clear the ground.

The way in which the fuel productivity of such a system may be determined, may now be explored, following the basic steps outlined in figure 3.1.

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[1] In Centre d'Etudes L'Energie dans les Communautes Rurales des pays du Tiers Monde, p. 371-184.

Figure 3.1 **ANALYTICAL STEPS FOR THE CALCULATION OF FUEL SUPPLY UNDER DIFFERENT SYSTEMS OF LAND USE**

1. Determine size of area from which fuel may be extracted.

2. Selected sample lots of land to be used in investigation of fuel productivity.

3. Identify species and parts of trees/plants at present used and potentially useable as fuel

4. Determine annual amount of fuel material produced on sample plots and convert to give increment for the total area available for fuel extraction.

5. Identify and measure non-fuel sources of demand for fuel measures (e.g. dung, fencing) and determine net fuel availability.

6. Compare net availability with fuel use to assess whether, or under what circumstances, the supply of fuel can be sustained on a long-term basis.

(i) Determining the size of the area from which fuel may be extracted

Conventionally, energy surveys have tended to focus on villages as one of the basic levels of analysis, and this is perfectly acceptable where fuel is obtained from privately or communally owned agricultural and forest land. Such an approach, however, will almost inevitably prove unsatisfactory where fuel is extracted from forest or other land to which members of many communities have access; and under these circumstances, it will probably be better if the forest as well as the communities using it become the object of investigation.

As such, the first step in conducting an analysis of a shifting cultivation system must be to establish realistic systems boundaries.

(ii) Selecting sample plots of land

Selecting the pieces of land to be taken for investigation is a relatively complicated process with shifting cultivation, since it is not just a random sample which is required, but ideally, a random sample of plots which are about to be cleared; which can only be identified through careful consultation with local people.

(iii) Identifying types and parts of trees used and useable as fuel

The importance of the third step - the determination of the species and parts of trees used as fuel - will already be apparent from Chapter II. Once again the information might be obtained through questioning people, but direct observation of practices would be better, and the enlisting of assistants who were themselves users of fuel, better still. In instances where not all combustible materials are conventionally used, it will be helpful to make separate measurements of this quantity also. This would make it possible to determine potential fuel availability, in the light of future demands rising to levels in excess of the regenerative capacity of currently preferred fuel types.

(iv) Determining the annual increment of fuel materials produced on sample plots, and converting to give the total for the whole area from which fuel is collected

This step breaks down into three distinct operations, viz.:

- determining the average quantity of fuel materials available on land to be cleared;
- converting the quantity to an average annual increment for all land;
- converting the sample increment to the increment for the entire area from which fuel is extracted.

The third is a simple mathematical calculation, whilst the first and second require more detailed exploration.

Determining the quantity of fuel materials available on a piece of land is a relatively simple process where direct measurements of weight can be made in the course of the land being cleared. The only complication here arises with the conversion of crude into dry weight, and dry weight to calories, and references dealing with these problems have already been mentioned in Chapter II.[2]

Very often, however, measurement of this kind will not be possible, and even where they can be carried out, considerations of time will inevitably rule out their extensive use. At the very least, therefore, direct measurement by weighing will only be useable as a cross-check on the reliability of other, less time-consuming, alternatives.

These alternatives take the form of various proxy measures used in sequence; none of which appear very satisfactory, and most of which point clearly to the need for basic research which would establish more reliable indicators for future use. The sequence involves: calculating the

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[2] See Chapter II, footnote [1].

timber volume of a tree; converting that figure into fuel volume;[3] summing the volume of all trees of a single species; converting volume to weight by using a density factor which will vary from one species to another,[4] and then summing the weights of the individual species. The calculation can be expressed:

$$W = \sum_{i=1}^{i=1} d \left(\sum_{i=n}^{i=1} 1.4 \times h \right)$$

Where W = weight of fuel wood on a selected piece of land

h = height to a 10 cm diameter of a particular tree

x = diameter at breast height of a particular tree

1.4 = factor for converting timber volume to fuelwood volume

d = density (i.e. weight/unit volume) of an individual species of tree

Having determined the stock of fuel on land about to be cleared, the next step is to convert this into a flow or annual increment figure. This can be done using the formula:

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[3]Bajracharya Implications of Fuel and Fuel Needs for Deforestation. An Energy Study in a Hill Village Panchayat of Eastern Nepal page 342 gives a breakdown indicating the difference between timber and total above ground biomass volume of trees as follows:

Category	Volume as % Timber volume
Small trees	18
Branches and tops of other trees	20
Dead wood	3
	41

This figure has been used in the calculations which follow but further research to determine its accuracy, and the extent to which it holds good elsewhere, would be desirable.

[4]Figure giving an average density of common species should be available in most countries.

$$I = w \times y$$

Where I = annual average increment of fuels by weight per unit of land

w = weight of fuelwood on land to be cleared

y = percentage of land cleared each year

"y" is the reciprocal of the length of the rotational cycle, expressed as a percentage, and the operation presents little difficulty where this can be expressed with accuracy. Very often, however, this will not be the case, and a somewhat more complicated procedure will have to be resorted to where:

$$y = p/t$$

Where p = percentage of total land area under cultivation at a particular point in time

c = average length of time for which an individual plot is to be cultivated (in years)

It should be possible to determine "t" with reasonable accuracy through questioning local people; whilst "p" can be assesed either through the use of aerial photographs, or by direct observation on the ground. The final step in this part of the calculation involves converting the figures arrived at on the basis of investigation of a sample of pieces of land, to the total increment for the area in question.

(v) Identifying competing demands for fuel materials and determining net fuel availability

This item might also have appeared in the chapter on fuel demand, and could be investigated using methods already discussed here. In asessing non-fuel uses of fuel materials, it is important to distinguish between cases where use of fuel is merely postponed (as it sometimes arises where wood is used first for fencing) and those where it is precluded, and then only to incorporate the latter in any calculation of net fuel availability. This may be expressed as follows:

$$A = m \Big/ {}_{t}^{p} \left[\sum_{i=n}^{i=1} d \left(\sum_{i=n}^{i=1} 1.4 \times .h \right) \right] - s$$

Where m = total area - sample area

s = total non-fuel consumption of fuel materials

(vi) **Sustainability of supply**

The final step is to compare the availability of fuel in an area with the consumption requirements of the inhabitants, in order to determine whether, or under what circumstances, supply can be sustained. The outcome of such a comparison may demonstrate either that availability exceeds, or is exceeded by, present levels of consumption.

In the former instance, it will be possible to relate present consumption to the level which could be sustained given current availability, in order to determine, for example, the level of population which could be supported. Alternatively, given that future availability under systems of shifting cultivation may well be a function of the frequency with which land is cleared for agricultural production, rather than of fuel consumption per se, it might be useful to calculate the extent to which the length of the present land use cycle could be shortened before consumption exceeded supply. Research of the kind carried out by Adejuwon, which shows how fuel productivity declines as the period for regrowth is reduced, could be drawn upon for this purpose.[5]

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[5]Adejuwon in Centre d'Etudes (op. cit) p. 384 presents the relationship between wood productivity and length of fallow system in graph form, from which the values in the table which follows have been read off:

Length of fallow system (years)	Wood productivity in m^3/hectare/annum
5	0
10	25
15	36
20	40
30	45
40	48

(b) **The continuous use of tree resources**

The procedures for determing the annual increment of fuel materials extracted on a continuing basis from the same pieces of land, correspond in many respects to those already described in relation to shifting cultivation, and only the differences need to be highlighted here.[6]

Following the same sequence, the first question concerns the area from which fuel is being extracted. Once again, here, it will be important to establish realistic systems boundaries; but in addition, it will be necessary to take into account areas of land on which fuel is grown, which are generally overlooked in calculations of timber availability. These may include homesteads, home gardens, fields, field boundaries, shrub lands and wood lots.

Once the types of land from which fuel may be extracted have been identified, it will then be necessary to select a sample of plots for investigation in which each is adequately represented. Once again, following the same procedure, it will not be necessary to identify the specific parts and kinds of trees which are useable as fuel.

The method for determining annual fuel increment will be different in this instance, and will depend upon the way in which fuel is obtained. Where only dead wood is collected, it is clear that consumption is less than sustainable supply, and there may be little need to determine actual productivity. The same will apply where trees are felled when they have reached maturity, although here one might wish to adapt the method described in relation to shifting cultivation, in order to determine what level of consumption could be sustained on a regular basis. This would simply entail measuring the fuel wood weight of mature trees on sample plots of land, as opposed to the total fuelwood productivity of plots about to be cleared (which would also include some immature trees). A similar adaptation of the basic method described could be used in instances where immature trees were being felled, and the fuel resource base was being "mined".

The problem becomes more difficult to resolve where trees periodically have their branches removed, or are cut back to ground level, rather than being completely cut down. Here there would appear to be no good substitute for long term research investigating the level of fuel offtake which could be sustained using particular methods with specific species in different environments. Some of the information required may already be available to researchers.

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[6]For a detailed example, see Bajracharya, (op. cit).

Another potential approach has been identified by Adjuwon.[7] It relies upon general measures of biological productivity, calculated on the basis of evapotranspiration data collected from different locations. The possibility of using such approaches in conjunction with other forms of measurement cannot be ruled out, but by themselves they suffer rather serious limitations. To begin with, biological productivity will not exhibit any constant or predictable relationship with fuel productivity. The ratio between the two will vary by species, age of tree and other factors. Also, substantial variations in biological productivity itself will arise as a result of differences in soil type; a factor which is highly localized in its impact, and which has not been allowed for in currently available calculations.

Once incemental fuel availability has been determined, net availability can be calculated in exactly the same way as with shifting cultivation.

(c) **Crop residues**

The final type of situation, where crop residues from agricultural land reused as fuel, presents the least difficulty as far as measurement is concerned and can be dealt with quickly. this is because flows are equal to stocks, or to the combined total of stocks where more than one crop is grown in a piece of land in a year. The only possible difficulties arise from the more seasonal nature of residue availability and the accordant need for measurements to be conducted on more than one occasion. Briscoe, for example, identifies nine crop residues and three additional fuel plants and their use in his village in Bangladesh;[8] whilst Alia-el-Din reports eight different crop residues in use in Egypt.[9] More superficial investigation particularly of the 'one-off' type which does not account adequately for seasonal variations in fuel availability and use will often miss important detail of this kind. It is also necessary to pay close attention to the parts of different plants which are used if reasonably accurate estimates of flow are to be obtained.

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[7] G.J.A. Ujo (ed). Rural Energy in South-Western Nigeria: A Preliminary Report (United Nations University, 1979). p. 62-74.

[8] J. Briscoe. Energy Use and Social Structures in a Bangladesh Village p. 619.

[9] Alia-el-Din (op cit) p. 17.

Having established the range of residues and the parts used, the normal procedure has been to use crop cutting experiments to determine yields per unit of land. It is not necessary that these should be repeated extensively, since once a relatively small number of results have been obtained by direct measurement, it should be possible to establish indictors. The first and simplest of these would enable fuel availability to be calculated on the basis of average yields per unit of land. This, however, will not always prove reliable. Alla-el-Din, for example, describes how official Egyptian statistics on crop residues were reported as remaining the same over a twenty-year period, during the course of which there were substantial changes in the extent of chemical fertilizer use; and detailed field measurements of yields subsequently indicated that these could be anything from twenty to ninety per cent higher than the official figures indicated.[10]

Similar changes might be anticipated when irrigation is introduced.[11] There will also be substantial year by year variations arising as a result of differences in weather conditions. Given problems of these kinds, a better approach will generally be to establish residue to main crop weight ratios, so that wherever the latter is known or can easily be estimated, the former can then be determined from it. This, however, assumes that such relationships will remain constant, and some tests may be desirable in order to establish whether this is in fact the case with particular crops in particular locations.

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[10] Ibid pp.5 and 32-5.

[11] There are, however, circumstances under which this can actually lead to a reduction in residue availability; where dwarf varieties of rice replace those with longer stems.

2. INDIRECT INDICATORS OF DECLINING FUEL AVAILABILITY

With crop residues, where stocks are equal to flows, the effects of any shortage will be experienced immediately. Under other regimes, where stocks and flows are distinct, there is always the possibility that shortfalls in the latter will be made good, for a certain period at least, by the 'mining' or progressive destruction of the former. Direct comparisons between consumption and the level of sustainable flow from a given stock, will indicate whether such a process is in fact underway, or whether it might be expected to arise at some future point as a result of population growth, or other factors, thus increasing consumption.

Such direct comparisons of available flows or increments with consumption need to be made if a clear answer is to be obtained to the question of whether fuel extraction either is, or might conceivably become, the cause of declining availability. The discussion in the earlier part of this chapter will, however, have indicated that very considerable practical difficulties will often be encountered in assembling the necessary data. An additional disadvantage of such comparisons is that they only provide an impression of the relationship between availability and consumption at a particular point in time, and contribute little or nothing to an understanding of the processes which have been at work in bringing about such a state of affairs in the first place. An alternative approach which may be considered in the remaining part of this chapter, is to look at indirect indicators or symtoms of change. These can often be established much more quickly but need to be treated with caution, insofar as particular outcomes, as far as fuel availability is concerned, may be associated with more than one set of underlying causes.

(a) Indirect indicators

Such indicators have from time to time already been employed in rural energy surveys, although in somewhat partial and unsatisfactory ways. The most popular has been the distance which people have to travel on average in order to collect fuel; which, in turn, stands as a proxy for the amount of labour time which has to be expended in performing this task. This figure is of relatively little value in its own right, other than as a highly approximate means of determining the relative scarcity of fuel in different locations but becomes more useful where researchers have been able to devise means of comparing present situations with those at various points in the past. Here it has often been suggested that where distances are increasing, this may be taken as a sign of declining availability, but that where they are constant, then no problem exists.

Taken by itself, this argument is suspect on a number of grounds. In the first place, it assumed that fuel collection is a discrete activity, and that all fuel is gathered from a common location. Where this is not the case, and people either gather fuel in the course of carrying out other activities, or collect it in different ways on different occasions, distance as an indicator of availability becomes virtually meaningless since it gives little impression of the amount of labour time required for collection or whether it could have been put to any alternative productive use. Even where these complications do not arise, it can only be assumed that an increase in distance indicates growing shortage, and not that there is no problem where distances remain constant. When faced with shortage, users may either choose or be obliged to modify the types of fuel which they use and the means by which they are extracted, rather than travelling further afield to maintain a previous pattern of consumption.

Such modifications are generally not considered in the literature, but can have important implications for the environment and the future livelihoods of people over much wider areas than those under immediate investigations. These may take a number of forms. Wood from living trees may be used where the previous practice was to use dead wood only; or where it was customary to cut living trees, this operation may now be performed at a higher level of intensity (for example, with more branches being removed), or when the tree is at a younger age. Similarly, there may be a process of switching from preferred parts of trees, such as stemwood and branches, to less favoured parts such as twigs, bark, and in extreme cases, roots. Yet again, more popular species may become depleted and replaced by those which are liked less, and fuelwood may have to give way completely for crop residues. Finally, there may be instances where biomass with alternative end uses, such as fruit trees or dung, has to be diverted to fill the vacuum left by the disappearance of more conventional fuels. Under any of these circumstances it is possible that growing shortages can actually be accompanied, in the short run at least, by a reduction in the distance travelled.

But as with distance, none of these indicators by themselves can be treated with very great confidence. Many of the changes mentioned need not necessarily lead either to difficulties nor give cause for concern. A transition from non-destructive to destructive extraction practices may lead to a situation which is perfectly sustainable in the long run, and which poses no threat whatsoever to the environment. At the same time, however, it is important to consider any change which may arise in relation to fuel processing and consumption practices, since a change to a different type of fuel may well entail an increase in the amount of labour time required for operations such as fuel shortage or cooking, and may also be associated with undesirable side

effects such as a deterioration in health caused by the increased amount of smoke present in the kitchen.

Figure 3.2 **POSSIBLE INDICATORS OF DECLINING FUEL AVAILABILITY**

A. **Fuel Collection**

- increase in time required
- increase in distance travelled
- change in who collects
- change in means of transportation employed
- shortening in length of rotational cycle (under shifting cultivation and similar regimes)

B. **Type of Fuel Used/Extraction Practices**

- change from dead to green wood
- change to younger trees
- change from more to less preferred parts of trees or plants
- change from more to less preferred species
- change from species without, to those with alternative end uses

C. **Fuel Using Practices**

- increase in duration of cooking operation
- increase in intensity of cooking operation
- introduction of fuel saving devices
- reduction in amount of fuel using activities
- change to consumption patterns using less fuel

D. **Market Penetration**

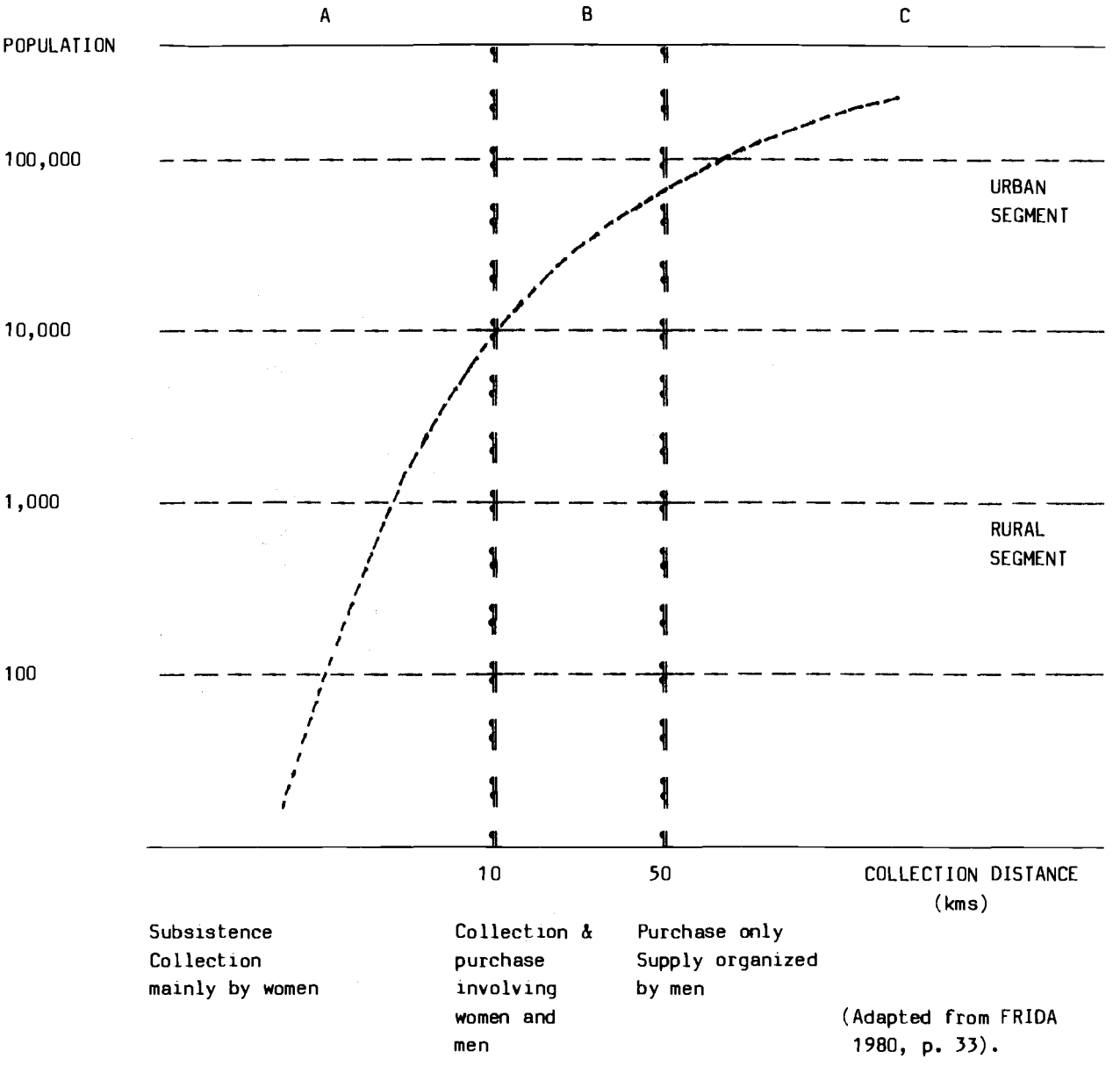
- increase in range of fuels commercially transacted
- increase in proportion of commercially transacted fuels in total consumption
- increase in the cost of individual fuels
- increase in proportion of household expenditure devoted to fuel

Alternatively, a growing scarcity of fuels of the preferred type may be accompanied, not by a change to some inferior alternative, but by attempts to economize, involving a greater intensity of effort during the period in which cooking is taking place. It may be easier or more expedient for additional labour time to be expended in this way, rather than through extending the periods involved either in the collection of fuels, or in the cooking process itself. Another possibility involving an improvement in the efficiency with which fuel is converted into heat may be the adoption of a different design of stove; and instances may also arise where fuel consumption is reduced by cutting back on the amount of food prepared, or by switching to a diet which requires less cooking.

These are all changes which may occur where growing shortage takes place within a context in which the collection and utilization of fuel continues to be organized upon a purely subsistence basis. A final set of possible indicators, which may either accompany others, or appear in isolation, involve either the appearance or the growth of fuel markets. Once again, this is a type of development which may take a number of particular forms. Certain types of fuel such as kerosene, which are always commercially transacted, may make their appearance or grow in importance; the range of fuel commodities may be extended to incorporate types of biomass which were previously only collected for self use; and households may start to purchase some fuel for the first time, or purchase a larger proportion than was customary in the past.

As with other indicators, caution should be exercised in using such changes in isolation as signs of reduced viability. There will be at least certain instances where any of the phenomena mentioned might reflect a general growth in the degree of market penetration and/or prosperity of the society in question, rather than any increasing hardship. Further evidence should thus be sought, wherever possible. This might also entail looking for changes in the prices of different fuels to see if these were increasing in real terms; although comparisons of present and former price levels might be complicated by uncertainties regarding the accuracy with which quantities were measured, as well as by doubts as to whether quality could be held constant. The possibility of price being influenced by other factors such as an increase in transportation costs, should also be taken into account.

Figure 3.3 **CHANGES IN FUEL AVAILABILITY WITH GROWTH IN COMMUNITY SIZE**



(Adapted from FRIDA 1980, p. 33).

Individual indicators are rarely likely to prove conclusive in themselves. Approaches need to be developed which at least allow cross checking to take place, and which ideally make it possible to explore the interrelated nature of the types of changes which have been explored in isolation here; and to show how they unfold through time.

(b) **Relations between indicators of growing scarcity**

FRIDA draws together evidence from a series of studies conducted in a group of sub-Saharan countries, in an attempt to establish the relationship between increasing community size, the distance from which fuel has to be obtained, the people responsible for collection, the means of transportation employed and the extent of commercialization.[12] The relationship is illustrated in Figure 3.3.

Community size is plotted along the vertical axis, and the distance from which fuel has to be collected along the horizontal access; and both are set to logarithmic scales. The curve then indicates the rate at which distance grows as community size increases. Two cut-off points are identified. The first is between 'rural' and 'urban' communities at the 10,000 population level; and the second between smaller and larger urban centres at the 100,000 level. Corresponding to these, three types of situation, (respectively 'A', 'B' and 'C') are found to arise.

In 'A' type situations, pertinent to communities of 10,000 or less, wood is generally collected by women and children for the use of their own households, and carried on foot from sources not more than 10 kms. from home. 'B' type situations that apply to communities of more than 10,000 but less then 100,000 are intermediate in character. Collection for self-use continues on a substantial scale, but is accompanied and then progressively displaced by fuel gathering for sale. As the transition to fuel as a commodity takes place, collection becomes an

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[12] FRIDA Domestic Energy in Sub-Saharan Africa: The Impending Crisis, its Measurement and the Framework for Practical Solutions. The countries are Mauritania, Upper Volta, Niger, Sudan and Ethiopia. More limited examples of how different indicators are related to each other are provided by Weatherly (op cit) in his discussion of Java (pp. 20-23) and Donovan (op cit) in her account of Nepal pp. 40-43.

increasingly specialized activity, concentrated in the hands of small numbers of men. At the same time, the scale upon which gathering activities are now conducted justifies the introduction of more advanced means of transportation, which typically take the form of carts drawn by a variety of draft animals.

The transition to situations of the 'C' type, with communities of 100,000 or more, sees an extended development of these tendencies. With sources of fuel at least 50 kms. distant, self collection is virtually eliminated, and women play little or no part. Further concentration of activity takes place, and motorized transport (requiring far greater initial capital) displaces draft animals. In addition, labour is organized into gangs; mechanized means of wood cutting are introduced; and charcoal takes over from wood in a process which reduces transport costs, but at the same time increases per capita levels of wood consumption.

The FRIDA model clearly has certain limitations. The cut of points identified only represent approximate average thresholds for the region in question, and are subject, as the authors clearly acknowledge, to very substantial local variation. At the same time, it only deals with one part of the spectrum of changes which may arise in the transition from a situation of fuel abundance to one of growing scarcity. Next, it only deals with the transitions, before the effects of the incorporation of small communities within the catchment areas of growing urban centres begins to be experienced on a substantial scale. Finally, it cannot be expected to apply in all of its particulars to regions beyond that relation to which it was initially devised.

These, however, are relatively minor objections, and on balance, the model does provide a useful starting point for examing a type of situation which seems increasingly likely to arise in many different parts of the rural Third World. Analysis can be undertaken which seek to identify how the population level at which a transition form A to B takes place varies according to ecology and types of land use system. Enquiries can be carried out to distinguish situations with little scope for substitution to alternative gathered fuels, or fuel savings, where transition tends to occur rapidly; from those where developments proceed at a much slower pace, and there the urgency of intervention is far less. The possibility of 'early warning' signals of transition, perhaps in the form of relatively small changes in fuel extraction practices, can be explored; and the possible association between a growing commoditization of biomass fuels and the demand for non-biomass fuels, investigated. Finally, the impact of transition upon the welfare of specific groups (men and women, rich and poor, etc.), which will be examined in detail in the next chapter, can also be considered.

Furthermore, the FRIDA example illustrates the types of connections between indicators of scarcity which might arise, where the major underlying contributory factor is a concentration of consumption at particular locations exceeding the regenerative capacity of biomass in its immediate environment. Where other factors, acting either individually or in combination, are primarily responsible for reduced availability, transition may then pursue somewhat different paths. As such, it might be useful to enquire into the course of events set in motion by land clearance for agriculture; and perhaps to distinguish further between scenarios involving large-scale planned land clearance schemes, and more incremental unplanned expansion. Also, it might prove useful to investigate what happens when fuels such as stemwood which were previously used for domestic consumption becomes unavailable as a result of competition from industrial end uses to explore the implications of growing population density in areas already dependent upon crop residues as a source of fuel; and to trace through various other developments as these unfold under different sets of social and environmental conditions. In each instance, it might also be possible to go a step further than the FRIDA exercise in actually seeking to determine the nature of the impact on the environment which different courses of events might entail; and the implications which these, in turn, might hold for future levels of fuel availability, or welfare more broadly conceived.

3. METHODS OF INVESTIGATION

The first and most important point to be made in this connection is that conventional survey techniques are not likely to prove particularly appropriate here. This is not to say that they are entirely without value. If questions are formulated in a sensible way then the data obtained will be of some value; and this method will have more to contribute where the changes experienced show a high propensity to vary between informants. But by comparison with consumption, where large differences can and do arise between different households within specific or similar locations, experience regarding availability is likely to be far more uniform, as well as to produce answers which are likely to be repeated time and time again, if a survey approach is employed.

This is one factor which therefore tends to count against the use of surveys. Another and perhaps more compelling reason for avoiding them here is the large amount of potential changes which need to be explored, and the complexity of the causes which either individually, or in combination, serve to bring these about. These are matters which can be explored far more readily in open-ended discussion with key informants who have experienced the changes, appreciate their likely complexity, and will also be able to convey something of this if allowed to communicate with a reasonable degree of freedom.

However, because the subject of investigation here is not a straightforward one, it would be foolish to rely upon this method alone. Other devices should be used wherever possible as a means of cross checking verbal accounts, and of opening up new lines of enquiry to be explored through this medium. The most reliable of these would be the longitudinal study, where observations of particular phenomena were repeated periodically over extended periods of time to establish time series data. But such studies generally make very heavy demands upon resources, and more rough and ready methods normally have to be adopted. These might include the use of old maps and records of land use, aerial photographs taken at different points in time, or direct observation of the various forms of biomass available and the means employed of extracting them for use as fuel.

A good example is supplied by Best,[13] who took measures of the quantities of biomass available, and garthered evidence on the forms which extraction was taking at selected points along the lines followed by women to collect fuel in the different villages in which he worked. This approach might have been extended to include observations of species available at different points, and to establish whether these were annual or perennial. It could also have been related to a more abstract approach of the type advocated by Moss, who attempts to model the composition of an eco-system at different stages of regeneration and degeneration.[14]

Either individually or in combination, these types of methods offer insights which can never realistically be obtained through exclusive use of structured survey approaches; and it is

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[13]Best (op cit) pp. 6, 8 and 97.

[14]Ojo (op cit) p. 47-61.

perhaps because so much emphasis has been placed upon surveys as a means of obtaining data in the past, that we presently know so little about the availability side of the fuel question, or the dynamic interaction of supply and consumption.

CHAPTER IV: THE SOCIAL CONTEXT OF FUEL SUPPLY AND USE

Although it is important to resolve the problems raised previously in relation to the consumption and supply of biomass fuels, an appreciation of these things in themselves is quite insufficient for the purpose of rural energy policy making. This can only be successfully undertaken where there is also a clear understanding of the social context within which fuel is produced and used. Three points are of particular significance in this respect.

Firstly, there is a need to view rural society as being made up of groups and classes defined by differential access to assets and income. These differences may give rise to situations where overall balances between fuel consumption and supply conceal more localized pockets of hardships. Similarly, when there is aggregate shortage, structures of inequality will almost certainly lead to a state of affairs where the effects are borne disproportionately by already disadvantaged groups. Under these circumstances, identifying the operative social groupings become a necessary first step towards the determination of fuel needs.

Social differences, and the ensuring relations between groups, are also of significance insofar as they influence possible types of solution. Sometimes a particular form of action will be to the advantage of all concerned parties, but on other occasions conflicts in interests between groups may result in the weaker losing out. The ability to identify such states of affairs may, in turn, lead to the important negative conclusion that what appeared initially as a problem amenable to solution by technical means, is in fact more deeply rooted in social structures which themselves might need to be changed before a satisfactory conclusion can be achieved.

The second point is of a similar nature to the first. Just as it is important to recognize differences between households with regard to fuel, so too it is necessary to take account of differences that arise between household members. Since it is primarily women who are involved in fuel related activities, it is they who are most likely to be affected by changes in supply; yet it may be men who have the power to decide whether or not any ameliorative action should be taken. Given this general state of affairs, the nature of the division of labour between men and women (henceforth the "gender division of labour") within particular societies should be ascertained in order to specify the nature of fuel related needs, to see how these might change

under circumstances of growing shortage, and to assess the likely feasibility of alternative forms of intervention.

The third point is rather different, and concerns the linkages between rural communities and the wider networks of social and economic relationships within which they are incorporated. These networks, which are facilitated by improved communications and characterized by a growing volume of transactions between town and countryside, can influence the supply of fuel in a number of more and less direct ways. Determining whether such influences are at work in the case of specific communities and areas will be of interest since this will again be of critical importance in determining the types of solution which may be feasible where fuel shortages arise.

Each of these three social dimensions of fuel supply and use have generally been neglected in the energy literature, and it is therefore necessary that they should be considered in some detail. In the first major section of the chapter an attempt is made to review them each at greater length. The second part is then devoted to three case studies which provide an opportunity to explore the issues arising at a more concrete level.

1. PROBLEM AREAS

(a) Differentiating consumers of fuel, and understanding how variations in consumption arise

The majority of rural energy surveys make no attempt to distinguish between domestic users of fuel; but amongst those who do, a number of different approaches are apparent. The simplest divides population into frequency interval groupings, such as quintiles or deciles, according to consumption levels. (See Figure IV:1 below). This has the advantage of making only very limited demands in terms of the data which need be collected, and can be of value under certain limited circumstances. Where fuel end uses are dis-aggregated and where allowances are made for variations in household composition, the use of frequency intervals can give at least some indication of the proportion of households attaining or not attaining levels of consumption deemed consistent with independently arived indices of need, thus providing a basis for assessing the scale upon which intervention will be required, if certain minimal standards are to be achieved.

If, on the other hand, end uses are not disaggregated, this approach is of little or no value, since no criterion of need can be applied. Indeed, frequency intervals might well be misleading if employed in these instances, since it is very often the poor who are driven into types of activity, such as beer production, which give higher overall per capita levels of consupmtion than those who are better off and only need to consume fuel for domestic purposes. The same would apply where no account is taken of household size or composition.

Figure IV:1

ILLUSTRATIONS OF ALTERNATIVE APPROACHES TO THE DIFFERENTION OF HOUSEHOLDS

1. PATTERN OF COOKING ENERGY USE BY 20% PERCENTILE FREQUENCY INTERVALS

Percentile	Tons Firewood Equivalent/Household year
1	1.5
2	2.0
3	2.5
4	3.0
5	5.0

(Adapted from Weatherly p. 18)

2. INPUT OF ENERGY FOR COOKING (PER CAPITA PER DAY) BY DIFFERENT HOUSEHOLD INCOME CATEGORIES

Household Categories by Income	Households using				
	Biomass only			Kerosene only	
(Rp/cap/month)	kg	kcal	(Kcal/Kg)	lt	Kcal
Under 5,000	1.57	5,229	(3,331)	.27	2,327
5,000-7,999	2.04		(3,152)	.32	2,379
8,000-14,999	1.71	5,408	(3,163)	.38	3,266
15,000 and above	3.41	7,692	(2,256)	.53	4,541
All Households	1.86	5,745	(3,089)	.35	3,024

Source: Soesatro in Islam et al 1984, p. 137

3. OWNERSHIP OF FUEL-PRODUCING ASSETS (PER FAMILY) BY LANDHOLDING SIZE GROUP

	Hindu	Muslims			
	Fishermen	Landless	Poor	Medium	Rich
(Number of families)	(8)	(14)	(11)	(8)	(8)
Land (decimals[a])					
Median	0	8.5	66.0	126.5	242.0
Mean	0.7	9.5	65.2	135.1	295.8
Trees					
Median	0	6.0	8.0	16.0	182.0
Mean	2.0	11.1	12.2	17.5	209.0
Cattle					
Median	0	0	0	1.0	4.0
Mean	0	0.3	1.3	1.3	2.6

[a] One decimal = 1/100 acre

Source: Briscoe, p. 629

A further objection to the frequency interval approach is that while it provides some impression of how access to fuel is distributed within a society, it gives no indication of how differences arise, or of why shortages are experienced by certain households but by others. Matters of this kind can only begin to be resolved where an external referent to fuel consumption like income, or ownership of assets is employed. In reviewing these and other means of classifying rural populations, it has to be remembered that no particular criterion will be superior in all instances.

Societies themselves differ greatly. Some rely heavily upon agriculture, whilst other have relatively large numbers of people engaged in non-agricultural occupations. Some are characterized by forms of control of labour, of distribution and exchange organized according to customary principles; in others, the underlying logic may be dictated by market forces. The land to labour ratio will be far more favourable in some than in others; and so forth. All of these are factors which influence the forms which social differences will take, the manner in which they will appear, and thus the means by which they might best be investigated and the forms of remedial action which might ultimately prove appropriate.

There will also be differences with regard to the extent informants are either able or willing to provide certain forms of information. In certain instances, for example, people may not actually be aware of the amount of land they own, whilst in others the fear of land reform may prevent them from divulging this information. The form of classification employed must inevitably also be heavily influenced by the quality of records already available on the population under investigation. Access to reliable land or tax records provides the researcher with certain options that are otherwise not open. The same applies to relatively well endowed research projects with the capacity to generate their own detailed data base. In the event that the available data are of poor quality or resources are limited, rough and ready means of analysis will need to be adopted.

Bearing all this in mind, the indicator most commonly employed in the rural energy survey literature is income. This is most relevant and easiest to apply where a high degree of market penetration has taken place, and access to fuel is highly dependent upon the availability of cash. Where the greater part of production is for self consumption, the criterion becomes less useful although it might still be employed in instances where asset ownership alone provides an imperfect indication of the standard of living enjoyed, and where the goods and services produced

are actually marketed elsewhere in the economy, and can therefore be valued fairly easily in cash terms.

These considerations aside, the income criterion has a number of other strengths and weaknesses which need to be taken into account in arriving at a decision as to whether it should be employed or not. In agricultural systems, it works best where a single crop predominates, and where harvesting occurs at a single point in time. It becomes more difficult to apply where a number of crops are grown, and where the harvesting of individual crops is spread over periods of time (as with fodder and vegetables), since each of these factors makes it more difficult for informants to recall quantities, and still more difficult for measurements to be made which might help to establish the reliability of verbal estimates.

Income is also a difficult criterion to apply where sources include agricultural, or other forms of hired labour that occur on an intermittant basis, with no fixed or regular patterns. On the other hand, at the other end of the economic scale, similar problems may arise in relation to income derived from activities such as trade or money lending.

Apart from any recall difficulties, informants may also wish to conceal the real state of affairs from others for various reasons. Although income is frequently contemplated as a means of classification in energy surveys, it is not surprising to note that it can prove extremely difficult to apply in practice. Also, the results obtained may not be regarded with a great deal of confidence, and the most successful attempts to use it may well occur in instances where detailed information is already available from national household income and expenditure surveys, or similar sources, and does not actually have to be collected in the course of the energy survey itself.[1]

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[1]See Mungala Estimation of Present and Likely Future Demand for fuelwood and Charcoal in Machakos District Kenyan p. 73-74 for an abortive attempt to classify using income; Weatherly (op cit) p. 32-3, for a reference to the confidence with which income categories actually used could be regarded, and Soesastro (op cit) p. 16 where the prior existence of village tax records made it possible to apply income as a criterion upon a fairly extensive basis.

Because it enables the effects of employment and self employment to be taken into account, the income criterion is generally more satisfactory than control of assets, and is probably therefore preferable where it can be established with precision. Nevertheless, given the difficulties which have been described, this will frequently not be possible. For this reason, researchers have sometimes resorted to proxy indicators which can be established more readily than income itself. These have commonly included such things as the quality of housing, levels of education, and the number of months of a year that a household is able to feed itself from its own produce without being forced into the market place. The advantage of such indicators is fairly obvious. They are generally far less sensitive to respondents than income itself, and they can be collected far more easily. They can play a particularly valuable part where they can be cross-checked for reliability and have confidence limits attached to them. By and large, however, they represent only a rather rough and ready option to be resorted to when time is very short and other resources limited.

The other major criterion against which energy consumption can be assessed is ownership of assets. This works best where market penetration is relatively slight, and where the assets in question serve as a direct source of fuel. In some societies, particularly though not exclusively African, the most important assets may be livestock, and a household's relative wealth may most readily be expressed by the number of cattle or other animals it owns. such societies are, however, in a fairly small minority in the rural Third World, and in most instances it is ownership and control of land which provides by far the most useful individual criterion for establishing relative wealth. Land is likely to prove a particularly powerful indicator wherever high population densities place it in short supply; but even where this is not the case, it is becoming increasingly important wherever the incursion of markets contributes to a breakdown in communalistic systems of tenure, and their replacement by private property as the basic principle upon which society is organized.

Land ownership is not, however, without its difficulties as an indicator. As was suggested earlier, people may either be unaware of how much they own, or unwilling to divulge this information to an investigator who may appear to be acting in some official capacity. In addition, ownership may be difficult to establish where tenacy and mortgaging are widespread, and where title may frequently be in dispute. The viability of land as an economic asset may be contingent upon the ownership of other assets such as ploughs, or draft animals which do not follow the same pattern of distribution, and land itself can, of course, vary greatly in its productive capacity even from one part of a relatively small area to another. Yet again, land,

or for that matter any asset, may give no more than a partial indication of a household's economic standing; since this might also be heavily dependent upon the degree of access to employment and other income generating activities like trade and money lending.

Some of these problems can be overcome. Land, for instance, might be weighted according to whether it was irrigated or not; or in some other way which would reflect the value of what it could be used to produce. Also, the values of major assets might be aggregated, although valuation could prove complicated, particularly where markets had not yet firmly established their hold.

In spite of the difficulties with which they are associated, attempts to differentiate households on the basis of income or asset ownership, and then to show how these relate to differences in fuel consumption, tell much more about why problems and differences arise than attempts to differentiate strictly on the basis of consumption itself. Predicting future needs in areas other than those directly surveyed becomes much easier where external referents of these kinds are employed, particularly where records of income or asset distribution are already available. Furthermore, a knowledge of the relationship between these things and present levels of consumption, affords a basis upon which the likely implications of changes such as increasing income, or declining per capita land holding, might have for fuel availability and use.

But however carefully classes are distinguished on the basis of income or asset ownership, and however close a correlation with fuel consumption it may be possible to demonstrate through the use of such procedures, they can never go more than part of the way towards explaining how fuel is actually distributed. In order to achieve a full understanding, it will be necessary to show how variations in wealth or assets provide the basis for relationships between classes, and how these relationships, in turn, operate.

Typically, there may exist a three-fold distinction between those whose land and assets holdings are too extensive to be operated by household members; those who are able to subsist comfortably using only household labour; and those who own very few assets and are obliged to work for others. The analysis could then be taken further by exploring the precise nature of the relationship between the first and the third classes mentioned, to see whether this was of a purely economic nature, or whether it involved the recognition of a wider set of social obligations, included amongst which might be the provision of fuel.

Following such a procedure would yield adequate explanations, to the extent that land resources were privately owned, but additional factors would frequently also need to be taken into account. In an extreme instance, as cited by Siwatibau, certain rural communities in Fiji were found to be organized along communalistic lines with private ownership of land not featuring at all as an element of social organization.[2] Here the household as an institution scarcely exists, and notions of class and the forms of distribution with which they are associated would need to be set aside and replaced by other types of analysis.

A rather more frequently encountered situation in the rural Third World is one in which the principle of privatized access to land has only been partially established, and where common access to grazing of forest land remains. An example of this is provided by Mungala, writing about the Machakos District in Kenya.[3] Again, in a comprehensive case reviewed later in this chapter, Briscoe describes a rural area of Bangladesh where private ownership of land has become firmly established as the basis upon which social limited access to the land of others for the gathering of crop residues in accordance with a customary system of rights and obligations.[4]

The interesting thing to note about these cases, however, is that in each instance the author describes how communalistic tendencies are gradually breaking down, indicating a transition to a type of society which lends itself more readily to the form of analysis described earlier. Siwatibau indicates that private interests in land are progressively displacing communal types of organization in Fiji. Mungala reports that in the least remote of the three zones in which he studied in Kenya, land has been redistributed in such a way that the formerly communal village woodlots have now fallen under private control; while Briscoe, in turn, shows how customary forms of access to residue in Bangladesh are now being denied to a sector of the

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[2]Siwatibau (op cit) p. 45

[3]Mungala (op cit) p.91.

[4]Briscoe (op cit).

landless population, and are likely to be withdrawn from all landless households within a fairly limited period of time. It is precisely in the course of transitions of these kinds that fuel problems often start to arise; it is therefore important that studies of the social and economic dimensions of access to fuel do not confine themselves merely to the functioning of systems of distribution as if these were static, but seek also to encompass processes of transformation.

(b) **Fuel in the gender division of labour**

The previous section has shown how the rural energy survey literature tended to neglect the connection between fuel and class; thus failing in general to indicate how access to fuel was distributed, or what the nature or need for it might be. Equally significant has been the failure to take account of the relationship between fuel availability, the division of labour within households, and the particular implications which this has for women's work and the way in which they allocate their time.

Although there are clearly variations both between and within societies with regard to the work women do, there is a well established, overall tendency to allocate to them the responsibility for the rearing of children and the processing and preparation of food. Hand in hand with this goes an almost exclusive responsibility for fuel using activities; which, in addition to cooking, may also include the heating of water for bathing, washing clothers, and other purposes.

Their responsibility also tends to extend into the areas of fuel collection; which has attracted the attention of researchers who seem primarily concerned with their labour time as an indicator of growing fuel shortage, rather than as a subject of legitimate concern in its own right. But fuel collection, although a predominantly female activity, can also be subject to its own internal divisions with men sometimes performing the heavier cutting and transporting tasks and being responsible for securing specific types of fuel. A review conducted by Murdoch and Provost, in fact suggests that women are responsible for the collection of fuel in approximately

two-thirds of the societies covered, with the responsibility either being shared with or devolving exclusively upon men in the remainder.[5]

Because of the gender division of labour, and the close association between women and fuel to which this gives rise, failure to look at the specific activities within the household can lead to difficulties which are similar to those that arise from the failure to disaggregate society as a whole into classes. Specific problems relating to women can very easily remain invisible; it is therefore important that their distinctive role and interests be recognized and that the strategies which they pursue in allocating their time be explored.

In spite of the broad similarities between women in most rural Third World situations, particular circumstances mean that a range of such strategies may be encountered. In certain instances, the overriding consideration may be to save on collection time by introducing a more economic use of fuel. Elsewhere, rather more fuel than is strictly necessary might be used in order to reduce the length of the cooking process during periods when time is very short, on the understanding that this could subsequently be made good by devoting more time to the collection and storage of fuel during slack periods, when there are few alternative productive uses for labour time. Sometimes inferior fuels may be used because these are available close to the home, can be gathered quickly, and thus create time during which women can engage in other forms of production. Alternatively, a greater amount of time may be devoted to gathering fuel of higher quality, so that fires need to be tended less during the cooking period, and other types of work can be carried out at the same time.[6]

Apart from being of interest in its own right, an understanding of the relationship between fuel availability and the way in which women allocate their time can also serve as a baseline against which the effects of changing (normally deteriorating) availability can have on women

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[5]Cited in Cecelski Household Fuel Availabilities, Rural Women's Work and Family Nutrition p. 27.

[6]All of these instances are adapted from actual situations reported by Cecelski (op cit) pp. 29-33.

themselves, and upon other household members who depend upon their labour for their own well-being. In certain instances, where fuel collection is regarded as a form of recreation, therefore enabling women the freedom to spend time in each other's company, it might simply be the case that collection is extended to take up previous non-working time, with nothing else being affected.[7] Far more often, however, fuel collection is an arduous and unpopular task, increases in the difficulty of which are likely to involve some adjustment in the expenditure of labour time, particularly where women do not have access to means of transportation such as carts and draft animals.

Some adjustments may take a number of forms. Women may simply re-allocate their own time by cutting back on other activities, thus enabling themselves to continue to collect the same amounts of fuel as before. Alternatively, they might cook less, either taking less food themselves or allocating proportionately smaller amounts to other household members. The number of cooked meals might be reduced from two to one a day. Yet again, the proportion of income spent on the purchase of fuel might be increased, and other forms of expenditure reduced accordingly, with implications either for the welfare of the household as a whole or for various members within it. Children, who had little or no previous work responsibilities, might be enlisted to help, and men might begin to take over the task of fuel collection as distances are greater,[8] perhaps leaving women to perform certain tasks for which they were previously responsible.

Other responses might include attempts to plant more trees or fuel yielding plants, or the adoption of more fuel efficient stoves, which could help to reduce collection time. But such options can only be pursued where the subordinate position of women does not preclude them from making decisions about the use and operation of land, or the expenditure of money; or where men see some direct advantage for themselves as a result.

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[7]See AID The Socio-Economic Context of Fuelwood Use in Small Rural Communities p. 23, for example.

[8]See the example from FRIDA discussed in the final section of Chapter 3.

29-33.

In studying how women organize their time in the light of fuel availability, and how they respond to change, it is also important to recognize that the gender division of labour interacts with class to create a situation where certain categories of women may find themselves in very different positions vis-a-vis fuel from others within the same society. The amount of labour time required by a woman from a wealthy household with its own home garden or tree lot to gather fuel may well differ substantially from that needed by a woman from a poorer household with no fuel producing land of its own. This becomes a paticularly important consideration where the fuel needs of poorer women exceed those of their wealthier counterparts owing to the market oriented production activities in which the former engage. Similarly, differential capacities to purchase fuel may well have a very substantial influence upon the ways in which women of different classes allocate their time, and upon the respective degrees of privation which they experience.

Female headed households may experience difficulty where access to fuel follows from access to land, where this is subject to male control. Older women may suffer from not having younger female relations resident with them and where convention dictates that men do not engage in fuel collection. All these factors must be considered if the impact of fuel availability on women is to be understood, and if forms of policy intervention which address their special needs are to be devised.

The question of formulating a methodology to investigate the major issues raised in connection with fuel availability for women, is therefore of central importance. The first, and most obvious point to be made here is that it is essential that women themselves must be consulted when researchers go into the field. It is impossible to determine whether or not this is normal procedure where the energy survey material reviewed only reveals the source from which information as gathered, in a small minority of instances. However, the absence of any explicit statement to the effect that women have been interviewed, suggests that they have been overlooked, given normal male bias in survey work. If this is so, then the omission is a significant one; not only because women's interests are often so vitally involved in questions of fuel, but also because they will more often than not provide the best source of information on such matters as the growing patterns, burning qualities and other properties of alternative fuel

sources.[9] Where fuel is a problem it is thus important to remember that we are not so much dealing with "The Poor Man's Energy Crisis", as the title of a paper by Nkonoki implies, but with the poor woman's crisis.[10]

The next point to be borne in mind is that fuel collection and use cannot be understood in isolation from each other, or from the wider range of activities in which women engage. Apart from the obvious point that any alteration in the amount of time required to perform a particular task is likely to lead to re-adjustments in the time allocated to other work, one also has to take account of the fact that tasks tend to be performed in clusters rather than as a sequence of discrete acts; so that a change at any particular point is likely to set off a complicated set of reactions with unexpected, widespread effects.

In this context, the ideal research approach would be to carry out detailed time budget studies,[11] and then to repeat these after a period of time to establish the direction of change. But in practice, this would rarely prove possible and rather less resource intensive forms of enquiry would need to be devised. At a minimum, these studies would need to establish the broad parameters of the gender division of labour as they existed at a particular point in time; and within this framework, the types of strategies which women adopted in allocating their time within the range of fuel related activities, as well as between these and other kinds of activities. Given the present levels of understanding, there would generally therefore appear to be no real substitute for detailed and localized investigation; and this perhaps goes at least

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[9] AID (op cit) p.22.

[10] Nkonoki (op cit).

[11] The best available examples of such studies have been carried out in relation to the economic activities of children. They are: T. Cain, 'The Economic Activities of Children in a Village in Bangladesh', in H.P. Binswanger (et al) ed.): Rural Household Studies in Asia, (Singapore University, 1980), and B. White 'The Economic Importance of Children in a Javanere Village', in Moniang (ed.): Population and Social Organization (The Hague, 1975).

part of the way towards explaining why women have remained largely invisible in much of the rural energy research which has been carried out to date.

There are, however, notable exceptions to this general pattern of neglect, one of which is presented a little later in the form of a case study illustrating the linkages between fuel availability, women's work and household nutrition in an area of Peru. Apart from showing clearly how women organize, their time, and how this subject may be studied, this particular piece of work also provides a particularly good illustration of how variations arise between women of different kinds operating in different locations.

(c) The transformation of rural societies

In the preceding sections we have seen how social organization in the form of class and gender relations can interact with fuel to produce particular types of need, and possibilities for intervention that have frequently been overlooked. In the course of these investigations, it has been assumed that one is dealing with small-scale rural societies, which are unchanging other than in their responses to alterations in fuel availability. It has been necessary to adopt this assumption as a means of exploring certain matters of concern, but it departs from reality insofar as actual rural communities are nearly always caught up in wider relationships with centres of economic activity, which leads to continual change in their internal structures. As a part of this process, patterns of fuel supply and use are influenced in a number of more or less direct ways. The purpose of this section is to outline what some of these relationships are, and to identify the more particular consequences which can follow from them.

It has to be recognized at the outset that there are rather strict limits to the extent to which such matters can usefully be explored at a general level. This having been said, the particular concerns here are a number of influences, all of which ultimately derive from the concentration of economic activities within particular locations, arising in the course of development.

The first is the process of urbanization, which can affect rural fuel situtions in a number of different ways. Here it is shown that the concentration of population in a particular location, could lead to the clearing of the surrounding area of fuel materials to an extent where self-collection would no longer prove feasible. A system would then develop whereby specialists employing particular means of production and transportation took over, and ordinary consumers were left with little alternative other than to purchase fuel from them.

Such processes of fuel "commercialization" have important implications for town dwellers, as well as for villagers whose homes lie within the area from which fuel is supplied to satisfy urban needs. Women's labour time may be released, but this has to be seen in relation to the greater household case requirement arising from the need to purchase fuel. Such developments can cause severe hardship and it is important to investigate the way in which the different types of consumer adjust to the evolving situation. At the same time income-generating opportunities for suppliers of fuel should also be taken into account throught studies of the organization of the fuel trade.

As rural communities get drawn into the sphere of wider economic systems, other types of changes may also occur. Increases in production for sale are likely to lead to changes in the composition of agricultural production, and through this to changes in the availability of different types of biomass. Land previously under forest may be cleared for cultivation, again changing the composition and overall quantity of biomass fuel availability. At the same time, the increased capacity of certain consumers to purchase alternative fuels may free additional biomass resources for the less well off.

Transformations of these kinds are likely to occur fairly slowly where exchange is only organized on a local basis. But they can become far more dramatic where production for world markets is involved, and the relative advantage of different forms of activity can shift rapidly, with little previous warning. These changes may influence both the local supply of biomass materials and the availability of fuels from world markets that may be used as alternatives.

A final set of influences arise where new forms of production activity start to compete with domestic consumers of the same sources of biomass fuel. As with urbanization, this can once again lead to shortages, to the need for more or less painful processes of re-adjustment, and to the desirability of intervention.

No one case study could adequately illuminate all of these issues and the relations between them, but Digernes' work in the Sudan addresses a good number, and in addition, succeeds in

relating them to at least some of the other matters raised earlier in the chapter.[12] It has therefore been chosen as one of the three cases to be considered.

2. CASE STUDIES

(a) Case 1: Energy use and social structure in a Bangladesh village

Briscoe's well-known study of "Energy and Social Structure in a Bangladesh Village",[13] is the best example we have found of how questions relating to fuel availability and use may be set within a broader understanding of social relations and the way in which these are being transformed.

(i) Methods

The study is based upon eight and a half months intensive fieldwork, carried out in Ulipur in Eastern Bangladesh during 1977. A 50% random sample of the village population was selected for investigation, and data collected at the outset on family size and composition, income and employment, animals owned, land owned and land use. Informants were also asked for details of the production and distribution of crops and residues from the fields which they had cultivated during the preceding years. A series of further sets of data were then compiled in the course of fortnightly visits to the selected households. These visits continued for the duration of the research.

Information was recorded on the productive activities in which members had engaged, the production and distribution of food, fodder, fuel and fertiliser (with physical measurements being used to estimate residue production). At the same time, the names of the families using the residues were recorded, together with the uses to which they were put. Similar information was also recorded for residues consumed but obtained from sources other than these owned by the

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[12] Digernes (op cit).

[13] Briscoe (op cit).

household itself. Finally, direct measurements were also made of the quantities of fuel used for coding and parboiling paddy on the day in question. In addition to these repetitive systematic enquiries, Briscoe's general account (although not his own description of the methods employed) makes it clear that he also relied upon unstructured conversations with villagers to provide insights into the working of village society, and the place of fuel within it.

(ii) **Fuel Use**

Ulipur lies in the flood plain of the Meghna river, and is under water each year from June to October, during which time the main deep water among paddy crop is grown. The soil is highly fertile, and this has led to extreme concentrations of population of approximately 2,300 people per square mile. The results of a detailed investigation of the energy use of 49 households, eight of which are Hindu and 41 Muslim are presented.

A large number of different types of fuel are used, but crop residues are the most important, and at present account for about two thirds of total villagers' consumption. The most common of these is the course straw (nara) paddy crop, which by itself contributes some 43% of total consumption. This is used extensively by all villagers from November onwards after the amon harvest. It may be used on occasions for compost, construction work, or even as a rather inferior form of fodder, but these competing end uses are relatively unimportant, and nara remains in abundant supply, at least by comparison with the other residues. It is often left unused in the field of larger land owners who produce more than is required for their own home consumption.

The more tender upper straw (kher) harvested from the early monsoon, winter and amon paddy crops is also sometimes used as fuel; although to a much more limited extent, since it is only available in far smaller quantities and is more normally used as fodder. Unlike nara, which is generally left in the field unless it is specifically required as fuel, kher will always be carried to the homestead before being separated from the grain and can therefore be used as fuel without any labour time being devoted specifically to its collection. Other fairly commonly used residues include grain husks, which are used throughout the year, and a series of other materials from crops harvested at the end of the winter season, which include sesamum, mustard and chilli.

The second, most important source of fuel after residues is firewood, which accounts for just over twenty per cent of calories consumed. Just over a half of this comes from village

trees. These supply both high quality materials in the form of trunks and branches, as well as inferior twigs and leaves. Smaller quantities are also retrieved from the river area after the floods have receded each year, and a certain amount of firewood, equivalent to about five per cent of total fuel consumption, is also commercially transacted. This is the only fuel which changes hands for money on a significant scale.

Other fuels include doinshah, an annual leuminosa which grows during the monsoon on the small ridges between the paddy fields and is highly valued; bamboo which is also a good quality fuel, although fairly difficult to obtain; and water hyacinth which is widely available, but less convenient to use because of its high water content and accordingly lengthy drying time.

(iii) **Social groups**

The degree of access enjoyed by different social groups to more and less desirable types of fuel varies considerably, Briscoe identifies five categories (see Table IV:1). The first are the Hindu fishing households. They are the most marginal social group, owning hardly any land, trees or cattle; and having few other sources of income apart from their fishing. They have suffered in recent years from increased competition as other groups have taken up the occupation.

The majority Muslim population is then divided into four categories, identified here in terms of the amount of land owned, yet at the same time reflecting distinctions initially drawn by the people of the community themselves.

TABLE IV:1: OWNERSHIP OF FUEL PRODUCING ASSETS BY SOCIAL CATEGORIES

	HINDU	MUSLIMS			
	Fishermen	Landless	Poor	Medium	Rich
Land holding	N.A.	0.00 -	0.30 -	0.95 -	above
(Acres)		0.29	0.94	2.00	2.00
% of families	16	29	22	16	16
No. of assets owned					
- Land	1	2	17	25	55
- Trees	1	8	6	7	79
- Cattle	0	8	29	20	43

N.A. Not applicable

Totals may not add up to 100 due to rounding

(Source: Adapted from Briscoe p. 629).

The small group of "rich" households enjoy a disproportionate share of village resources. Although they comprise only 16% of the total number of households, they own over half of the land, almost four-fifths of the trees, and a little less than half of all the cattle. They are identified by the fact that they own two acres of land or more (indicating that rich is a relative rather than an absolute term).

Immediately below them are the middle category, with between 0.95 on two acres of land, who also comprise 16% of the total number of households; and the rather more numerous poor landowners, with 0.3 to 0.94 acres. Apart from their smaller land holdings these groups may be distinguished from the rich by their ownership of a far smaller percentage of trees and a substantially smaller relative proportion of cattle. Beneath them come the landless who, with 29% of the population, are much larger than any other group, yet who enjoy hardly any control at all over any of the major categories of assets under consideration here.

While vestiges of the system of traditional rights and obligations between groups still remain, relations are now of a more narrowly economic nature than in the past. Little land is given out in sharecrop, and where labour is hired, this will generally be for a cash wage, and on a day by day basis. In other words, the relatively well off no longer regard themselves as being obliged to underwrite the security of those without resources as they once did; and the position of members of the poorer groups has become more precarious as a result, although this has to be offset to some extent against increased employment opportunities outside the village in factories and other occupations.

Before asking how social differences and changes have influenced access to fuel, it will be useful to comment briefly on the system of classification which Briscoes uses. The Muslim population is divided along class lines according to control of land as the primary means of production. The Hindus, as a separate cultural and occupational category, cannot however, be fitted neatly within the same framework, and as a result we have referred here to "groups" and not classes as such.

Although selecting social groups which conform to local perceptions of relative position, and thus ensuring that the form of stratification selected corresponds more closely to social reality than would normally be the case, the methods employed nevertheless leave Briscoe open to criticism on certain grounds. In the first place, no account is taken of relative household size

and composition in assigning households to classes. This almost inevitably means that relatively large households will tend to receive higher ranking than their per capita resource availability would warrant, with the opposite applying in the case of relatively small households. Secondly, the exclusive reliance upon land as a criterion may lead to misleading results under certain circumstances. Figures presented by Briscoe, for example,[14] suggest that some "poor" households seem to own rather more cattle than those classified above them. Thirdly, the existence of earning opportunities outside of the village in factories for some of the landless households will almost inevitably place them in a far stronger position than those from the same agrarian category who do not enjoy access; and this too might ideally have been taken into account. Finally, the choice of landholding size intervals as a means of differentiating households is inevitably somewhat arbitary, and fails to convey any clear sense of the types of economic and social relations in which each category engages.

(iv) **Access to fuel**

A direct consequence of this system of unequal access to land and other resources is that decisions about cropping patterns and related matters which influence the availability of fuel enjoyed by the population as a whole, are taken by a small minority in accordance with what they regard as being in their own best interests. This factor interacts with the seasonal pattern of agricultural activities (summarized in Figure IV:2 below) and the various preferences which people have as regards different types of fuel; to lead to a highly diversified pattern of consumption.

In the case of the rich households, the amount of land owned is more than sufficient to satisfy all fuel needs. In the six months preceeding the amon harvest in November, residues from the various crops grown during the winter season are used and supplemented by high quality wood fuel from trees grown specifically for fuel purposes. After the amon harvest the pattern changes with fuel being obtained from grain husks, tender straw and gathered coarse straw, supplemented by smaller amounts of doinshah. Since husks and tender straw are already available for use as fuel in the homestead as a result of having been carried there for post harvest processing, only coarse straw and nara need to be collected as fuels; and only a part of the total amount of these residues grown on the land of the rich is actually used by them. (See Table below Figure IV:3).

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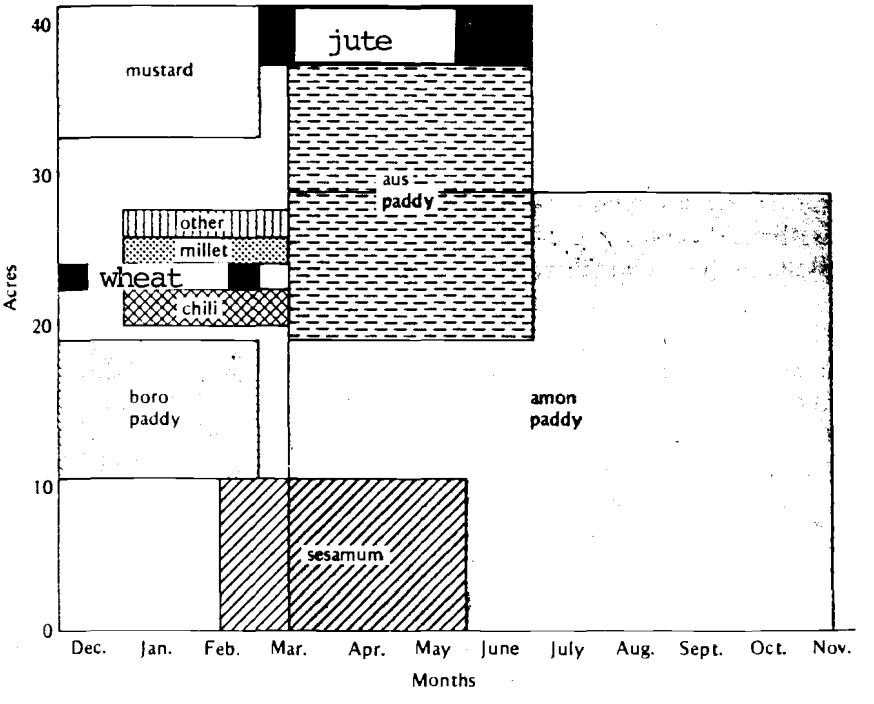
[14] Ibid p. 629.

Figure 2
Land Utilization
in Ali Sardar Somaj

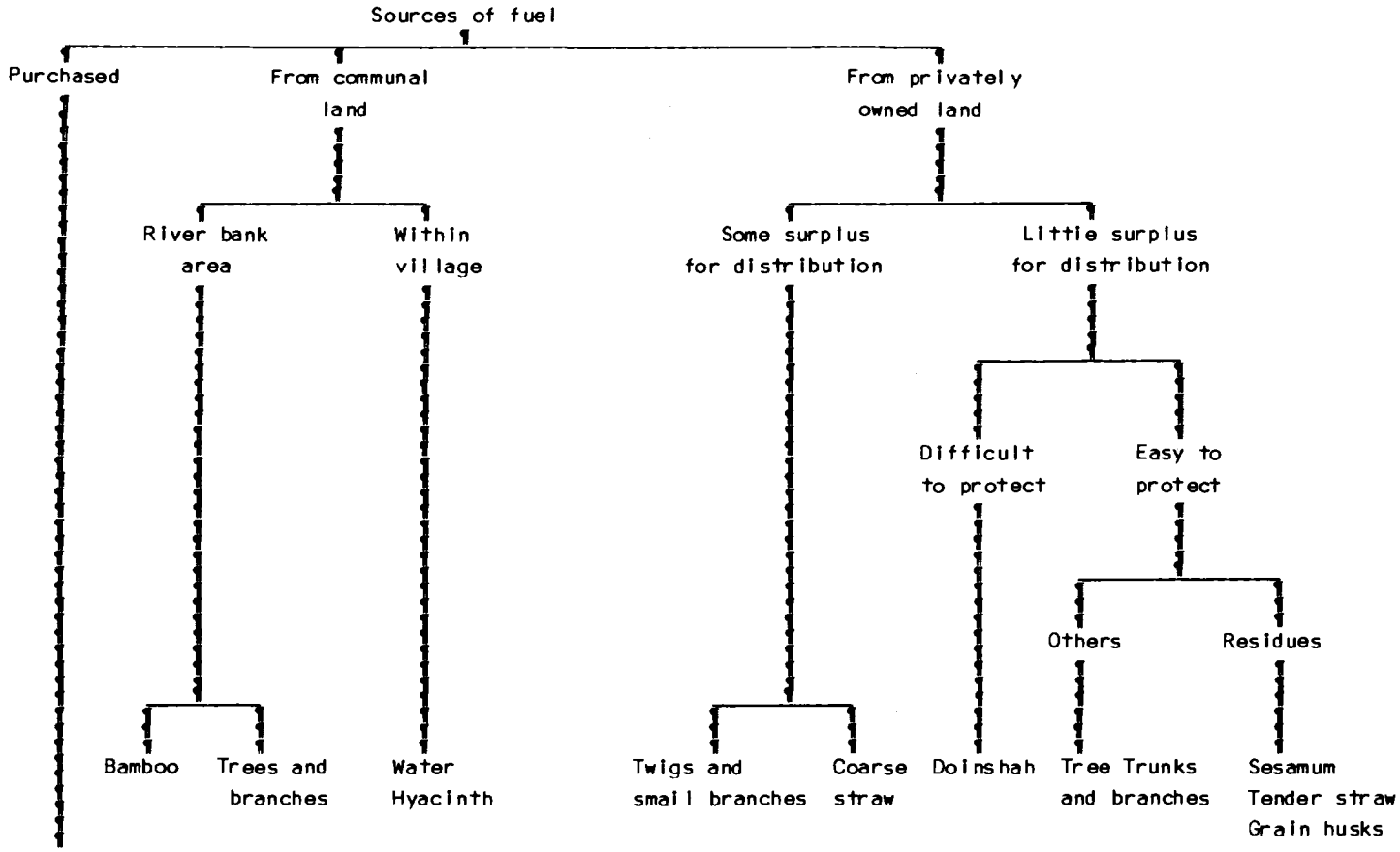


The position of the medium class of households is only marginally different from that of the rich. The smaller amounts of land owned mean that rather smaller quantities of residues are directly available in the homestead after the amon harvest. Consequently, much more coarse straw and doinshah has to be gathered, but consumption patterns in the period preceeding the harvest appear largely the same.

The amount of coarse straw used by the poorest landholders as fuel exceeds other crop residues from the first time, although the proportion of coarse straw consumed by this class is smaller than in the case of the medium householders, reflecting the smaller amount of land owned in this instance. In addition to having to collect most of the residues to be used as fuel, this means that the poor also have to spend substantial amounts of time scavenging for twigs and small branches, particularly in the period before the amon harvest. This inferior form of fuel, which is hardly used at all by the more wealthy, accounts for nearly one-third of all consumption by this class.

Figure IV: 3

SOURCES OF FUEL AND ACCESS BY SOCIAL CLASS IN A BANGLADESH VILLAGE



Fuels as	Fishermen	25.4	16.6	21.5	-	-	25.0	1.4	-	4.7	5.4	100
% of	Landless	-	3.1	-	4.8	26.8	38.4	7.5	-	10.1	9.3	100
total	Poor	-	1.2	-	1.7	31.1	26.0	5.3	-	25.3	9.4	100
Consumption	Medium	-	4.8	-	1.8	9.0	33.2	9.3	-	35.0	6.4	100
for	Rich	-	1.5	-	1.8	-	19.2	7.5	10.8	53.3	5.9	100
	Overall	5.2	3.6	4.4	1.6	8.0	43.4	4.9	2.8	15.7	10.4	100

The Muslim landless, with little or no direct access to crop residues of their own, are forced to pursue rather different strategies. They rely very heavily upon coarse straw from the land of others which must either be pilfered or collected with the permission of land owners who have surpluses which they do not require for their own use. A certain amount of doinshah is also used, since, although this is a fairly highly valued fuel, it is almost impossible to prevent its removal by those who need it. This means that the landless are able to manage reasonably well during the period after the amon harvest, but the lack of surplus residues during the earlier period, forces them to rely upon gathered twigs, supplemented by poor quality water haycinth and bamboo, which mainly has to be obtained from locations well removed from the village itself.

The difficulties experienced by the Hindu fishing households are more extreme. In addition to not having land of their own, they also lack the indirect access to residues and other sources which the landless Muslims enjoy as a result of their relations with richer villagers. All of the surplus coarse straw in the village goes to the Muslim poor, and Hindus are not allowed to gather twigs from the land of richer Muslims. They cannot even use water hyacinth since this requires considerable space to dry, and unlike their Muslim counterparts, they lack access either to the shared homestead land of richer relations, or to village paths and open spaces. They have to obtain straw from distant unprotected fields outside the main village boundaries, which is inevitably a much more time consuming process. Alternatively, they rely heavily upon the collection of bamboo and wood from the river area where they fish. This, however, is only available at certain times of the year, and unlike any other group, the Hindus are therefore forced to purchase a substantial portion of the fuel they require.

In summary, the wealthiest households consume only good quality fuel and have to devote very little labour time specifically to its collection. As landholdings become smaller, more time has to be devoted to this task, and poorer quality fuels have to be relied upon to an increasing extent. The poorest landholders have to rely to some extent upon the good will of wealthier villages to allow them access to fuel. For those who are landless, this dependence becomes absolute, and the tendency towards increasing collection time and increasing reliance upon inferior fuels continues. The Hindus, with no access to village resources, are in the worst position of all. They bear the brunt of growing aggregate shortages by having to search further and further afield fo refuel, as well as having to purchase a portion of their requirements.

(iv) **Change in consumption and supply**

So far, the case illustrate the very great difference in types of fuel consumption which can arise and the way in which these can be located in differential access to means of production, and the types of social relationships and patterns of distribution which follow from this. This establishes the important pricipie, very frequently overlooked in the rural energy literature, that fuel availability and use cannot be adequately investigated as if in within a closed system; but rather should be explored in considerably broader contexts. Briscoe's analysis, however, does not stop at this point, but also goes on to show how the present patterns of fuel use have reflected demographic pressure on resources and the transformation of social relations through time; and to ask how a further working out of these procesess might effect the fuel situation in future.

A situation is outlined where population has virtually quadrupled during the last century and where virtually all forest, fallow and pasture land have been eliminated, in an attempt to satisfy the greatly increased need for food. Cropping patterns have only altered slightly, with some switching towards food crops, but yields have declined under the pressure of more intensive cultivation practices and the inability of farmers to replace exhausted soil nutrients. The net food surplus of a hundred years ago had been transformed by the 1940's to a position of bare self-sufficiency, culminating in a situation where less than half of the food which is now consumed can actually be grown on the communities' land.

This growing shortage of food has been followed, at one remove, by parallel shortages of fuel and fodder. Like food, both were said to be available in abundant supply during the earlier period, but increasing population now means that only about three quarters of fuel consumption can be satisfied from village crop land. Fodder requirements, on the other hand, can still be met, but growing competition with fuel for the same materials has meant that inferior sources now have to be relied upon.

All of these changes have been accompanied by a quite radical transformation in the composition of village society, and in the relations between the groups of which it is made up. The number of landless households is now far greater than it ever was in the past, and this has gone hand in hand with a breakdown in the former system of patron-client relations, whereby those with land found that it could most easily be managed on the basis of various forms of share-croping arrangement, or through entering into long term relationships with their hired labour. Such arrangements, which offered reasonable security to those without resources of

their own, have now been displaced by relations of a more economic kind, where people are hired, as and when they are needed, for a cash wage.

The change in social relations and the general reduction in levels per capita resource availability, have had a marked effect upon access to fuel. Formerly, those without land were free to use the surplus of the land which would otherwise have gone to waste, and these being so substantial, nobody experienced any difficulty in obtaining fuel. But now, as we have seen, most surpluses have disappeared, and that which remains in coarse straw is sufficient to supply only a part of the requirements of landless households. The poor and the landless have been left with no alternative but to switch to inferior fuels; and matters have been made even worse by the tendency of richer groups to now use materials for fuel which would previously have been available as fodder.

The Hindus have suffered worst of all in the course of these developments. As more Muslims have become landless they have started to enter into competition with Hindus for an ever diminishing catch of fish. At the same time Hindus have been virtually excluded from access to village fuels, and are now even being placed under pressure to remove themselves entirely from the community.

(v) **The future**

The prospects for the future are mixed. The introduction of flood protection and irrigation schemes will make it possible to substitute high yielding varieties (HYV's) for the deep water paddy which is grown at present. This will lead to an increase in agregate food production, but most, if not all of, the benefit of this will be enjoyed by the relatively better-off villagers. As far as they are concerned, the extra food obtained will easily outweigh the cost of reduced residue availability with HYV's, since they are already producing more than enough fuel for their own immediate needs. The overall effect, however, is likely to be quite serious as the community as a whole is projected into a situation of far greater fuel and fodder shortage.

This will occur at the same time as there are further increases in landlessness; and together with the tendency for migrant labour to start to compete with local people for employment, this will lead to a further marginalization of the poor. The first stage will probably see them being pushed into the position now occupied by the Hindus, where they will be virtually excluded from all access to village resources, and forced both to spend more time

gathering inferior fuel, and to spend a growing percentage of their incomes on firewood (thus further reducing their capacity to purchase food). Ultimately, they may, like the Hindus before them, be faced by the prospect of being driven from their homes.

This investigation of the social dynamics of energy availability and use reinforces the points made earlier about the inseparability of questions related to fuel from those governing matters of resource allocation as a whole. It demonstrates not only that the effects of aggregate fuel shortage are likely to be unevenly distributed, but also that behind any apparent fuel problem is likely to lie a more general problem of proverty. In seeking to make the nature of this connection explicit, the rural energy survey can help to pave the way towards a more informed consideration of the various possibilities for ameliorative action. These will not necessarily exclude rather narrowly technical responses but it is almost inevitable that the heavy reliance upon such solutions which have become the hallmark of most of the energy literature, will need to be challenged when questions of political economy are taken into account.

(b) Case II: Fuel availability, women's work and household nutrition in Highland Peru

Although a number of studies refer in passing to the particular relationship between fuel availability and women's work, it is very difficult to find examples which deal comprehensively with the range of questions discussed in the previous section. Skar's study in Highland Peru provides a notable exception to this rule.[15] Based on three months' fieldwork carried out in the economically backward Apurimac valley during the early part of 1981, it presents a series of detailed case studies of individual women that illustrate the relationship between fuel availability, women's work and family nutrition in three contrasting locations. The first is the centralized village of Huancarama which is located on the valley floor; the second, the agrarian cooperative at Pincos; and the third is the dispersed village of Matapuquio on the higher slopes.

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[15] See Skar, S.L. Fuel Availability, Nutrition and Women's Work in Highland Peru, International Labour Organisation, Geneva, mimeographed, World Employment Programme Research Working Paper; restricted.

(i) **Methods**

Time was divided equally between the three locations, with one month being spent on each. The original intention was to take ten women in each case - purposely selected to represent the range of social and economic conditions encountered - but in practise this only proved possible in two locations, with only eight women being found who would co-operate in the third. With the help of two assistants, each woman chosen in two of the locations was visited every day during the month, and every day for two weeks in the third.

Questionnaires and physical measurements were used to gather fairly systematic data on the quantity of fuel used, the time spent in the preparations of meals, and the types of food consumed. The author also participated in the gathering of fuel and other aspects of community life, relying heavily upon this and other relatively unstructured forms of research in order to assemble the information which she required.

For the sake of brevity, only the results of the enquiries conducted in Huancarama and Matappuquio will be considered here. The major theme to be explored will be the contrasts in the relationship between fuel and women's work arising from differences in geography, settlement pattern, land tenure and culture between the two places; but we shall also be concerned with the way in which variations arise within communities, and with the implications of this for changes in fuel availability.

(ii) **Huancarama**

Huancarama is a centralized village community with a population of about 1,300. It is connected to the rest of the department in which it is located by a rudimentary road system, and serves the surrounding area as an administrative and trading centre. Most of the population would regard themselves as Mistis, which means that, by comparison with other groups living in the area, they are both relatively highly educated, and relatively highly involved in the cash economy.

Almost every household is involved in some agricultual activities. Everybody owns at least a limited amount of land in the area immediately surrounding the village, on which an irrigated corn crop is cultivated; and many village members also have access to communal lands higher up the valley where potatoes can be grown. In addition, some households have their own pasture lands, but there are no communal lands upon which poorer members can forage for fuel. Livestock, ranging from chicken and duck, through pigs to cows and horses, also play an important part in

the production system; and there are opportunities for non-agricultural employment in trading, in small scale enterprises such as restuarants and bakeries, and in various administrative, clerical and professional capacities.

Although the village has to some extent been assimilated to metropolitan Spanish culture, which tends to confine women mainly to the home, the persistance of a largly subsistence agriculture and of the traditional values with which this has been associated, means that men and women share responsibility for cultivation, tending animals and related activities. A rigid gender division of labour is only observed with regard to cooking, which remains an exclusively female form of work.

The fuel used in cooking, as well as in more specialized activities such as baking, or brewing beer, is predominantly eucalyptus. This is grown on privately owned land around the boundaries of some of the irrigated corn fields, and about half of the households are able to secure all of the wood which they require from their own supplies. Others have either to purchase wood locally from those who have a surplus, or from the inhabitants of outlying communities who come to the village in order to obtain provisions. There is also a limited amount of foraging on private land for smaller branches, although there is now a tendency for owners to guard their fuel resources more carefully now than in the past. A relatively small amount of kerosene may also be used as cooking fuel by certain households.

There are certain broad similarities linking the types of fuel used, the cooking practices engaged in, and the types of work performed by all of the women in the community. Most importantly, fuel of good quality is reasonably easy to obtain. Access to cash means that it is generally possible to purchase at least some foods and thus to choose alternatives which require relatively little cooking when fuel is short. Lastly, involvement in other activities both within and beyond the home can normally be maintained at a level where a substantial amount of time may be devoted to cooking. The combined availability of food, fuel and time help to bring about a situation in most households where women cook three meals each day, and where each meal may consist of more than one course. But at the same time, we have seen that there are variations in access to land and fuel, and that households engage in a range of non-agricultural activities. Together with other factors, this can lead to quite substantial differences between the ways in which individual women allocate their time, and in the standards of nutrition which they and their households enjoy. Some of the most important of these differences may now be explored.

There are variations which arise as a result of class, access to resources and the types of occupations in which women engage. Some women belong to households which have their own trees, and this places them in a relatively favourable position. Skar cites one example where all annual fuel needs can be satisfied for as little as $12 (the amount which it costs to hire labour to cut down and chop up the wood); and a number of consequences follow from this. The woman in question does not have to spend any time gathering fuel, and is in addition left with disposable income which can go towards the purchase of food, and the general easing of the burden of domestic work. As such, it is a relatively easy matter for her to conform to the nutritional norms described earlier. The same applies to women such as teachers who have their own cash incomes and are able either to purchase time-saving kerosene as fuel or, in effect, by the labour time of other women by paying for their families to eat in restaurants.

Others, without such ready access to fuel or cash, find themselves in much more difficult positions, which can often be made worse still by limited access to pasture land, and the accordant need to spend more time tending to larger livestock. An instance is cited of a woman who has insufficient land on which to grow fuel and has to purchase virtually her entire requirement at a cost which may be as much as $45 per year; or almost four times the expenditure incurred by the relatively well-off household mentioned earlier. Raising amounts of this kind can present severe difficulties for those who only enjoy small cash incomes; and fuel price inflation, though running at a lower rate than the increase in wages, also creates problems for these people. Foraging for fuel is a possibility but the restrictions imposed by landowners makes this increasingly difficult, and under the best circumstances, it is a time consuming activity which reduces the periods available for other types of work. These kinds of factors operate to bring about a situation where a minority of the women in the village are forced to cook less often, and to cook less at each meal than others; and where relatively poor levels of nutrition go hand in hand with comparatively heavy work burdens.

A second set of differences cut across those which occur in relation to economic status and occupation. These revolve around household size and composition, and break down into two major elements. On the one hand, there are variations in the number of other people for whom a woman has to cater for. This inevitably influences the duration of cooking time and/or the amounts of food prepared, and hence the overall pattern of activities. On the other hand, there will be differences in the number of women available within a household to share the work. This is

important not only in influencing the size of the burden which the individual must bear, but also in determining the extent to which it is possible for labour to be divided; a central consideration where a multiplicity of tasks have to be performed both within and beyond the family home.

The two sets of factors that have been outlined interact to crate a diversity of individual situations; notwithstanding, fuel is reasonably readily available for most women, and those experiencing difficulties in maintaining ideal patterns of cooking and nutrition are the exception rather than the rule. The situation is very different when we turn to the second community.

(iii) **Matapuquio**

Matapuquio is located on the valley slopes at a higher altitude than Huancarama. It is made up of 218 households with homesteads scattered among individual maize fields. It has no recognizable market or other centre, and is only connected by path to the valley floor. The population is Indian, and strong elements of the traditional culture based on subsistence agriculture and collective labour remain; although this is now beginning to be undermined by the incursion of the cash economy.

The village is divided into upper and lower sections, which differ to some extent with regard to land tenure and occupation. Irrigated maize is the most important crop in both instances, and this is grown on land which belongs to the community and cannot be alienated from it. Both upper and lower villagers also grow potatoes higher up the valley side, but only the former own the land upon which this activity is carried out. The latter are obliged to cultivate on land which is not their own, acording to an arrangement which will be discussed shortly. All villagers also keep cattle and sheep, to produce cheese and milk, but neither the upper nor the lower villagers own the pasture lands on which they graze their livestock.

All of the land surrounding the village, but lying outside of its boundaries, was formerly the legal property of large haciendas centred on the valley floor; although in the Indian tradition villagers held rights to access to it. As a part of an uneasy process of accommodation between these conflicting systems, lower villages had been partially drawn into the hacienda system, supplying labour to it in return for the use of land upon which to grow potatoes and pasture their animals. The land used by upper villagers for pasture, on the other hand, was so

high up the valley side and so difficult to control, as to be of little interest to the hacienda owners. Villagers were therefore able to use it without having to provide anything in return, and thus managed to sustain a much more self-sufficient existence than those living lower down.

Two factors have served to modify this state of affairs in recent years, although significant distinctions between the two parts of the village remain. There has been the gradual incursion of a cash economy, which has encouraged members of both upper and lower sections to engage increasingly in wage labour; although the upper section still maintains a high degree of self-sufficiency. The next, and far more fundamental factor, is the land reform legislation enacted in 1974, which did away with the haciendas and reallocated to the land which they had formerly controlled to co-operatives which villagers could join.

This proved more popular with the inhabitants of the lower section villages who suffered more from a shortage of land, and men from the majority of households joined. Some, however, chose to remain outside since the co-operative was too firmly associated in their minds with the hacienda which had preceded it. In the upper section of the village only a minority of households chose to take advantage, since people here were in a better position to manage with the resource they already had. Those who did not become members were able to work for the co-operative from time to time in order to raise cash for specific purposes.

The people who did join were able to enjoy reasonable access to the types of land which they had previously used for grazing their livestock under the hacienda system. For the others, the situation remained difficult, with their relationship with the cooperative coming to resemble that experienced earlier with the hacienda: the important difference being that it was often now members of their own community with whom they were entering into conflict. (This was not always the case since not all of the former hacienda lands used by village members were taken over by the co-operative which people from their community were able to join.) Indeed, in recent years, there has been growing evidence to suggest that the new conflicts are becoming more intense than those which existed before. Struggling co-operatives have started policing grazing lands more closely with the objective of extracting the additional labour from villagers which they require in order to survive. The process of regulation has begun to extend as far as the higher slopes which members of the upper section have traditionally used without any interference.

The system of land tenure and the fairly complicated links between community and co-operative have exercised an important influence upon the gender division of labour, as well as to the pattern of fuel use. As far as the former is concerned, the situation in certain respects resembles that reported earlier in relation to Huancarama; yet differing from it quite fundamentally in other ways. Once again women have legal rights over land and other property, and once again - with the exception of cooking, which remains the exclusive preserve of women - men and women both participate in the full range of subsistence agriculture activities. Here, however, the similarity ends. The distance between fields of different kinds tend to be far greater, and the lack of good pasture land near homesteads means that both crop production and animal husbandry are more time consuming activities on the valley side. This inevitably influences the way in which women allocate time between activities performed in and outside the home. Even more fundamentally, the fact that men may be away working at the co-operative for as many as two weeks in four, means that women must often take the sole responsibility for recultivating crops and tending animals, while at the same time having to attend to a range of other tasks including cooking, collecting water, looking after children and gathering fuel.[16]

There are further differences with regard to the availability of fuel. The shortage of water in Matapuquio means that all irrigated land must be devoted to maize production and no space can be spared for the planting of trees. Consequently, except during harvest times, when the pressure of work forces people to use inferior crop residues, all fuel must either be gathered or purchased. Villagers from the upper section rely mainly on kindling and dung which they collect from high pasture and mountain side areas. Material gathered from these sources account for about 75% of total consumption, with the remaining 25% being purchased from the co-operative and other sources lower down the valley. These are then hauled to the upper section by returning workers. In the case of the lower section, where access to land is more restricted, but cash incomes greater, the proportions are reversed, with about 60% of fuel being purchased and about 40% gathered. But as time goes by, and co-operatives seek to regulate more strictly the use of all of the land to which they have title, gathering, which goes hand in hand with pasturing of animals, seems likely to become more and more difficult for members of both parts of

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[16]See Skar, S.L. Fuel Availability, Nutrition and Women's Work in Highland Peru, International Labour Organisation, Geneva, mimeographed, World Employment Programme Research Working Paper; restricted.

the community, and particularly so for the women who are solely responsible for this activity when the men are absent.

The unavailability of good quality fuels within the area of the village, and the difficulty and expense of transporting it up the side of the valley from areas where it is in more abundant supply, mean that levels of consumption are low in Matappuquio. In the upper section a household consumes on average only 124 kgs of wood fuels per year and in the lower section only 135 kgs., compared with 687 kgs. in Huancarame. But at the same time, the much lower cash incomes of the Matapuquios mean that they are much less able to purchase food, and must therefore rely upon stored foods which they have produced themselves; and which require more fuel to prepare than those cooked fresh. This set of factors, together with those discussed earlier regarding women and time use contribute to a situation where only two cooked meals can be prepared per day, and where the number of courses consumed at each meal must be kept to a minimum.

Differences in land tenure, settlement pattern, physical environment and fuel availability all play their part in influencing the way in which women in particular must allocate their time; with the result that Matapuuio women, as a whole, are placed in a position which is quite distinct from that enjoyed by those in Huancarama.

Important differences also exist within the valley side community. These are most pronounced in the lower section, where two distinct situations are of particular significance. The more important is the question of access to fuel. Women whose husbands are co-operative members enjoy reasonable access to good quality fuel. Although it is difficult to haul to the village and absorbs a substantial proportion of small incomes, this reduces some of the pressure on women to gather fuel. Those not enjoying such access, on the other hand, must devote much more time to collection, and must constantly run the risk of being apprehended and punished by those on whose land they forage without permission.

The second difference, which appeared in Huancarama, but which is of much greater significance in Matapuquio, concerns women who are in a position to share and divide their labour with others, and those who are not. The latter are particularly disadvantaged in the circumstances of the valley slopes which, as we have seen, impose many conflicting demands upon a woman's time, which can become virtually impossible to reconcile without the support of others. The harshness of the environment means that the aged and physically weak suffer particularly severly if placed in this position.

(iv) **Conclusion**

The case has served to demonstrate in a concrete fashion some of the genral and more abstract points raised earlier. It has illustrated that there will nearly always be an important connection between the availability of fuel, the way in which women allocate their time and the kinds of lives they lead; all of which will never be apparent where the household is treated as a category that does not need to be opened up and explored further.

It has also shown that the nature of this connection is not of importance only for women as a distinct interest group, but also that through the influence which it exerts upon them, it can exercise a profound effect upon the effect upon the activities and livelihoods of all household members. At the same time, the danger of treating women as a unitary category has been demonstrated, by indicating how the nature of the connection is subject to very substantial variation given particular environmental conditions, access to resources, and the size and composition of the domestic unit. Finally, the case has served to re-emphasize a theme emerging in relation to the Bangladesh village, namely, the inseparability of particular forms of social differentiation from more general structures governing the control and allocation of resources within a society.

(c) **Broader issues of political economy: fuel, land use and the transformation of rural communities**

The final case study explores the evolution of fuel availability and use against the background of changing patterns of land exploitation and desertification in an area of the Sudan, and raises, in a different geographical context, a number of issues already explored earlier in the chapter. Once again it is made apparent here that fuel availability must be seen as a function of the relationship between production in general and the environment in which it takes place; and that an understanding of the principles governing the ownership and control of land and rela-

ted resources is of critical importance. The superiority of approaches which do not confine themselves to a purely static perspective, but seek to explain availability and use of fuel as the outcome of processes working themselves out through time, is also once again demonstrated.

But the study also breaks new ground in showing how factors operating at broader levels can bring an important influence to bear upon local fuel situations. In this respect, it provides a particularly good illustration of the impact of urbanization upon rural areas, as well as throwing considerable light on market operations and the more or less direct means by which these affect the ways in which fuel is obtained and used. The study is based on seven months fieldwork in 1976/7 carried out by Digernes in and around Bara, a small town in an area of the semi-arid Sudan in which desertification had become a serious problem.

(i) **Methods**

Assisted by a small research team, with whom she worked closely, Digernes carried out interviews with 137 town women. This represented a ten per cent sample drawn from the local list of rate payers, and sub-divided into three broad income groups. Each of these informants was visited once and asked a small number of standard questions about the energy sources used in households, how and where fuel was obtained, the kinds of trees used for wood and charcoal, the amounts used and prices, and changes taking place in any of these respects during the preceding ten years. Given the small number of questions to be administered, time was also available on these occasions for more informal discussions with respondents and their friends and relations. In the villages surrounding Bara which supplied the town with fuel, a series of less structured interviews were also carried out about the way in which this process worked, as well as about the operation of the land tenure system. Further information on the trade in firewood was gathered from sellers as they went about their business; and a series of other sources of information, including aerial photographs which indicated the growing trend towards desertification, were also drawn upon.

(ii) **Economic activities**

At the time of the research study, Bara had a population of some 11,000. It had first been established as a trading centre in the 19th century, at a location where a good aquifer lay close to the surface and water could easily be extracted. Trade, however, had diminished considerably since the 1960's, with the installation of a new railway line some distance away. As a result, the town came to depend to an increasing extent upon irrigated, commercial vegetable production, carried out in the immediate surrounding area of land. Both the trading activities which remained (mainly sesame and gum), and the irrigated agriculture, were mainly controlled by the Danagla, who were the original settlers in Bara.

A second group, the Gumayna, were also traders originally, but gradually abandoned this activity and became more heavily involved in rainfed agriculture in areas further from the town. A rotational system was followed which started with the planting of acacia senegal seeds for gum production, and the cultivation of a combination of cash and subsistence crops in the intervening years. The crops would continue to be grown over a four to five year period until yields started to decline, and the land then left unused until about the seventh year when the acacia could be tapped for gum. This, in turn, would continue for a further seven to ten years, after which time the trees would be cut down and burnt to make charcoal, and the rest of the land cleared to restart the cycle.

Each household whose ancestors were among the earlier settlers, had three to four plots of land. In the past, when the population of the town had been smaller, this left certain potentially cultivable areas unused and these were under the control of town leaders, who would from time to time allocate them to more recent arrivals under arrangements which permitted

cultivation, but not tapping gum. From the strictly legal point of view, these gum tapping rights should have reverted to the community as a whole, but the practice actually adopted was for leaders to extract fees or rents from tappers which they would then retain for their own private use.

Cultivated, or potentially cultivable land around Bara, under the trusteeship of local leaders, was classified as registered and similar areas of land could be found around the villages surrounding Bara. All other land was regarded as unregistered, with ownership rights vested in the government. Access to land falling within this category was not limited to any particular groups, and it was used for grazing both by local inhabitants and by passing nomadic herdsmen. However, with the development of the gum industry in the 19th century, early settlers in Bara were able to establish property rights over acacia trees growing on this land, which they then either rented out, or had tapped for them by hired labourers.

As had already been noted, this system of land exploitation was associated with a pattern of fuel use which was dominated by charcoal. But certain amounts of firewood were also gathered from areas close to the town. More recently, richer households in particular, have been using a considerable amount of kerosene for cooking and refrigeration, as well as for lighting.

(iii) **Desertification and the changing supply of fuel**

This describes the situation which obtained some twenty years ago, in the period prior to the onset of rapid desertification. We may now turn to this process itself, the consequences which followed from it, and the way in which these combined with other factors to bring about quite fundamental changes in the use of land, the occupational structure of the population, and the availability of fuel.

The immediate cause of the desertification experienced in the area during recent years may be located in the period of drought from 1968 through the mid-1970's, but this did no more than bring to a head a crisis which has been developing over a period of years. The first important

element was the steady build up of livestock populations on unregistered land following the introduction of improved forms of treatment for diseases. Together with a growing tendency towards specialization in particular subsets of the available vegetation on which they depended, a situation developed where certain types of plants were being eliminated, and where the carrying capacity of grazing land as a whole was being slowly undermined.

The second contributing factor involved the working out of a similar process on cultivated registered land. Increasing human population and the growing need for food and income which inevitably followed, initially led to a situation where all available land was brought under cultivation; and subsequently, to the length of the rotational cycle being progressively reduced by half. An inevitable consequence was a reduction in soil fertility, culminating eventually in the abandoning of certain plants, where it was found that no further cultivation could be sustained after the completion of shortened cycles. At the same time, this tendency towards shorter cycles and declining soil fertility was being reinforced by the denial of gum tapping rights to more recently established settlers. They were left with no option but to cut down gum trees and re-establish crops at the earliest possible opportunity in order to sustain their livelihood.

Against a background of growing pressure on land resources, the effect of the drought was to dramatically reduce the number of animals and people that the environment could support. Nomadic herders suffered heavy livestock losses, and were in many instances forced to give up their traditional way of life and settle either on the edge of Bara itself, or around the surrounding villages. At the same time, many villagers found that they were no longer able to survive on rainfed agriculture, and also moved to Bara in search of new opportunities. The outcome was a rapid increase in the population of the town, a heavy concentration of people who, though able to secure some employment in the vegetable gardens, were also desperate for other ways of earning a living. It also signified a greatly increased demand for fuel from an environment now only capable of sustaining lower levels of productivity than had previously been the case.

A possible solution to the problem of increasd fuel demand at this time of reduced availability would have been to have switched from wood and charcoal to a far more intensive use of kerosene. This, however was ruled out by the price increases of the early 1970's, which may actually have been responsible for some substitution into biomass fuel. Given the lack of alternatives, the inevitable consequence of increased demand was a progressive clearing of trees from the area adjoining the town, creating a ring of land virtually denuded of all vegetation

around it, which grew progressively larger as time passed. Those without land of their own took to cutting younger and younger trees from unregistered land, and few steps were taken to prevent this since a collapse in world demand for gum had left the owners of trees with a reduced incentive to protect them. Town and village people with access to registered land in turn responded to lower gum prices and greater fuel needs by further reducing the length of the agricultural cycle, thus increasing the rate at which the soil became exhausted. The increase in transport costs from the early 1970's onwards also had its effect, making trade and the production of cash crops less attractive; encouraging a shift towards subsistence food production, accompanied by the removal of trees from land in order to make space for other crops.

(iv) **Conclusion**

More than any other which has been considered so far, this case helps to demonstrate the complexity of the issues surrounding fuel. It is not merely a question of locating fuel in the context of environment, production and social relations at the local level; although all of these things are important in their own right. Very often a much broader perspective is also required.

Digernes' study provides such a perspective in two important respects. In the first place, it shows how the development of Bara as an urban centre, and the factors which lie behind this, not only have important consequences for the townspeople themselves, but extend far further to influence the lives of the inhabitants of villages in an ever-growing surrounding area. In showing how such relationships arise, and how they may be investigated, the study opens up areas which are rarely touched upon in the energy survey literature, but which seem likely to be of considerable significance in helping to explain many of the more severe cases of fuel shortage arising in the rural Third World.

Of possibly even greater significance, although emphasized rather less by the author, are the more or less direct influences exerted by market forces. The decline in the world gum prices was clearly an important contributory factor both in explaining the shortening of agricultural cycles on registered land, and in setting in motion the process of desertification which would lead subsequently to a fuel and a more general crisis. Furthermore, once the process was underway, it created a situation where trees on registered land were left unprotected, and where unregulated and environmentally harmful fuel extraction could take place. We have also seen how the so-called "commercial energy crisis" made itself felt in the form of increased kerosene prices, which worked against the possibility of substitution from biomass fuels when they became

scarce; and the way in which increasing transport costs discouraged cash cropping, and led increasingly to the removal of trees in the course of the return to subsistence food production. Factors of this kind are likely to be found at work wherever trade and exchange have developed beyond the most rudimentary level; and through influencing the manner in which production is carried out invariably also bear upon fuel availability.

Only when the full range of influences are identified and the relations between them understood, only, in other words, when questions relating to the social and economic contexts in which fuel is embedded are explored, can a proper basis be laid for explaining why things are as they are, and what therefore might be done to change them.

CHAPTER V. STRATEGIES FOR RURAL ENERGY SURVEYS

The previous three chapters have looked, in succession, at the problems raised by trying to understand the consumption of fuel, the factors affecting its supply, and the economic and social contexts within which fuel use take place. In each instance, it has also been possible to explore the various methods which might be used, and to look in passing at their relative strengths and weaknesses.

We may now take stock of the major substantive issues which have been explored. Not all, of course, may be relevant on every occasion, and the emphasis may change substantially according to the particular energy problem under investigation. Nevertheless, what follows should serve as a preliminary check-list which might usefully be employed in the planning stages of any piece of rural energy work.

Together with the substantive scope of surveys, decisions also have to be taken about geographical coverage, and the way in which study communities are to be identified. The considerations governing this secondary set of decisions are investigated in the next part of the chapter.

This leads directly to a consolidated examination of the types of methods which are available for energy survey work, and an attempt to indicate the range of choices existing in relation to each possible major area of substantive concern. Finally, there is an opportunity to discuss the different ways in which issues, locations and methods can be packaged together within overall research approaches. In conclusion, the chapter outlines a series of general principles which will be vital to the success of any rural energy research exercise.

1. SUBSTANTIVE ISSUES

Broadly following the sequence in which they have been discussed, the major research issues arising out of rural energy surveys may be summarized as follows:

A. Fuel Consumption

1. Major parameters

a. What are the different categories of production activity/fuel using institutions (e.g. domestic consumption, home industry?)

b. What the specific processes within which fuel is used in each category (e.g. within domestic: cooking, space heating?

c. What are the type(s) of fuel used in each process, distinguishing between general categories (e.g. wood, residues), individual species, and parts of plant/tree? Why are these particular fuels used?

d. What are the alternative uses (if any) to which fuel materials may be put?

2. Timings

a. What is the distribution of each process through time (whether it occurs daily throughout the year, or within cycles of a seasonal or shorter duration: relationship with broader cycles of production activity e.g. agriculture)?

b. What is the nature of variations in types of fuel used at different points in time for individual activities?

3. Quantities

a. How much fuel and energy are consumed by each process per unit of output (e.g. meals of a certain size and composition per standard adult equivalent consumption unit: kg of fish or tobacco cures)?

b. How many units of output are produced and what is the total consumption of fuel per year?

c. What quantities of fuel materials are consumed for non-fuel uses per year?

4. **Variations**

a. Do systematic variations arise in consumption by consumers within the same categories (e.g., households by economic class, ethnic group)?

B. **Fuel Supply**

1. For each type of wood used:

a. On what types of land is it grown (e.g., private woodlot, field boundary, communal forest land)?

b. How much land of each type do community members have access to (allowing for joint access with other communities)?

c. What are average annual yields and total availability (adjusted for moisture content)?

2. For each residue used:

a. What area is devoted to the cultivation of the crop from which it is derived?

b. In each instance, what are annual yields and total availability (adjusted for moisture content)?

c. When during the year is each residue available?

3. For each type of wood and/or residue, is storage possible, and if so, are storage facilities available?

4. For each type of wood and/or residue, what is the normal range withing which yields can vary on a year by year basis?

5. Are there types and parts of trees and residues which could potentially serve as fuels but which are not used at present? If so, determine levels of availability and competing end uses.

6. How do aggregate levels of consumption and supply compare?

C. Factors determining access to fuel

1. General

a. How is the ownership/control of land and other major productive assets distributed among the population?

b. What types of relationship arise upon the basis of this distribution (e.g., between landlords/tenants; landowners/hired labourers)? How extensive is the practice of self cultivation, and do systems exist for the exchange of pooling of labour? Are other forms of economic cooperation between households in operation, and if so, what is their social basis? (Kinship, factions, etc.).

c. Do other factors influence the distribution of income and/or consumption opportunities (e.g., employment opportunities outside the village and/or of a professional nature; control of trade and credits)?

2. Specific

a. To what extent are fuels derived from private, or from public land? Where private land is the source, do ownership rights extend to the fuels themselves?

b. What principles govern the ways in which fuels are distributed between owners and non-owners? Do market mechanisms operate?

c. How do the answers to the other questions in this section relate to differences in labour expended in fuel collection and using activities and/or relative expenditures on fuel, and/or amounts and qualities of fuels consumed?

D. Fuel and the allocation of labour use

1. How are the tasks involved in the gathering and use of fuel allocated between men and women. How does the division practised with regard to the former relate to the

availability of tools and means of transportation, and the methods by which fuels are extracted?

2. How do those involved allocate their time between these sets of activities; bearing in mind seasonal variations in fuel availability, and the extent of other demands upon their time?

3. How is the responsibility for fuel related tasks distributed between those involved within households; and do people engage in systems of inter-household labour exchange and cooperation?

4. Are there any significant differences in any of these respects between households according to social class, age structure, and whether they are headed by men or women?

E. Changing patterns of consumption and supply

1. Symptoms

a. Are changes occurring in the types of fuel used, and the ways in which extraction takes place (e.g., changes from dead to greenwood, or from older to younger trees)?

b. Are there corresponding changes in the supply of fuel (e.g., shortening in length of cycle under shifting cultivation, increased distances travelled to gather fuel)?

c. Is the way in which fuel is collected changing (e.g., in terms of the time required, or of who carries out the work)? Are there changes in the use of fuel (e.g., altered duration or intensity of cooking, or amount of food prepared)?

d. Is fuel either becoming commercialized or increasing in cost?

2. What are the implications of the types of changes outlined for members of different classes, for the division of labour between men and women, and for other social categories and groups (e.g., ethnic minorities, the aged)?

3. Origins

What evidence is there for the following, acting either individually or in combination:

a. increasing demographic pressure on the fuel resource stock making itself felt either directly, or indirectly, through encouraging shifts in land use, which themselves affect the availability of fuel;

b. increasing pressure from animal populations; the incorporation of rural communities within wider networks of economic transactions which affect the composition of production, the allocation of land and other resources between alternative uses, the relations between members, and through the mediation of all these factors, the availability of fuel;

c. the development of alternative end uses and end use systems entering into competition with conventional uses for the same fuel materials.

This listing of questions reflects the full range of issues which have been raised in the preceding chapters. Later we shall look again at the alternative means of providing answers where these exist, and at how choices between alternatives might be made. It will also be necessary to address the broader questions of whether it is either desirable or necessary for research to concern itself simultaneously with all of the general areas of concern which have been outlined; and of whether certain questions within particular areas might be regarded as having higher priority than others. These are matters which may be taken up in the later discussion of overall research strategy.

2. CHOICE OF COMMUNITY

Parallel with the decisions which have to be taken about the substantive scope of a piece of work, the researcher will also need to determine how wide a geographical area might be covered at a given level of resources availability. Conversely, if geographic coverage is given, then decisions will have to be made about the number of communities which will need to be selected for investigation, in order for the diversity of conditions arising to be reflected as accurately as possible. Earlier chapters have dealt in passing with the types of differences in fuel availability and use which may arise from one place to another, but it will now be useful to review these in a more consolidated fashion.

In the first place variations may arise for environmental reasons. Differences in levels of rainfall or in soil type will affect the rate at which forestry resources regenerate after use, as well as the types of crops which are grown and the quantities of residues available as fuel. Environment can influence the demand for fuel, with the need for space heating becoming much greater at higher altitudes and as one moves further from the equator.

Superimposed upon these physical differences will be variations in the patterns of human settlement which are also likely to prove significant. Large communities are likely to obtain and use fuel in ways that differ quite substantially from smaller ones; and patterns are also likely to vary considerably between areas of higher and lower population density. We have also seen how the density of animal populations can become a critical consideration.

Over and above these simple demographic factors, account will also have to be taken of the spatial distribution of different types of fuel using activities. These may include small scale industries such as brick making, fish drying and tobacco curing which are likely to be confined to a fairly small number of places, but which can have an important local influence upon fuel supply and consumption patterns. Similarly, whether people prepare alcohol or not, or engage in other particular domestic uses of fuel, will often be a function of the particular cultural group to which they belong, and the tendency of people of similar backgrond to cluster around particular locations can again give rise to geographical differences in consumption levels.

The compostion of fuel using activities will also vary significantly from one area to another according to differences in levels of development, with advanced communities exhibiting a far greater diversity and far higher levels of aggregate demand than those where development has proceeded less rapidly. Communications and the proximity of rural communities to larger urban centres is also likely to be an important consideration, since relatively accessible locations are likely not only to exercise a greater demand for fuel in their own right but also to be subject to competing demands from larger centres to a far larger extent than those which are more remote.

Finally, communities will differ from each other with regard to the degree of internal differentiation which they exhibit, and hence in the extent to which fuel needs of various kinds arise. This factor will also need to be considered in arriving at a decision about how many communities need to be studied, and which these should be. It should be noted in passing that it

will also have implications for the number of households which will need to be interviewed in each community.

In view of the large number of variables listed which might potentially affect fuel availability and consumption, the task of selecting representative communities may be made to appear almost impossibly complex. While not wishing to underestimate the difficulties - a subject to which we shall return a little later - the problems raised are in practice made less severe by the tendency of many of the sets of variables mentioned to hang together in ways which reduce the overall number of permutations arising. As the Peruvian case study demonstrated, accessibility tends to be associated with a relatively high degree of development, a relatively wide range of fuel consuming activities, a relatively high degree of social differentiation, and a relatively high degree of social differentiation, and a relatively favourable set of physical conditions. This is a fairly familiar state of affairs in many, if not all societies, and even where it does not obtain it is likely that other correspondences of a similar nature may be located without undue difficulty.

Even where these difficulties can be overcome, however, other problems will remain. Selecting representative communities presupposes that we know what a community is, and as Brokensha has pointed out,[1] this is often far from straightforward, with the administrative units in terms of which previously available data is generally assembled, often not corresponding closely to social realities on the ground. Over and above this is the problem that even where social boundaries can be clearly demarcated, the unit identified may still not represent the optimum level at which to explore matters related to fuel. A situation might easily arise, where the members of a number of villages all collected wood from the same area of forest land; and where the interplay of supply and consumption could only be adequately explored if enquiries were to be pitched at the level of the overall cluster, and not of the individual unit. Yet again, the case from the Sudan illustrates that it may sometimes be desirable to cast the net wider still.

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[1]Brokensha, D., and A.P. Castro. Methods of Fact Finding in FAO, 1983, (op cit) p. 88.

3. CHOICE OF METHOD

The final set of choices which have to be made in designing a piece of rural energy research concern the different methods which can be used. Many of these have already been mentioned in earlier chapters, but they can now be explored more systematically, both in relation to each other, and to the kinds of questions to which they can help to provide answers.

Most of the methods to be considered can be located along a simple continuum. At one extreme lie the relatively unstructured approaches to data collection where the researcher has not yet arrived at a precise impression of the parameters of the problems to be investigated, and is attempting to open up lines of enquiry which will assist in the formation of hypotheses. At the other, lie the far more focused types of approach where the field of enquiry has been clearly delineated and the objective is typically either to measure certain phenomena or to determine whether certain anticipated relationships actually hold good or not. Stated in slightly different terms, the distinction is between approaches where researchers interact with members of the society under investigation and expose themselves directly to the physical environment within which it is found; and those where they simply treat their informants as if they were passive objects. Enquiries of the first type tend to preceed those of the second, in many areas of research. But there are also other types of question in relation to which either one or other approach is always likely to prove superior.

The discussion will be confined initially to the direct or primary methods of collecting data from respondents or through other forms of measurement which have to be carried out by researchers themselves. The use of secondary sources, which include records of various kinds and the results of other already completed pieces or research, will be considered at a slightly later stage.

(a) Participation and observation

We start with the relatively unstructured or open-ended methods of participation and observation, commonly employed by anthropologists in the course of extensive pieces of fieldwork. Actual participation in fuel related activities is likely to prove highly time consuming, and is subject to the limitations that researchers can never be sure how representative either the period at which they have arrived on the scene might be, or how typical the activity participated in is of what other members of the study population do. These, however, are problems which can be overcome and the method has many positive attributes to commend it.

It provides a particularly good means of understanding sequences of events, and the contexts within which they occur, as well as helping the researcher to build up a vacabulary of relevant local terms, and to understand the significance of what is going on in the way it is perceived by the people themselves. Two examples will be instructive in illustrating how this style of research can work.

The first is provided by Skar,[2] who accompanied women from a study community on their fuel gathering trips. This provided the opportunity not only to see where fuel was gathered from, which might not have been easy to communicate verbally, but also to see how fuel gathering was interrelated to other activities such as the grazing of animals, and how much labour time it actually required. Under slightly different circumstances, a similar approach might also have been employed to have determined how wood was cut, and as an opportunity to explore verbally why certain extraction practices were engaged in rather than others, or why certain parts or species of plants/trees were selected in preference to others.

The second example concerns participation in cooking and is hypothetical. (Why no actual instance cold be discovered in the literature reviewed, remains something of a mystery.) Engaging in this activity would once again be valuable as a means of understanding the allocation of labour time, with the researcher being able to form a better impression of the interaction between fuel use and other aspects of the food preparation process, than could be achieved by any other method. Similarly, direct involvement would provide a good basis for comparing cooking times, and fuel requirements for the preparation of different kinds of food, as well as for assessing the properties of different types and conditions of fuel, where this was a relevant consideration.

More passive forms of observation also have their part to play, particularly where direct participation might prove unduly obtrusive or disruptive. In addition, these could be used to cross check information obtained from other sources on the range of fuel using activities and processes; the types of fuels used in each, and their alternative end uses; the types of land from which various fuels could be obtained, as well as their areas and yields.

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[2] Skar (op cit) p.11.

These, and the other types of questions which participation and direct observation can help to answer, are indicated in Figure 5.1 below. As a general rule, they should be employed wherever phenomena are open to visual inspection; both in order to check data obtained from other sources, and as a way of drawing the researcher's attention to matters of significance, which might otherwise not come to light.

(b) Direct measurement

The second set of methods to be considered are those involving direct measurement. Essentially, they may be seen as a more organized and highly structured form of observation than those discussed in the previous section, and have useful applications across a relatively limited range of phenomena. Since they have already been discussed in some detail in Chapters II and III, only the briefest of summaries will be presented at this stage.[3]

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[3]See Sections on: 'Methods of Assessment' in Chapter II, and 'Biomass Productivity Under Different Systems of Fuel Extraction' in Chapter III.

FIGURE V.I

MATCHING QUESTIONS WI METHODS

QUESTIONS (see pages above)	METHODS					
	DIRECT OBSERVATION	DIRECT MEASUREMENT	KEY INFORMANT	INTERVIEW	ITK	QUESTIONNAIRE
A. CONSUMPTION						
1. Major Parameters						
a) Production categories	x	-	x	x	-	-
b) Processes	x	-	x	x	-	x
c) Fuel types	x	-	x	x	x	x
d) Other uses	x	-	x	x	x	x
2. Timings	x	-	x	x	-	-
3. Quantities						
a) Consumption rates	x	x	x	x	-	-
b) Fuel uses	-	x	-	-	x	x
c) Non-fuel uses	-	x	-	-	x	x
4. Variations	x	x	-	x	x	x
B. SUPPLY						
1. Wood						
a) Land categories	x	-	x	x	-	-
b) Land allocation	x	x	x	x	-	x
c) Yields	-	x	-	-	x	x
2. Residues						
a) Area cultivated	x	x	-	-	-	x
b) Yields	-	x	-	-	x	x
c) Timing	x	-	x	x	-	x
3. Storage	x	-	x	x	-	x
4. Annual Variations	-	-	x	x	x	-
5. Potential Fuels	x	-	x	x	x	-
6. Link to Consumption	-	x	-	-	-	x
C. ACCESS						
1. General						
a) Asset distribution	-	-	-	-	-	x

b) Social relations	-	-	x	x	-	-
c) Other factors	-	-	x	x	-	-
2. Specific						
a) Fuel rights	-	-	-	-	-	x
b) Fuel distribution	-	-	x	x	-	-
c) Implications	-	-	-	x	-	x
D. LABOUR TIME	x	-	x	x	-	-
E. CHANGE						
1. Symtoms	-	-	x	x	-	x
2. Implications	-	-	-	x	-	x
3. Origins	-	-	x	x	-	-

As far as fuel supply is concerned, direct measurements taken by the researcher, in the form of simple mapping exercises, may be useful to determine areas devoted to the growth of fuel producing trees or residue bearing crops; as well as a means of assessing yields per unit area. With regard to consumption, on the other hand, direct measurements in the field can serve either to establish approximate size ranges of non-standard local units, or to ascertain levels of fuel use on a daily, or slightly longer term basis. Very often, however, difficulties in establishing sufficient control over certain field observations will mean that tests need to be carried out under laboratory conditions. Very likely this will be specifically required where the efficiency with which available energy is being converted within a specific process such as cooking, has to be established. It may also be advisable as a means of assessing moisture contents, where these can exhibit a high degree of variability. The greater control made possible by the laboratory experiment will, however, always need to be off-set against the difficulty of faithfully reproducing the actual conditions within which a technology is used. Ideally, tests of both kinds should be carried out so that the results can then be checked against each other.

Direct measurements can provide the only relatively accurate means of obtaining data within the general areas outlined. At the same time, it is important to recognize that they have two major limitations.

Firstly, by contrast with most other methods, they can hardly ever be used in isolation. Knowing how much fuel is consumed by a household in a day, for example, is of little value unless it can be determined at the same time, by other means, how typical the day in question might be. Secondly, they are nearly always relatively time consuming, and may well make heavy demands also upon other scarce resources. This, in turn, suggests that direct measurements need to be used selectively, and that their most significant contribution may in fact be as a means of establishing confidence limits around data secured by more rough and ready means.

(c) **The use of key informants**

Another technique used at the stage of hypothesis formation is the "open ended" interview of a key informant; which, although it may be directed to some extent by a pre-determined agenda of questions prepared by the researcher, at the same time allows ample scope for the correcting of initial misconceptions, and the opening up of areas not previously perceived as being of importance. In the initial stages of a piece of research, it is particularly important as a means of coming to grips with less readily observable aspects of community life, such as past events and social relationships.

Key informants can fall into any of a number of categories. Community leaders will generally have an extensive range of dealings and contacts which place them in a good position to provide an overview of social conditions. The old are likely to be the best informants as regards significant historical events and change (and will generally have more time to talk than other types of informants). Specialists such as fuel traders are likely to have particular insights which will be of value. Local government officials, while perhaps lacking intimate inside knowledge, may, at the same time provide valuable information about important aspects of village life such as the illegal cutting of trees, which others have a vested interest in concealing.

The sensitive use of key informants is a potentially powerful research technique; but at the same time it can only be really effective if employed with a consciousness of its limitations.

We have already mentioned the possible unwillingness of certain categories of informants to deal with issues of a sensitive nature in this respect. In addition, informants' perceptions may often be blinkered by membership of a certain class, the behaviour of which does not represent the norm; or by the fact tht they will be men, and therefore lacking in direct personal experience of critical aspects of fuel collection and use. These problems can be overcome by the use of a series of informants, but the researcher will not always be in a good position to determine what the operative categories and distinctions are. Even where this is not a problem, members of certain groups, such as the poor or women, may either feel inhibited or may actually be prevented by others from acting as informants. For this reason it will be seldom advisable to use key informants to the exclusion of any other method of gathering data.

The technique works best where the subject under investigation is not controversial; where it is common knowledge (at least among some readily identifiable sub-categories); and where similar answers may be anticipated, irrespective of who it is that is being questioned. It can be applied across virtually the entire range of issues amenable to investigation by direct observation; although in certain areas, most notably the allocation of labour time, it should only be regarded as a second best option to be employed where time is very short. It comes into its own where questions of social relations and distribution are concerned, and is a particularly effective means for the exploration of changes occurring through shorter or relatively more extensive periods of time.

(d) **The Group Interview**

The group interview is suitable for covering broadly the same range of questions as the key informant and should be regarded as a broadly complementary method. It lends itself rather better to circumstances where there is likely to be a range of responses to a particular question across a population (as in the case of fuel consumption where resources are scarce and access is uneven), and can go a considerable way towards eliminating the danger of bias under these circumstances. It will also probably prove superior where there is a need to obtain accurate listings of things like fuel-using activities or processes, and the knowledge of individuals operating in isolation may be either insufficient or unreliable.

Yet, there remain two major difficulties. Controversial subjects may be even more difficult to address meaningfully in more 'public' discussion; and again, certain interest groups may feel inhibited either from attending, or from making their opinions heard. Where it is suspected that

this may be a factor, then the possibility of interviewing groups such as labourers, tenants, or women individually might be explored.

(e) **Understanding Indigeneous Technical Knowledge**

Each of the methods concerning rural energy research which have been discussed so far have relied on relatively loosely organized forms of interaction, between researcher and members of the study population, as a means of arriving at an understanding of what the relevant categories and relationships are, and how they operate. We now look at two alternative ways of eliciting some of the same types of information, which are more highly structured, but which at the same time, retain an essential element of openendedness.

One is the Triads test, which provides a particularly good way of determining the essential properties and range of uses of different objects within sets, such as wood fuels. It is described by Richards,[4] who explains it in the following term:

> "... (respondents) are presented with 'elements' ... in sets of threes and asked to discriminate by pairing two on the basis of similiarity and isolating the third on the basis of difference. Respondents are then asked to explain the 'construct' underlying their discrimination, and where appropriate, other objects under consideration are scaled according to this particular construct. The test is repeated until combinations amongst a given set of objects are exhausted and a complete classification of the objects under scrutiny personal to the respondent is created. This is the repertory grid which forms the basis for subsequent analysis."

In an investigation of wood fuels, the first step would be to collect together all of the species of wood found in a particular location. Three types would then initially be selected and informants asked to pair them in the manner described. An initial pairing might elucidate the category fast/slow burning, and a subsequent one the contract of smoky/non-smoky fuels. Other

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[4] P. Richards, 'Community Environmental Knowledge in African Rural Development' in R. Chambers (ed.) 'Rural Development: Whose Knowledge Counts?' IDS Bulletin, January 1979, vol. 10 no. 2. pp. 28-36.

possibilities might include alternative end use for fencing/not used for fencing, or commercially/transacted/not transacted. The process would continue with new sets of three replacing the initial one until it was apparent that all significant categories had been obtained. Each type of wood could then be assessed against all categories to form an overall impression of the use pattern of wood resource in a society, and the reasons underlying this.

The important contrast between this and less open-ended approaches, is that the researcher does not need to make judgements in advance about what may and may not be significant. The matrix is not given, but arises out of the respondents' own perceptions, and the technique can easily be extended in order to test for potentially important differences in perception between forestry officials and fuel users, men and women, and rich and poor consumers. Apart from its own value, it is also useful as a means of opening up new lines of enquiry which might otherwise have eluded the researcher.

Another technique for eliciting informants' knowledge is described by Barker.[5] This involves the use of traditional games as a device for establishing relative magnitudes. It works particularly well where information of a statistical nature is required regarding matters which people themselves may not generally think about in numerical terms. The actual method used by Barker was based on a Nigerian game built around the distribution and redistribution of stones between a series of holes organized in rows on a board; and was adapted so that farmers' attitudes to various subjects could be ranked. It could, however, have served just as well in exploring matters relating to fuel.

A board with twelve holes, for example (or simply twelve holes dug in the ground) could be taken to represent the twelve months of the year, and informants could then be asked to allocate stones between holes to represent the total quantities of fuels consumed during different periods. Alternatively, a smaller number of holes might be used in a similar way as a means of comparing yield of crop residues either from different species, or from one year to another. Where a number of different fuels were used, the method could be adapated again so as to indicate their relative importance over a period of time, and so forth.

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[5] D. Barker, 'Appropriate Methodology: An Example Using a Traditional African Board Game to Measure Farmer's Attitudes and Environmental Images', R. Chambers, Ibid.

None of these possibilities could be expected to yield completely accurate data, but it seems highly likely that outcomes would at least be more satisfactory than if only simple verbal enquiries were used. They could therefore prove very useful either in planning more detailed pieces of research, or as a substitute when research resources were limited. The use of a familiar idiom provided by a game can provide a breakthrough into an area that might otherwise remain virtually inaccessible; and even where the game itself is unfamiliar, the use of counters which people can manipulate and observe is far more likely to prove satisfactory than purely mental number juggling exercises.

These then are two examples show how knowledge can be elicited, and the integrity of informants' own perceptions preserved, within the confines of a situation which is basically structured and controlled by the researcher. Other approaches to understanding indigeneous technical knowledge may be found in the articles cited, as well as at other points in the Bulletin in which they appear.[6]

(f) **The Questionnaire Base Survey**

The questionnaire based survey, the most structured of all the methods described and almost certainly the most familiar to readers, provides an economical way of obtaining answers to questions which can be precisely formulated in advance. It works best in relation to phenomena which have clearly been identified as significant within a particular problem area, and where there is a need for these to be measured across an extensive range of informants. For example, a questionnaire would most probably not be used to determine the range of fuel using processes or fuels used within a society; but it would be used to establish patterns and variations in individual behaviour from within a range which had already been specified by other means.

There are, of course, relatively more and less structured ways of using this overall approach. Provision may be made within a questionnaire for certain open-ended questions, and questionnaires can be used in combination with other methods, but variants of this kind on the basic model will be ignored here.

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[6] Ibid.

In assessing the utility of the questionnaire it is relevant to identify initially the types of questions it is not well equipped to answer. These fall into a number of categories. In the first place, it is not a suitable device for examining complex phenomena which cannot readily be broken down into component parts. Examples of this type are summarized under the heading of Origins in the questions on changing patterns of consumption and supply listed earlier. The most that one could expect of such a questionnaire is that it might indicate certain symptoms of change as perceived by different individuals. These could then provide the starting point for an investigation of causes by other means. Similarly, one would not use a questionnaire to explore overall patterns of social relationships (see question C1b); although it might be employed for more limited purposes within this field such as the determination of the percentage of the study population who engaged neither in the hiring in, nor the hiring out, of labour. The unsuitability of the questionnaire in other areas such as the understanding of time allocation, has already been indirectly indicated in earlier discussion of other methods.

A second general area where it should not be used is in relation to questions which are likely to yield the same or very similar answers irrespective of who the particular respondent might be. The precise extent of this category will vary to some extent from society to society. It will, however, nearly always incorporate matters such as the identification of potential fuel materials, the determination of year by year variations in residue yields, and the times of year at which different types of fuel material are available and may be used.

There is a final set of problems in relation to which questionnaires may sometimes have to be used, but where other methods are clearly superior when research resources are sufficient. These will include phenomena which may be difficult to recall, or thing such as quantities of fuel consumption, which may never have been conceived in precise terms.

Seeing where questionnaires do not work well helps to specify the types of issues which they can most readily be used to explore. In general, these will be relatively simple, and will exhibit substantial variation between individual respondents. Perhaps the best example of this is provided by asset ownership whether this is explored at a general level, or more specifically in relation to fuel. Possible answers can be anticipated in advance, and there will clearly be variations which will make it virtually impossible for any individual or group of individuals to possess an exhaustive community-wide knowledge where reliable written records are not available. Surveys (in combination with physical measurements) also represent the only real means of determining fuel consumption levels, or levels of supply where fuel bearing assets are privately owned and controlled.

The strength of the well designed survey is that it enables data to be collected on the types of subjects outlined by relatively inexperienced field researchers. This approach, however, is not without its difficulties. The rigid format that must be employed if it is to work, and the passive role into which this casts the respondent, means that by contrast with other methods there is little scope of identifying meaningless or misguided questions. The desire of the respondent to please a researcher who comes from a group of relatively high social status, or simply to get rid of him/her as soon as possible, will frequently mean answers will be given even where questions make little sense.

Given the extent of the cultural divide which will generally separate researcher from researched, and the fact that this is often overlaid by problems of language, the scope for breakdowns in communication is often considerable. For this reason, care has to be taken to ensure that pre-testing always takes place and that internal cross-checkes for consistency are built in . It is clearly also important that regular contact be maintained between supervisor and field staff. All too often, it is exactly the opposite that actually happens. Faced by uncertainty, a very common response is for the research to prepare and attempt to administer a massive questionnaire which indiscriminately covers all factors which might conceivably have any bearing upon fuel availability or use. Apart from being quite unsatisfactory in itself, this runs the risk of alienating respondents who have better things to do, and yields vast quantities of data which are either of no value, or require far more time to process and analyze than is ever actually at the researcher's disposal.

(g) Methods and Questions: A Summary

For ease of reference, a chart has been prepared that indicates which methods are suitable for the exploration of different questions. The questions are laid out down the side of the page in the same order in which they were presented earlier in the chapter. On occasions, where all of the questions within a section are amenable to investigation by the same set of methods (as in the case in relation to labour time), then only the general category, and not the individual questions have been noted. Methods are set out across the page from left to right in the sequence within which they have just been considered; that is to say, with the most open-ended preceding the more structured.

The chart should be largely self-explanatory, but since some of the distinctions which have been drawn may appear somewhat arbitrary, a few points may be made by way of clarification. All of these relate to situations where the presence of more than one cross in a row implies that alternative approaches to particular questions are open. Sometimes this will actually be the case, but not on other occasions. In certain instances, different aspects of compound or relatively complex questions will lend themselves to investigation by different methods. With question B3, for example, it might be best to determine by means of group interviews whether certain fuels were storable or not, but then to use individually administered questionnaires in order to find out the extent and distribution of actual storage capacity.

On other occasions, it could be that more than one method needs to be utilized in order to arrive at a satisfactory answer to an individual question. In seeking to establish fuel consumption totals, for instance, it might well be advisable to use physical measurement to establish the size of the basic units with which informants deal, and a questionnaire to establish how many such units might be consumed within a given period of time. Generally, however, when two or more crosses appear side by side within a row, this may be taken as an indication that choices will need to be made between methods. In relation to the example just cited, ITK methods might be employed instead of questionnaires; where the amount of time available per informant was relatively high; where the situation to be dealt with was relatively complex (perhaps involving multiple fuel use or seasonal variation); or where simple recall might be deemed for some other reasons to be unlikely to provide an adequate response.

It should also be recognized that differences between societies can lead to certain methods being more appropriate in some instances than in others. Where all land upon which fuel wood grows is communal, then only a small number of people will need to be consulted in order to determine the total area upon which a community may draw; but where there are private woodlots, more extensive and systematic forms of enquiry will most probably be required. In yet other cases, alternatives have been given that will always be less satisfactory than others, but these may need to be used on occasions, where time available per respondent is limited.

In view of these various qualifications, it must be emphasized that the chart provides no more than a rough guide which should only be used in conjunction with the preceding text.

4. RESEARCH PACKAGES

The preceding sections of this chapter have dealt with the range of substantive issues raised by rural energy research, the factors which must be taken into account in determining when research will be carried out, and the methods of data collection which are available. If the discussion were to be terminated at this point, then it might be concluded that the ideal research package would explore all of the questions outlined in a large number of locations, using the most accurate methods. This, however, takes no account of resource constraints, and the need to make trade-offs between substantive and geographical scope; the precision of the methods used and the number of informants who can be contacted, and a range of other factors. In this section we shall be looking at the different types of research strategy or package which have been devised in response to this probelm. The first of these is the extensive sample survey; the second, the single community study; and the third, occupying an intermediate position between the others, the purposively selected multi-community approach.

(a) The Extensive Sample Survey

The extensive sample survey is typicaly either national or regional in scope. It relies heavily, if not exclusively upon the use of questionnaires. Considerable differences can arise in the substantive scope of enquiries falling within this category, but the overall tendency is for breadth of geographical coverage to go hand in hand with the exploration of a fairly narrow range of questions, and for these to be predominatly concerned with the consumption of fuel. There are naturally, variations in the scale upon which execises are conducted. At the lower end it is difficult to imagine a survey involving much less than 1,000 respondents, but at the upper end of the spectrum, numbers may be very high indeed.

Respondents are selected according to a multi-stage sampling procedure, which normally combines purposive and random elements. A not unusual sequence of events would be for a number of provinces to be purposively selected to represent broad regional differences arising within a country; for these to provide the sample frame from which a number of smaller administrative units could be randomly drawn; and for these units, in turn, to provide the sampling frame for the random selection of a set of households or other energy consuming units.

Since this research package is closely associated with the questionnaire method discussed earlier in the chapter, it will not be necessary to explore all of its positive and negative

aspects here. As far as the former are concerned, the strength of the approach lies essentially in its capacity to yield aggregate macro level data on relatively simple and clearly identifiable phenomena. In addition, the results obtained will be statistically representative, and will lend themselves to rapid, computer based analysis.

The limitations of the questionnaire method need to be explored at slightly greater length. There are four problems, in particular, which should be mentioned. The main difficulty is that however expertly the approach is applied, it will never prove capable of yielding answers to certain types of questions. While it is very difficult to characterize these accurately, they will tend to concern matters lying towards the more complex end of the spectrum explored and to include topics such as the allocation of labour time to fuel using activities.

The second general set of difficulties arises in relation to matters which might potentially lend themselves to investigation by extensive survey, but which have not been sufficiently well understood in advance to be explored within the confines of a predetermined format. Finding an appropriate illustration is not easy, but reference to earlier discussions of what constitutes a household, or of the distinction between domestic production for self consumption and for markets, will help to convey the sense of what is intended here.[7] The result of preceeding without proper clarification of such matters will be misleading responses that either go undetected or, if noted, will require that certain schedules be abandoned. In either instance the validity of the random survey procedure will be undermined.

The third limitation is that the approach can only be applied where suitable sampling frames already exist, or where sufficient resources exist for estabishing them in advance of any direct enquiry into energy related matters. This will generally not be a serious problem at higher and intermediate levels, but can often pose very serious difficulties indeed at the lowest level, where individual household information may be frequently inaccurate and characterized by a large number of omissions. Any attempt to proceed under these circumstances is to invite substantial, and at the same time, largely unpredictable degrees of inaccuracy.

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[7]See Chapter II Sections on 'Household Size and Composition' and 'non-domestic Forms of Fuel Consumption'.

The final type of problem arising in relation to the extensive survey is its tendency towards exclusion. Information about domestic fuel consumption may be of limited value if not accompanied by an understanding of non-domestic end uses, where the latter are competing for scarce supplies. Exploring consumption in isolation from supply will generally beg the question of whether fuel related activity actually constitutes a problem for local people or not. Failing to locate fuel consumption within the broader context of access to resources, and the division of labour, leaves the analyst ignorant of the interest groups involved and hence of the feasibility of possible forms of intervention. Also, a failure to look at the past means that the future and the possible need for intervention cannot readily be anticipated, and so forth. All of these matters can, in principle, be explored within the extensive survey format. However, the fact that they are so often overlooked in practice, suggests that it may be a somewhat imperfect means for investigating the kinds of linkages and relationships which they encompass.

In summary, it is important to mention a common variant to the basic form so far described. This is the survey which is carried out as a part of some more comprehensive data collection exercise, which also concerns itself with non-energy questions.[8] The advantage of 'piggy backing' one survey on another is that it offers certain economies of scale. The establishment of reliable sampling frames becomes at least a stronger possibility and a larger number of informants can be reached with the same input of research time. There are, however, also potential drawbacks. The total amount of data to be collected from individual informants may become excessively large, thus adversely affecting the quality of the responses received. The energy researcher may also have to accept sampling procedures and frames which are sub-optimal in terms of the specific nature of the energy issues to be investigated.

(b) **The Single Community Study**

The single community study lies at the other end of the spectrum of research possibilities and contrasts with the extensive survey in a number of specific respects. It is generally carried out by an individual or small team of researchers with relatively little previous

[8] A good example of this is provided by Energy Unit, Ministry of Agriculture, Malawi Rural Energy Survey, 1981. Mimeo. The survey is described in a slightly different context later in this chapter.

experience, who remain in their chosen location for an extended period of time. The number of informants contacted is comparatively small, sometimes numbering as few as thirty or forty, and only seldom exceeding two hundred persons. In principle at least, this makes it possible for a wider range of issues to be explored. There is also scope to check the accuracy of informants' responses against physical measurements in certain instances; to assess validity of long term recall by means of repeat visits at short and regular intervals; and in general to bring a greater diversity of methods to bear in the exploration of particular questions. Finally, while few studies provide detailed information on the subject, it is apparent that the overall resources required to carry out research of this kind are of a much lower order of magnitude than is true of the extensive survey.

These particular features combine to give such studies a distinctive set of advantages and disadvantages. On the positive side, opportunities arise to reformulate research plans in the light of actual experiences of the problems under investigation. This is likely to be particularly important in enabling the researcher to properly identify such things as the range of uses to which a fuel may be put, or variations in its use through time. Continuing interaction with the study population will also provide a far better basis for assessing the range of social interests likely to be affected by any attempt to intervene; as well as for identifying possible types of reactions. In addition, it will help to establish how energy is connected to agricultural and other forms of production; and to determine the priority which energy issues enjoy in the minds of the people being studied. In conclusion, it provides an opportunity to test different methods and to tailor those eventually close to the precise requirments of the matters under investigation.

These strengths make the village study a particularly good device for arriving at an understanding of the factors which need to be taken into consideration in the preparation of more systematic and geographically extensive work. But it is important at the same time to note that it can never act as a substitute for these forms of enquiry. However carefully a community is selected, there will always be severe limits to the extent to which it may be claimed to represent any wider entity, and attempts to project national or regional consumption from what has been discovered from a small number of people in a particular location, must invariably prove futile. The most that can be asked is that the clearly atypical should be avoided.

The community level study is also limited, insofar as it excludes from consideration various external linkages and relationships which may bear upon fuel availaibility and uses.

Instances such as those explored by Bajracharya, where it was possible to identify a small and relatively self-contained exo-system, are likely to prove few and far between. Much more often, it will be necessary to look further afield for a proper explanation of the underlying determinants of a fuel situation. This applies particularly to that important sub-set of situations where fuel is in short or declining supply. This suggests the advisability of using the single community study as an element in a package of approaches, wherever possible.

(c) **The Purposively Selected, Multi-Community Approach**

Many examples of rural energy research that fall into the first two categories can be cited. Yet, neither appears as frequently in the literature as the purposively selected multi-community approach. In essence, this may be seen as an attempt to go at least some way towards representing the diversity of conditions found in any region or country, without using substantially more research resources than those normally associated with the larger single community study. But like the other categories considered, this approach incorporates a range of packages with slightly different emphasis. At one extreme lies the single person study exemplified by Best's work in Southern Africa,[9] where three communities were selected to represent varying ecological conditions. At the other extreme we find studies such as that carried out by Soesastro,[10] where the purposive selection of communities goes hand in hand with the appliction of methods quite similar to those used in the extensive study.

At its best, this type of research strategy combines all of the strengths of the single community study with an abilty to understand the major respects in which fuel scenarios vary from place to place. As such, it provides the ideal basis for planning more systematic work, and can usefully perform a number of other functions. But in seeking to occupy the middle ground, it runs the risk of combining the worst of both worlds simultaneously, with more and more items being added to questionnaires as a means of trying to come to grips with issues that have not been properly understood, and where implicit claims for statistical representativeness are made, that have no basis in reality.

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[9]Best, (op cit)

[10]Soesastro (op cit).

The potential misuse of questionnaires has already been treated in sufficient detail. However, the problem of representativeness requires more attention. It has already been noted that researchers working on individual communities have often claimed that they were typical, when in fact they were not, and exactly the same 'tarmac road' bias may be detected in relation to many multi-community studies also. But even where this particular bias is corrected, it is still misguided to assume that a single community can represent an ecological or administrative zone. Powerful evidence in support of this assertion is provided by Islam, who in his survey work in Bangladesh took the unusual step of collecting fuel consumption data from all of the villages within an administrative union. Comparative results presented in one table show the enormous variations which can exist between places within very close proximity to one another.[11]

Two studies from Indonesia show how it is possible to begin to surmount difficulties of this kind, at the same time illustrating the importance of being able to differentiate clearly between the types of objectives which the purposively selected multiple community study can and cannot satisfy. It is perhaps significant that both studies were relatively well endowed with resources but it should be pointed out that both used less than two person years of research time in the data collection phase.

The first was carried out under the direction of Soesastro.[12] It explored fuel consumption and supply in forty West Javanese villages, using a combination of questionnaire and other methods. The study had a number of objectives which were clearly formulated at the outset. The first was to provide a baseline against which to analyze long term trends in rural energy availability and supply, in the light of changing incomes and technology. More specifically, the second was to understand how the poorer sector of the population used energy and to determine whether energy based intervention could be used as a vehicle for improving the distribution of income. The third objective, more specific still, was to provide data which could be used to assess the likely effects of changing levels of kerosene subsidy.

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[11] Islam (op cit). Table 3.3.3.

[12] Soesastro (op cit).

West Java was selected because it was more accessible than other parts of the country, and because the problem of fuel shortage was felt to be more serious here than elsewhere. Five districts were then chosen to represent different densities of population, different geographical features (including coastal and non-coastal locations, and places with good and bad road communications) and different ecologies (including high and low plains, varying land use patterns and fuel importing and exporting areas). Eight communities were then selected from each district. These were clustered together and included villages of 'traditional', 'transitional' and 'modern' types, in roughly the same proportions as those found in the region as a whole. Finally, local tax records were used to divide the population into four different income groups.

The second example is provided by Weatherly's study.[13] This was conducted in twelve villages in different parts of Indonesia, and was designed to determine the likely effects of rural electrification in relation to existing patterns of energy availability and use. The research covered domestic, home industry and small-scale industry end uses, as well as looking at fuel supply. Once again, questionnaires were relied upon as the major means of gathering data, but physical measurements and other methods were also employed.

Three basic sites were chosen. One was a newly cleared area with abundant woodlands; another had distant forests and a well developed firewood market; and third was a developed agricultural area with good access to agricultural wastes and commercial fuels, but little collectable firewood. Another site where electrification had already taken place, was then added for comparative purposes. From each area one poor, one average and one prosperous village was selected. Finally, fifteen households were chosen from each village to cover different categories of landholding; with landless and other non-agricultural groups being incorporated where appropriate.

These examples largely speak for themselves, but two specific features which they hold in common should be pointed out. The first is that neither sought to predict overall fuel consumption figures for the regions in which they worked. Surveys were not designed with this purpose in mind, but rather as a means of arriving at a better understanding of the likely implications of certain types of intervention - changes in kerosene prices and general poverty

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[13] Weatherly (op cit)

alleviation measures on the one hand, and the introduction of electricity on the other. The second is that in addition to making allowances for differences arising between areas, they also sought to encompass variations occurring with them, by selecting villages at different economic levels from within clustered groupings. In this way they demonstrate an awareness of the kinds of questions which this type of research, as a whole, can reasonably be expected to answer; and how at a rather lower level of research resource availability, it can be made as representative as possible.

5. GENERAL PRINCIPLES

This concluding section of the book will attempt to summarize some of the general principles which have arisen in the course of the discussion. These should help the potential researcher to decide which approach or combination of approaches are best adapted to the requirements of the particular situation to be investigated, and should be valid irrespective of the level of research resources which are available.

(a) Secondary Sources

Although they have not been mentioned until now, secondary sources of information, in the form of official records and the results of already completed pieces of research, can be of critical importance in determining the overall direction an enquiry should take. As such, they should always be explored as soon as a basic problem has been defined. This may seem so obvious as to be hardly worth mentioning, but the fact that less than half of the surveys which have been reviewed make any reference to secondary sources at all, suggests that this basic principle is not as well established as it should be.

How then can such sources be identified, and what functions can they perform? To begin with, land use maps, aerial photographs and satellite images can all be used to help identify the different ecological zones which will need to be incorporated in a piece of research. At the more micro level, they may, in addition, provide a means of assessing the area devoted to fuels of different kinds. Also, where records are available for different points in time, it may be possible to determine changes in patterns of fuel related land use, and hence to delineate zones of present or likely possible future fuel shortage.

Secondly, and perhaps most obvious of all, is the use of official records as a basis upon which to draw up sampling frames. Almost everybody who has carried out a multiple community study, must have used some census or other government data sources to choose the precise locations in which data collection was to take place; but there is rather less evidence of the potential applications of local land and tax records as a preliminiary means of coming to grips with micro-level social differences and the stratification of populations. The possibility of using surveys of activities such as rural industries as a sampling frame, should also be borne in mind.

Finally, secondary sources of information such as time allocation studies, can be used to clarify which fuel using activities require attention, and which are of less significance, as well as indicating from whom the information on different topics should be collected. Alternatively, the discovery of an existing data source may be used as a device to release resources, to explore questions which might not otherwise have been investigated. Reliable crop production statistics for example, may prove an adequate basis upon which to estimate residue availability, and thus reduce the need to enquire into the supply of fuel. The pre-existence of a domestic consumption survey might suggest the desirability of focusing upon industrial uses and the influence of these upon the availability for the domestic user, and so forth.

Where can these different types of information be obtained? Brokensha has dealt comprehensively with this subject, and it is necessary to do more than summarize his conclusions here.[14] The first major source will be the central governments' records, particularly those of census bureaus, ministries of agriculture and forestry departments. Local government institutions and the local branches of national ministries, will also generally repay investigation. Furthermore, local research institutions are likely to prove useful as a means of identifying unpublished sources of information such as farm management surveys and ethnographic reports.

All of the comments made in this section so far have related to secondary sources of substantive information. It is, however, worth noting in conclusion that much can be learnt from the methodological point of view by looking at other energy surveys, and other rural surveys on

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[14]Bronkensha (op cit).

topics that are in some way comparable to energy. It is hoped that this book will go a considerable way towards indicating what is available in a general sense; nevertheless, the researcher will always be well advised to review further the range of experience available in relation to the specific society which is to be explored.

(b) **Determination of issues**

One of the major conclusions to arise from this discussion has been that rural energy research can be a much more complicated matter than is often assumed. Indeed, the precise scope and direction of a particular piece of work generally cannot be determined satisfactorily in advance and although working hypotheses are always essential, at the same time, it is important not to pre-determine the nature of the enquiry to the point where nothing that is learnt during the period may be used to bring about a change in plan.

The possibility of using single community fieldwork as a way into a larger and more structured piece of research has already been mentioned. Often, however, even where the resources made availale for research are substantial, deadlines may exist which will rule out the possibility of a relatively lengthy introductory period. Under these circumstances, the temptation to move immediately to the comprehensive questionnaire may be strong, but this should be avoided until another set of possibilities has been exhausted. These may be considered together under the general heading of rapid rural appraisals (RRA).[15]

RRA approaches all take as their point of departure, the recognition that certain questions take logical priority over others. As far as fuel supply is concerned, for example, it will always be necessary to determine whether the land from which biomas fuels are obtained is under private or public control, before deciding how much attention has to be paid to class as a determinant of consumption. The importance of seasonal factors will need to be explored before the need for repeat visits can be assessed; and so on.

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[15]For a collection of writing on this subject see R. Longhurst (ed.) 'Rapid Rural Appraisal', IDS Bulletin, October 1981, vol. 12, no. 4.

The Malawi rural energy survey[16] provides a good example of one type of RRA approach, which successfully established the major 'features' in the energy landscape relatively quickly and cheaply, without pretending to assemble all of the different types of data which might be needed for a comprehensive planning exercise. It was carried out twice during a year in order to allow for seasonal variations, and involved posing additional questions to some 2,400 respondents, who were already being approached in the course of the National Sample Survey of Agriculture.

The objectives of the survey were simply to find out about the kinds of fuels which were being used, the ease with which they could be obtained, and the ways in which people ere responding to fuel shortages where these arose. A short questonnaire with alternative answers was designed with these purposes in mind. People were asked firstly to name the most important fuel which they used to satisfy a series of specified end uses, and the two most important fuels used for cooking. Next they were questioned on whether fuel was purchased or collected, and whether collection posed any difficulties, or any greater difficulty than had been experienced in the past. Attempts were also made to determine the nature of cooking and tree planting practices to see if there were any differences between areas of fuel shortage and abundance.

While it has already been indicated here that there are certain purposes for which such a survey could not be used, it is clear that the simple format proved sufficient as a means of satisfying the basic objectives for which it was designed. Areas of shortage were differentiated from areas where no difficulty was being experienced, and with regard to the former, it was noted that the people themselves had yet to take any steps which might help to effect a solution to the problem. Together with other pieces of information which were gathered, this enabled the organizers to eliminate certain possible forms of intervention, and to direct their attention on others which appeared more promising. Although it was not the intention in this particular case, it can easily be seen how the types of enquiry conducted might easily have provided a foundation for launching further surveys, which in turn, might have laid the foundations for more detailed planning exercises.

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[16]Energy Unit (op cit).

A quite different example is provided by Ensminger's work among the Galole Orma, a group of riverine pasturalists residing in the Tana river district of Kenya.[17] This was an area with poor communications and limited trade, where most of the communities were very small. About half the population lived permanently in areas where the pastures were relatively good. The remainder were semi-nomadic, but coming under increasing pressure to settle as a result of the effects of drought on their stock of cattle.

Mainly using the key informant method, and drawing on information about adjoining areas of higher and lower rainfall to provide comparative perspective, Ensminger set out over a period of a few weeks to build up a picture of the changes which were occurring and the implications of these for energy use. Her findings are summarized in Figure V.II overleaf. Although the author herself offers no clear indication of how this particular piece of work might have progressed further, it is once again apparent that it could have provided a very sound foundation for more detailed enquiry. The different types of fuel using activities are clearly identified, as are the areas in which availability is most likely to be a problem. A clear impression is drawn of the critical people who should be interviewed under different circumstances. In addition, it becomes apparent that alternative end uses of fuels need to be taken into account in settled areas, but not among nomadic peoples; and that the scope of enquiries would also need to be rather wider here, in order to take account of the trade in charcoal. This particular example shows how a very brief enquiry can help both to identify the major parameters of a problem and to define the areas within which further and more detailed enquiries may be required.

(c) Flexibility in Data Collection

The importance of avoiding exclusive reliance upon any particular method of gathering data is closely related to the need to allow time for hypothesis formation and reformation. Earlier discussions in the chapter indicated that there are very few occasions when only one method is open for exploring a question, and that it will nearly always be desirable to take advantage of a range of options wherever possible. Reliance upon a single method is far less

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[17] Ensminger, J. Energy Use Among the Galole Orma, 1981. Mimeo.

FIGURE V.2 **ENERGY TRANSITION AMONG THE GALOLE ORMA**

Settlement Pattern	Nomadic	Small permanent settlements	Large permanent settlements
Demand for firewood	Small, plentiful supply of milk which can be consumed without heating	Growing pastures crowded, milk yelds decline, more maize consumed which must be cooked. Wood also now required for fencing.	Further increase
Firewood availability	In excess of requirements	Gradual decline. Some switching to less preferred varieties.	Acute shortage
Fuel collection	Takes place during course of other activities	Become a separate activity performed by women on behalf of their households	Becomes a specialized activity.
Use of other fuels	Does not arise	Use of charcoal by hotels and wealthy households. Introduction of kerosene for lighting.	Charcoal used by all categories of consumer

likely to reveal any misconceptions that underlie the way in which a matter is being explored. Also, even where it is clear what is being measured, the use of only one method provides little or no indication of how successful an attempt may have been. The combination of different methods provide a better indication of accuracy, as well as a means of establishing confidence limits around less precise, but more easily administered alternatives. Physical measurements in the field can be checked against laboratory results, recall about consumption compared with direct physical measurements, and the outcome of single interviews assessed in relation to findings gathered from periodic, repeat visits.

The same principle also applies in relation to different levels of research. A village survey relying on relatively structured methods can be revised and strengthened by the addition of a small number of cases where the researcher interacts on a more formal basis with particular households. Similarly, a national level survey will gain in analytical depth if carried out side by side with some more wide ranging single community investigations. Clearly such options will not be easy to pursue where resources are very limited or deadlines particulary tight, but the potential rewards are great, however severe the constraints.

(d) **Awareness of issues which are not being investigated**

The final principle which should guide rural energy research is the need for an awareness of the questions which might potentially be asked, but which have, for various reasons, been excluded from a particular piece of work. This presents no problem where the decision to exclude has been taken consciously, either as a result of a lack of resources, or because it is known that the necessary data already exists in secondary form elsewhere.

Problems can however arise, where the act of focusing upon a particular relationship or question is carried out in ignorance of the 'dark areas' surrounding it. A number of examples of this kind have arisen in the course of the book.

Surveys of domestic fuel consumption, for example, are carried out in ignorance of the factors influencing availability. 'Representative' communities are chosen and analyzed with no regard to the broader networks of fuel transactions within which any reference to the past, and in each instance the danger of misconceptions and unhelpful policy prescriptions looms larger.

A closely related point is that the researcher also needs to be aware of the people who are not being asked. These may include the women who know most about fuel properties and uses, the poor who have greatest difficulty in obtaining the fuel which they need, and the old and infirm who may be able to engage in the business of collection on their own behalf, even where fuel is readily available.

In conclusion, and in keeping with the thrust of the final principle outlined, it should be remembered that this enquiry itself has been limited in scope. It has had little or nothing to say about the so-called commercial fuels, such as kerosene, petroleum, charcoal, and so forth, even though these are of considerable, and often growing importance to many in the rural Third World.

Similarly, it has entirely neglected animal and human muscle power on the grounds that these serve quite distinct end uses, and therefore can be regarded as a separate problem area. These are perhaps not unreasonable points at which to establish boundaries at present; nonetheless, such an approach may be more difficult to justify in future. Growing shortages of conventional biomass fuels are bound to lead in many areas to increased charcoal and kerosene consumption for domestic end uses. Meanwhile, the increased cost of fossil fuels is encouraging research into the possible uses of biomass to provide lift and motive power for agricultural and other purposes, which could lead to quite widespread practical applications in the fairly near future. It is towards these new interactions between domestic consumer and fuel commodity producer on the one hand, and between domestic and agricultural consumer on the other, that the next generation of energy researchers may need increasingly to turn their attention.

SELECTED ANNOTATED BIBLIOGRAPHY

The material in this annotated bibliography is divided into three major parts. The first covers rural energy surveys, and is sub-divided into sections on Africa, Asia and the Pacific, and Latin America. The second incorporates items focussing on research methods; while the third draws together contributions on rural energy issues of a more general nature, which help to illuminate some of the broader themes explored elsewhere in the book.

No attempt has been made to be comprehensive in the coverage of literature in any of these categories, although the proportion of available materials reviewed in the first and second parts is almost certainly greater than in the third. To have tried to have done anything more than this would not have been possible in the time available; but it was, in any case, our intention to indicate only the different types of work which have been carried out, rather than to deal exhaustively with all of the literature produced in the field. We offer our apologies in advance to the authors of the many valuable studies which we have not been able to accommodate here.

Individual annotations have been prepared with the major objective of informing the reader of the contents of the items to which they refer. But on many occasions we have also tried to go beyond this point in order to indicate what we regard as the major positive features of contributions, as well as their important limitations. Once again, we must apologise to those authors who may feel either that their work has been inadequately summarized, or that the criticisms made of them are unfair.

As in the case of the similar bibliography prepared by Barnett (et al),* we have tried, wherever possible, to select material which is accessible in the form of published books or journal articles. However, much valuable material is only available in less accessible forms; either as mimeos or other limited circulation publications of the institutions at which it was carried out. For this reason, all items mentioned have been deposited with the library of the International Development Research Centre, P.O. Box 8500, Ottawa, Ontario, Canada K1G 3H9. On application to the librarian, some form of copy of more inaccessable items may be obtained - at no charge to applicants from the Third World.

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* For a full reference see entry III 2 below.

I. SURVEYS AND EMPIRICAL STUDIES

A. AFRICA

1. Alla-el-Din, M.N. "Rural Energy in Egypt: A Survey of Domestic Needs and Resources," 1981. Mimeo.

This is a draft report on an IDRC project, based on a survey of energy sources and end uses in twelve Egyptian villages. An introductory section presents a general picture of energy use in Egypt and sets out the objectives of the study. This is followed by a discussion of methodology which provides information on the design and details of the questionnaire (which is included in an appendix); on the selection of villages and households; and on data processing and analysis. Twenty-five households were interviewed in each village and data obtained on the supply and consumption of commercial and non-commercial fuels. The final section of the paper reviews the social and economic features of sampled households, discusses the production of non-commercial sources of energy, presents findings on energy consumption by the rural population, and explores factors affecting the amount and pattern of energy consumption.

2. Arnold, J.E.M., M. DeBacker, and S. Pringle. Present Wood Consumption and Future Requirements in Kenya. Report to the East Africa High Commission, Food and Agricultural Organization of the United Nations. Rome: FAO, 1962.

This early study is one of a series of three which also covered Uganda and Tanganyika. It does not look at firewood and is primarily of interest as an example of a study of the other end uses to which wood may be put. It focuses in particular upon the consumption of sawn timber and industrial roundwood for building, fencing and furniture. Information was collected from a number of different categories of rural areas, and covers consumption by rural industries, households and larger farm enterprises. A detailed account of the sampling procedures and methodology adopted is given.

3. Babiker, A., and Alla-El-Din. "Rural Energy and the Environment: Impact of Women in Semi-Arid Sudan." In Women and the Environment in the Sudan ed. D. Barker, Papers presented at the workshop on 'Women and the Environment', Khartoum, 1981, The Institute of Environmental Studies, University of Khartoum, 1981.

Wood based energy resources provide almost all of the energy consumed in the rural areas of Sudan, and the burden of supplying firewood falls mainly on women. This short paper looks at the likely ecological implications of present patterns of collection and use. Two villages in different areas were studied, and following a general description of each, the authors then go on to outline patterns of energy use, with particular reference to the role of women. It is concluded from this that environmental degradation is an inevitable consequence of decisions taken by women, which are highly rational in their own terms, given the financial and geographical constraints within which they must operate, about at the same time, it is noted, in one instance at least, that it is the clearance of land for farming rather than the gathering of fuel which is the major cause of depletion of wood resources.

4. Best, M. The Scarcity of Domestic Energy: A Study in Three Villages. Working Paper no. 27. Southern Africa Labour and Development Research Unit, Cape Town, South Africa, November 1979.

This paper assesses energy consumption in three Southern African villages, describes a number of energy conversion devices which might potentially be introduced and also discusses the problem of implementing change. The uses of fuel for cooking, space heating and lighting are explored. Each village was visited three times over a nine-month period and fuelwood and dung piles weighed before and after a three day period of normal use. An interesting finding to arise from this exercise is that there are usually substantial differences between village women's perception of fuel use and results obtained by actual measurement.

5. Cline-Cole, R. "Firewood in a Rural Settlement in Sierra Leone. A Crisis of Policy Issues?" In L'énergie dans les commuautes rurales des pays du Tiers Monde, Colloque International de l'Université des Nations Unies, Centre d'Etudes Geographie Tropicale Centre National de la Recherche Scientifique, Université des Nations Unies, 1981.

This paper discusses the findings of an enquiry into consumption of firewood in the settlement of Waterloo, Sierra Leone; a town completely surrounded by forests which is nevertheless experienceing a growing fuel problem. Results of a sample survey of thirty houses are discussed, and consumers' fuel preferences are explored. Attempts to measure firewood supply by cutting down trees on sample plots and weighing the dried bundles produced, are also described. The distribution of different woodfuel types used in the town is plotted and seasonal variations in supply and demand discussed. The comparison of overall supply and demand figures suggests the imminent destruction of forest reserves, and the blame for this state of affairs is attributed to government policy, and the effect of this upon the behaviour of local people.

6. Digernes, T.H. "Wood for Fuel - Energy Crisis Implying Desertification. The Case of Bara, The Sudan." Thesis for Cand Polit Degree, University of Bergen, Norway, 1977.

This important case study is reviewed in detail in Chapter IV. Set against the background of drought in the Sahel from 1973 onwards, it explores changing patterns of fuel availability and use in Bara town and the rural communities by which it is surrounded. It combines questionnaire based methods of data collection with more open-ended anthropological types of enquiry, and also draws quite extensively on secondary sources. It is of particular interest as an example of what can be achieved by a woman researcher in a Muslim society, where access to local women and their knowledge of fuel collecting and using practices is essential to a proper understanding of the energy situation. (See also: Digernes, T.H.: Fuelwood Crisis Causing Unfortunate Land Use - and the Other Way Around. Norsk Georg. Tideskr. vol. 133, p. 23-32, Oslo, 1979.).

7. Energy Unit, Ministry of Agriculture. "Malawi Rural Energy Survey 1981." Mimeo.

This report discusses the findings of a nation wide survey of 2,400 households, which was designed to provide the degree of difficulty experienced in obtaining fuels, and the solutions adopted by rural people under circumstances of fuel scarcity. The allocation of alternative fuels to end uses is clearly established and areas of shortage are identified; but it is concluded that the people most affected have so far done little about the problem, and that a tree re-planting strategy directed at the combined production of non-fuel and fuel materials may be the best way forward. The survey, which was administered twice during the course of a year to allow for seasonal variations, provides a good example of how a useful macro-level picture can be established without recourse to highly time consuming or resource intensive data collection procedures.

8. Ernst, F. Fuel Consumption Among Rural Families in Upper Volta, West Africa. Voluntary paper, Eight World Forestry Congress, Jakarta, 1978.

Tree Plantation projects in Upper Volta have been undertaken by a number of organizations, including the Forestry Department, to provide for future needs; yet few attempts to measure consumption have actually been made. This paper describes the results of a study carried out in two villages where daily measurements of consumption were carried out over short periods of time with the cooperation of a number of households which volunteered their assistance. The most striking conclusion to emerge, in the light of previous assumptions that wood provided the only major source of fuel, is that millet stalks are actually being used for about six months of the year.

This, in turn, suggests that fears of rapid future deforestation might well prove unfounded.

9. Ensminger, J. "Energy Use Among the Galole Orma," 1980. Mimeo.

Most of this short paper takes the form of transcripts of open-ended interviews carried out by the author with selected key informants from among the Galole Orma, and other inhabitants of the Tana River District in Kenya. These are used to build up a picture of how fuel availability and use is changing as drought forces increasing numbers to settle permanently in areas where good grazing land can be found. An impression is also created of how things might look in future with growing concentrations of population in urban centres. Ensminger's account provides another good example of how an extensive area can be established without the use of costly data collection exercises.

10. Fleuret, P., and A. Fleuret. "Fuelwood Use in a Peasant Community: A Tanzanian Case Study. "The Journal of Developing Areas 12, (April 1978):

This article describes an investigation of fuel consumption which was carried out in a Tanzanian village in the course of a piece of anthropological fieldwork. An account is given of how fuel is collected and used, and the results of measurements of the fuel consumed by a small number of households over a period of a few days are reported. The procedure adopted of assessing volume rather than weight seems problematic, as does the attempt to generalize on the basis of such a limited set of results. Nevertheless, this remains a useful contribution with the discussion of the difficulties encountered in defining and identifying household composition proving particularly instructive.

11. Mung'Alia, P.M. "Estimation of Present and Likely Future Demand for Fuelwood and Charcoal in Machakos District, Kenya." M.S. thesis, University of Dares-Salaam, 1979.

Against a background of declining woodfuel availability, this thesis sets out to assess overall levels of fuel consumption in the Machakos District of Kenya in 1971; and to predict what consumption will be in 1980, 1990, and 2000. The area was divided into zones of good; medium and poor vegetation cover, and within each, attempts were then made to assess consumption by rural and urban households, private and public services and industries. Most data were collected by questionnaire but some direct measurements were also carried out. In addition, interviews with charcoal and wood fuel traders helped to build an impression of factors influencing the supply of fuel. In spite of certain difficulties concerning the stratification of the rural population,

and other matters which the author brings to the readers' attention; the study may be recommended for its unusually comprehensive treatment of the end uses of fuel.

12. Nkonoki, S.R. "The Poor Man's Energy Crisis." A Report of the Tanzanian Rural Energy Consumption Survey, Dar-es-Salaam, 1983.

This national survey has two major objectives. The first is to establish levels of energy consumption in rural Tanzania, and to determine the nature of the problems faced by rural people with regard to fuel. This is achieved through a study of twelve villages selected to broadly represent the range of agricultural and economic conditions found in the country, with members from different income groups being interviewed in each case. Each village was visited at least twice during the course of a two-year period to cover seasonal variations; and the consumption patterns associated with a range of rural industries were also investigated. The second objective - to evaluate the possibilities for increases in energy supply - is pursued through the investigation of a number of potential new energy sources and conversion devices. The study concludes with a series of useful appendices which include a case study on village electrification, and an exploration of charcoal markets.

13. Ojo, A. "User's Preferences of Various Fuels Types in the Ife Region. Some Guidelines for the Rural Systems Project." In Rural Energy Systems in the Humid Tropics, eds. W. Morgan, R. Moss, and A. Ojo. Proceedings of the First Workshop of the United Nations University Rural Energy Systems Project, Ife, Nigeria, 1978. The United Nations University, 1980, pp. 39-42.

This small preliminary study was intended to provide some guidelines for the United Nations University Rural Energy Systems Project by indicating areas of emphasis. A simplified questionnaire was administered to a sample of 150 respondents in the town of Ife and a further 30 in the major settlement of Osu, eliciting information on the frequency with which they cooked with seven types of fuel: dung, charcoal, sawdust, electricity, fuelwood, gas and kerosene. Informants were also asked to nominate their three most preferred sources of fuel on the assumption of no monetary constraint; and to suggest the fuel types which they would like to see developed for domestic use in urban and rural areas. Kerosene emerges as the most popular fuel, reflecting its convenience, availability and low cost.

14. Ojo, A. "Fuel Consumption Patterns in Rural Communities of South Western Nigeria." In L'energie dans les conmuantes rurales des pays du Tiers Monde. (Colloque Intrnatinal de l'univesite des Nations Unies). International de l'universitē des Nations Unies). Talence: Centre d'Etudes Geographie Tropicale, Centre National de la Recherche Scientifique, Universite des Scientifique, Universite des Nations Unies, 1981.

This is one of a number of papers from the Rural Energy Systems Project of the United Nations University and the University of Ife. It takes 10 villages from the Project's overall sample to build a composite picture of fuel consumption patterns. Four particular factors emerge as critical: the location of the village in relation to neighbouring towns, the rural housing environment, the socio-economic status of the population and the relative availability of alternative fuel sources. The changing pattern of fuel consumption is ascertained by asking respondents which fuel sources have been, and are currently being used for cooking and lighting. As with previous surveys (Ojo, 1980) consumer preferences are explored, and it is suggested that these should play an important part in determining the future of the projects's research.

15. Whitlow, J.R. The Household Use of Woodland Resources in Rural Areas. Zimbabwe, Department of Natural Resources, 1979.

This study of woodland resources in five African villages in Zimbabwe is once again motivated by concern with declining availability. Building on a questionnaire survey of 72 households, it presents details of present fuel consumption levels and collection practices. Fuel preferences are also explored, together with the alternative uses of wood for construction and medicinal purposes. While the contrast between the tribal areas and the adjacent wooded landscapes of commercial farmland and national parks is noted, the broader context of scarcity is not discussed.

B. ASIA AND THE PACIFIC

1. Bajracharya, D. "Implications of Fuel and Wood Needs for Deforestation. An Energy Study in a Hill Village Panchayat of Eastern Nepal." D. Phil, thesis, History and Social Studies of Science, University of Sussex, 1981.

This thesis which is based on fieldwork carried out during an extended period of residence in a Panchayat in the hills of Nepal, has already been discussed in detail in Chapter III. It explores the basic hypothesis that it is the clearing of land for agricultural purposes rather than the gathering of fuel which is primarily responsible for the deforestation which may be occurring. The study is unusual in the degree of attention which is paid to measuring the

availability of the types of fuel used at present (as opposed to potential new sources and conversion devices); and is able to demonstrate that the annual flow of fuel is in excess of the off-take for fuel consumption purposes. Apart from its contribution to the metholology of fuel supply measurement under field conditions, the thesis also contributes to our understanding of consumption assessment by showing how data collection on a week by week basis can be used to establish confidence limits around estimates arrived at through longer term recall . (See also Bajracharya, D. Firewood Consumption in the Nepal Hills: A Comparison of the Annual Recall and the Weekly Recorded Data - paper from the Rapid Rural Appraisal Conference, Institute of Development Studies, University of Sussex, 1979. Mimeo).

2. Bialy, J. Firewood Use in a Sri Lankan Village: A Preliminary Survey. Occasional Papers on Appropriate Technology, School of Engineering Science, University of Edinburgh, 1979.

This is a preliminary report of a study of fuelwood use in a village in the Sri Lankan Dry Zone. The use of fuelwood for coding and other purposes is described, and the pattern of seasonal variations explained. The major contribution of the paper lies in the procedures devised for direct measurements of fuel consumption for cooking and other purposes such as parboiling of paddy under field conditions. There is also a careful discussion of how to determine caloric values, and on devices for the standardization of family size for purposes of comparison. Attention is also paid to the question of how applicable the results obtained in this particular situation might be to the understanding of fuel consumption in other parts of Sri Lanka.

3. Briscoe. J. "Energy Use and Social Structures in a Bangladesh Village. "Population and Development Review 5, no. 4 (December 1979):

This widely cited study is based on eight and a half months' residence in Bangladesh. Data were collected through regular repeat visits to a sample of the population comprising some 50 households, using a combination of recall and more direct forms of measurement. The first part of the paper deals with the flows of animate and inanimate energy through the village system at an aggregate level. Briscoe then goes on to show how the unequal ownership of assets and the pattern of social relationships with which this is associated, leads to very marked differences in access to to energy between different and to anticipate the implications of certain likely future sectors of the population. An attempt is also made to understand present forms of distribution in their historical context, developments upon the availability of fuel. The major contribution of the study lies in its path-breaking exploration of these broader aspects of the

political economy of energy use. At the same time it should be recognized that the validity of the methods used for assessing energy flows have been questioned by certain observers.

4. Chirattananon, S. "Analysis of Rural Energy Development in Thailand." In Islam et al; Rural Energy to Meet Developmental Needs: Asian Village Approaches. East West Center, Honolulu, 1983.

Chirattananon's paper takes the form of a general discussion of energy issues in the context of Thai rural development. It also summarizes the findings of energy survey work carried out by other people; the most important of which is the study carried out by the National Energy Administration, which is only available in the Thai language. This is of interest as an example of the more extensive sample survey type of approach to data collection, with results being presented from interviews with some 22,000 informants, from 200 different villages. The study is also of interest in that consumption of the so-called 'commercial fuels' (gasoline, kerosene, etc.) is considered alongside the more familiar biomass. The consideration of energy use in agriculture and transportation, in addition to its domestic uses, is also an unusual feature.

5. Donovan, D. Woodfuel Utilization by Small-Scale Industry in Nepal. Progress Report No. 2, March 1980. Kathmandu, Nepal. Mimeo.

This report provides one of the most systematic investigations available of fuel use in small scale rural industries. It focuses primarily on firewood and suggests new research directions in a field which has perhaps been overly concerned with matters of domestic consumption. The research on which it is based was conducted mainly in districts in the mountain and hill regions of Nepal. It was prompted by the concern that assumptions were being made about the expansion of the rural industrial sector without any consideration of what its fuel requirements might be, or the possible impact of these upon the domestic consumer or the environment. In addition to the novelty of its subject matter, the report is also noteworthy for the methodological issues which it raises and explores.

6. Islam, M.N. "Study of the Problems and Prospects of Biogas Tehcnology as a Mechanism for Rural Development Study in a Pilot Area of Bangladesh." (Village Resources Survey for the Assessment of Alternative Energy Technology). Prepared for IDRC, Ottawa, Canada, 1980.

This study was prompted initially by the desire to explore the feasibility of biogas in rural Bangladesh, but then expanded to look at rural energy use in general, and at the various

alternative conversion and end use devices which might be introduced. Drawing upon information from almost 3,000 households, from 23 villages in a single administrative union, it is unusual for the insight provided into the extent to which fuel consumption can vary between communities located in close proximity to each other. The report draws extensively on secondary sources, reviewing all of the earlier major studies of rural energy carried out in Bangladesh. It is also noteworthy in the coverage given to the methods of research which were employed; providing a useful basis upon which to plan larger scale pieces of research. A large amount of useful material is present in tables, although ideally more time might have been devoted to its interpretation.

7. Newcombe, K., and T. Bayes. Energy in a Simbu Village. Man and the Biosphere Report no. 5 Papua New Guinea Ecology Programme, UNESCO/UNEP, Integrated Ecological Studies of Human Settlements, Lae and its Hinterland, 1981. Mimeo.

Set in the context of reduced forest cover around a village in the populous New Guinea highlands, this study sets out to understand the factors affecting the supply of fuel, and the various end uses to which fuel materials may be put. Following four months of residence in the community, during which researchers built up a general picture of social life and resource use, detailed measurements of consumption were carried out over short periods which were phased to reflect the main seasonal variations. Details of the methods employed are given, and the paper concludes with a description of a computer model which was designed to simulate a series of alternative future energy scenarios against different assumptions about availability and use.

8. Population and Development Company and the Population and Community Development Association. "Fuel Utilization Survey." Pre-final report submitted to Petroleum Authority of Thailand, Bangkok, Thailand, 1981.

Following the discovery of large natural gas reserves in the Gulf of Thailand, this study of existing patterns of energy use was commissioned in order to help assess the likely scale and composition of future domestic demand for the new commodity. The report details a massive data collection exercise, involving 185 interviewers and over 13,000 informants, and covering agricultural, industrial, commercial and domestic end users in the rural and urban sectors. The characteristics of present users and non-users of liquid petroleum gas *lpg) are compared, and potential lpg users are discussed. Lengthy appendices provide detailed breakdowns of survey results, together with information on data collection procedures.

9. Siwatibau, S. Rural Energy in Fiji: A Survey of Domestic Use and Potential. A report to the Fijian Government with assistance from the International Development Research Centre: Ottawa, Canada, IDRC, 1981.

The aims of this report were to provide information on local energy use and needs in selected rural areas of Fiji and to evaluate alternative sources of energy supply with particular reference to the possibilities of expanding biogas use and improving domestic cooking conditions. A wide range of secondary sources are drawn upon to supplement primary data from a survey of four representative villages and seven isolated farm homesteads. The methods used in various parts of the study are set out in considerable detail, with the use of village meetings, as an unusual, but apparently rather successful means of building confidence, being of particular interest. After the discussion of the results of the energy use surveys, details of the surveys on biogas, existing cookers, electricity from autogenerators and a social assessment of the study population's aspirations for change, are presented.

10. Soesastro, M.H. "Policy Analysis of Rural Household Energy Needs in West Java." In Islam et al; Rural Energy to Meet Development Needs: Asian Village Approaches. East West Centre, Honolulu, 1983.

This paper, already discussed in Chapter V, reports the findings of a survey which was carried out with three particular objectives in mind. The first was to increase understanding of the potential role of energy in bringing about a better distribution of income; the second, to assess the likely implications of changes in fertiliser subsidies; and the third, to provide a baseline against which subsequently to measure long term changes in energy consumption and supply in rural West Java. Data were collected from more than 500 households of varying economic status, drawn from 40 villages which were chosen to represent a range of ecological conditions, and grouped in clusters so that local differences in levels of economic development could be taken into account. Having presented results on the availability of fuel and its allocation between different domestic end uses, the report then goes on to look self critically at the research methods used, before concluding with a discussion of policy implications. It provides one of the best examples of how the diversity of conditions arising within a sizeable region can be captured by a survey deploying only relatively modest research resources.

11. Weatherly, W.P. "Environmental Assessment of the Rural Electrification I Project in Indonesia." Prepared for the US Agency for International Development, Jakarta, Indonesia, 1980. Mimeo.

This paper about Indonesia is a good example of how policy-relevant material on a region can be obtained at relatively little expense. Although formally commissioned as a rural electrification environmental impact assessment study, the subject is interpreted broadly to encompass extensive enquiries into present pattern of energy availability and use, as well as a consideration of alternative forms of energy intervention. All of this, in turn, is set within the context of the changing interrelationships between rural population and the natural resource base. Three regions, representing contrasting fuelwood conditions, were selected for investigation, and a smaller number of villages chosen for investigation in each. An attempt was made to draw informants from different social classes, and in addition to domestic users, small-scale rural industrial enterprises were also investigated. The factors influencing consumers preference for certain fuels for particular end uses are described, and the determinants of fuel supply explored. In overall terms, this is one of the most comprehensive and methodologically sound of the studies which have been reviewed. (See also Arnold in section on survey methodologies below.)

C. LATIN AMERICA

1. Bogach, V.S. A Fuelwood Policy for Guatemala. A report to the United Nations Development Programme. Ottawa, Canada. Van Meurs and Associates Ltd., Energy Consultants, 1981.

In the course of the six-year UNDP Petroleum and Energy Project Development in Guatemala, it was recognized that the problems of fuelwood supply were of major importance. Several background studies were carried out by the project "to determine the gravity of the fuelwood supply situation and to propose measures that would ensure that fuelwood remains a viable fuel in Guatemala." The introduction to this report discusses fuelwood policy for Guatemala, and subsequent chapters then go on to deal with domestic fuelwood use, the level of fuelwood supply, the potential for fuel efficient wood cookstoves, and the potential of commercial plantations for the production of fuelwood. Sample selection and survey methods are also discussed.

2. Instituto de Economia Energetica. A Regional Energy System. The Entire Rios Province, Argentina. Bariloche, 1982, 4 vols. Argentina, 1982.

This is one of the few examples available in the English language, from the rapidly expanding Latin American rural energy literature. It is a very large study dealing with all aspects of

energy used in the Entre Rios Province. Two central objectives are pursued. The first is to describe the region's energy system in detail, and the second to provide baseline data against which to assess the likely extent of electricity and natural gas penetration of energy markets. Separate volumes of the report deal respectively with the urban and rural domestic sectors; commercial services and industrial and mining sectors, and agricultural and other aspects of rural production. Far too much information is presented for any detailed attempt at a summary to be made here. Taken as a whole, the study provides a useful example of the types of data which are required at the wealthier end of the spectrum of less developed countries, where non-animate forms of energy use in agriculture becomes much more pronounced, rural industries become of increasing importance, a clear distinction emerges between domestic and non-domestic forms of consumption, and individual domestic end uses are served to an increasing extent through discrete channels of supply. Ideally, however, a more selective approach might have been adopted towards the statistical information presented so that more time could then be spent interpreting the significance of survey findings.

3. Skar, S.L. Fuel Availability, Nutrition and Women's Work in Highland Peru. International Labour Organisation, Geneva; mimeographed, World Employment Programme Research Working Paper; restricted.

This is a pilot study commissioned by the ILO, with a view to identifying areas for more detailed research. It is based on short periods of residence in Andean communities with contrasting patterns of wealth, production, culture and fuel availability, and explores the implications of these differences for the ways in which women allocate their time. It also shows how important differences can arise within communities, as well as tracing through the consequences for household nutrition as a whole of the decisions which women have to take at various levels of resource availability. Although the statistical materials presented are, by the author's own admission, somewhat weak, this remains an excellent example of what may be described as hypothesis generating research. It is virtually unique among the body of work on rural energy reviewed, in the degree of attention which it pays to problems encountered by women in the face of shortage, and to the strategies which they adopt.

II. METHODOLOGY

1. Arnold, J. "A Revised Methodology for Energy Demand Surveys." A Discussion Paper presented to the International Workshop on Energy Survey Methodologies, Jekyll Island, Georgia, January 1980. Mimeo.

This paper provides detailed discussion of the methodology used in an environmental review of the rural electrification project (see Weatherly's paper in the "Surveys and Empirical Studies" section above). Of particular interest are the differences which the author points out between the methodology employed in this instance and that of other energy surveys. These have already been summarized in Chapter V and in the Weatherly entry, and therefore need not be repeated here.

2. Ay, P. "Energy Research and the Crisis of Basic Data Collection in Developing Countries." In L'energie dans les communautes rurales des pays du Tiers Monte. (Colloque International de l'Universite des Nations Uines. Talence: Centre d'Etudes Geographie Tropicale, Centre National de la Recherche Scientifique, Universite des Nations Unies, 1981.

This short discussion of the problem of energy data collection in developing countries touches upon a number of problems which are not generally recognized elsewhere. Emphasis is given to the differing historical and structural contexts within which data collection must take place in developed and developing countries, and it is pointed out that systems for gathering information in the Third World are generally not well integrated with administrative structures. Policy makers often have to rely upon field research which was not designed with their particular needs in mind, and which can, in any case, be difficult to get hold of. In those instances were official data are available, these frequently represent little more than best guesses, and claims to representativeness can be highly misleading. The article shows how biases in sampling and selection arise, and identifies other impediments to the building up of a firm base of knowledge about rural conditions through research. The particular difficulties of assembling reliable data on energy, where both production and distribution are generally so decentralized, are pointed out.

3. Bhatia, R. "Energy Survey Methodologies: A Framework for Measuring Non-Conventional Energy Sources in Developing Countries." Paper prepared for the ESCAP/IEA Workshop on Energy

This very useful paper builds upon Shatia's earlier presentation to the Jekyll Island Workshop (see US National Academy of Sciences, 1980), and addresses itself to a rather wider range of issues than are normally discussed in reviews of energy survey methodology. The opening section outlines the different types of energy policy which a country might seek to pursue and identifies the kinds of data which would be required in each instance. The problems of measuring nonconventional energy sources are then reviewed. The author then goes on to explore the questions of methodology in more detail, looking at how the appropriate type of survey can be identified; how villages, households and respondents can be selected; and how data can be collected and analyzed. The major part of the paper then concludes with a discussion of some examples of rural energy research undertaken in the ESCAP region. This is followed by appendices which include materials which help explore some of the matters of research strategy raised earlier in more concrete terms.

4. Bhatia, R. "Energy and Rural Development. An Analytical Framework for Socio-Economic Assessment of Technological and Policy Alternatives." Resource Systems Institute, East West Centre, Hawaii, 1980. Mimeo.

This paper is another important contribution to the energy survey literature, although it is somewhat broader in scope, exploring data collection problems alongside a consideration of ways in which alternative forms of intervention can be assessed. In an opening section, Bhatia outlines the processes related to the generation and use of energy, identifies the states which are typically passed through in the development of surveys, and discusses the issues which need to be taken into account in determining the precise shape which they will take. Detailed attention is devoted to the kinds of data which they may need to be assembled at household and other levels. Subsequent sections then deal with technological and non-technological forms of intervention; different approaches to social cost-benefit analysis; and with the social and organizational aspects of implementing change.

5. Brokensha, D., and A.P. Castro. "Methods of Fact Finding." In Wood Fuel Surveys, Rome, FAO, 1983.

This extremely useful paper deals in condensed form with many of the issues explored at greater length in the present book. It falls into four major sections. The first details the range of topics which may need to be explored in the course of a woodfuel survey, and suggests

some general principles which can be employed where the time available for data collection is limited. The second reviews the different ways in which research can be conducted, starting with the exploration of secondary sources and proceeding from these through different forms of direct observation, to interviews, group interviews and questionnaires. The third section is concerned with the ways in which communities and individual informants may be selected. It concludes in a discussion of how communities can be defined and of what representativeness entails, as well as exploring household and other units of study and sampling procedures. A short final section deals with the selection, training and supervision of field workers and the considerations which should be taken into account in deciding how they are to be deployed.

6. Brokensha, D., and A.P. Castro. "What Sort of Information?" In Wood Fuel Surveys, Rome, FAO, 1983.

Written by the same authors, and appearing in the same publication, this item directly complements the previous entry. Following an introductory statement in which the scope of biomass fuel surveys is discussed, the remainder of the paper divides into five sections. In the first, the importance of arriving at an understanding of people's own perceptions of the fuels which they use is emphasized. The second then goes on to look at the various forms of land tenure arrangements which may be relevant towards the problems of groups, such as the landless and women, who may be places at a particular disadvantage as far as access to fuel is concerned. In the third section, the kinds of data which may be required on labour utilization are spelled out, while the fourth details other aspects of production and distribution, including transportation, marketing and sales, storage deforestation. Finally, in the fifth section, the different types of fuels, consumers and end uses are investigated.

7. Cecelski, E. "Household Fuel Availabilities, Rural Women's Work and Family Nutrition. "Rural Employment Policies Branch, Employment and Development Department, ILO, Geneva, Mimeo.

This draft paper discusses the issues to be explored in an ILO project relating women's work to fuel availability and nutrition, and also devotes considerable attention to questions of methodology. The implications of agricultural modernization for the sexual division of labour are explored. The results of time allocation studies are discussed, and their usefulness as a means of data collection reviewed. The new household economics approach is also considered, and the need to be conscious of external influences upon internal household labour allocation processes is emphasized. Turning more specifically to energy questions, the author points out the importance of understanding women both as direct consumers of energy in the course of the various

work activities in which they are involved, and as users and producers of fuel. The final sections of the paper then go on to look at the impact of fuel shortage on household labour allocation; the specific problems raised by the need to measure fuel availability; and the ways in which quantitative and qualitative forms of investigation can be combined to throw light upon these and related matters.

8. Delucia, R. "Defining the Scope of Wood Fuel Surveys." In Wood Fuel Surveys, Rome, FAO, 1983.

This paper provides an overview of the issues discussed in the book in which it appears; several other items from which are also reviewed in this section of the bibliography (see Brokensha, Geller and Openshaw). It takes as its major theme the factors which need to be considered in defining and executing a wood fuel survey. In an opening section, the basic characteristics of traditional fuel and energy systems are discussed. The author then goes on to emphasize the importance of viewing wood fuels firstly as integral parts of wider systems of resource use which can exercise an important influence uupon their availability; and secondly as themselves involved in cycles of activity which may be relatively localized where fuel is not commercially transacted, but which become far more extensive where it is. The dynamic aspects of wood fuel systems are also highlighted, with attention being directed towards the impact of growing shortages, the changing nature of energy demands in the course of development, and the possibility of substitution into wood fuels by industrial and agricultural end users. The paper then concludes with a discussion of the difficulties of measuring the demand and supply sides of traditional systems; and of the types of surveys which will be appropriate at different levesl of information need.

9. Geller, R.S., and G.S. Dutt. "Measuring Cooking Fuel Economy." In Wood Fuel Surveys, Rome, FAO, 1983.

This paper addresses the problems of measuring cooking fuel economy in the light of a concern to identify means of assessing wood stove performance. It is, however, also of broader interest for the insights it provides into the relationship between energy consumed and quantities of fuel used in a more general sense. The need for a thorough understanding of actual cooking practices is emphasized at the outset, and the types of data which will be required are outlined. The authors then discuss the measurement of fuel consumption and efficiency at a general level; outlining the practical difficulties of assessing the former, pointing out the superiority of energy consumption as a standardized measure, and exploring the different ways in which this can be assessed. Different concepts of efficiency are then explored, and this, in turn, leads on

to a discussion of the parameters which need to be incorporated in a test program. The paper concludes with sections no the uses of simulation tests; the procedures which can be used, and the ways in which results can be interpreted.

10. Graham, T. "Critical Issues for Designing Energy Surveys in Africa." In Energy for Africa: Selected Readings, eds. D. French and P. Casson, Washington, D.C.: US Agency for International Development, 1980.

This is a generalized, somewhat abstract discussion of critical issues and priorities in the designing of rural energy surveys for Africa. The first section sets out a number of priority issues which the author argues should be kept in mind during the design process. These are that surveys should reflect the needs of those being surveyed; that collecting surplus data should be avoided; that socio-economic data should be collected before technical data; that formal feasibility tests should precede demonstration and that technology specific surveys should be staggered with field tests. In the shorter second section, concrete examples of problems arising in the course of data collection exercises in Swaziland and Cameroon are explored.

11. Openshaw. K. "Measuring Fuelwood and Charcoal." In Wood Fuel Surveys, Rome, FAO, 1983.

This short paper explores the major problems associated with the physical measurement of fuelwood and charcoal. In relation to fuelwood, it discusses the difficulties arising as a result of the irregular nature of bundle sizes, before proceeding to assess the strengths and weaknesses of volume and weight as alternative mediums for arriving at standardized measurements. This exercise is repeated with regard to charcoal, and a method for converting from charcoal weight to roundwood equivalent is then discussed.

12. Thomson, J. "Firewood Survey: Theory and Methodology." In Energy for Africa: Selected Readings, eds. D. French and P. Casson. Washington, D.C.: US Agency for International Development, 1980.

This paper develops a framework for the surveying of firewood problems in Africa; and falls into two parts. The first aims to set a context within which may militate against the production of adequate firewood supplies. These include: the availability of seeds and seedlings; the nature of land or tree tenure; the feasibility of protecting trees from foraging livestock; the enforceability of property rights; and the potential for collective action in the light of local level and broader political structures. The feasibility of alternative fuel sources or of more efficient stoves as a means of conservation are also briefly reviewed. The second, and shorter,

section is then devoted to a discussion of how the various categories of information discussed earlier can be elicited; and a recommended research package is outlined.

13. US National Academy of Sciences. Proceedings: International Workshop on Energy Survey Methodologies for Developing Countries, Jekyll Island, Georgia, 1980. Board on Science and Technology for International Relations, National Academy of Sciences, National Research Council, National Academy Press, Washington, D.C., 1980.

This book summarizes the highlights of a USAID initiated workshop on energy surveys in developing countries, and includes the conclusions, recommendations and reports from rural, urban, industry and transportation working groups. Also included are a directory of energy surveys and excerpts from background papers. The workshop, as a whole, took as its point of departure the seriousness of energy problems in the developing countries and the lack of adequate information on which national policy solve these problems could be based. The Rural Workshop Group Report provides a clear discussion of the parameters of rural energy surveys and the different program strategies which, together, determine their scope and the nature or the methods which are used. The participation of local people, and organizational, personnel and management requirements, are also briefly discussed. The establishment of a central repository of data accessible to all countries is suggested.

III. GENERAL

1. Arnold, J.E.M., and J.A. Jongmar. "Fuelwood and Charcoal in Developing Countries." Unasylva, no. 118 (1977):

This article provides a brief but extremely useful discussion of the main issues concerned with the consumption of fuelwood and charcoal. It reviews existing literature/data on fuelwood use in rural and urban areas and argues that, in both East and West Africa, woodfuels account for 70% of all in both East and West Africa, woodfuels account for 70% of all energy used, excluding human and animal power. As a result, pressure on woodlands is now great - both near population centres and in rural areas, where dung is increasingly diverted from vital agricultural uses to burning. It also examines the impact of fuelwood on forest resources and their environment. The author highlights the increasing use of charcoal and explores the trade-offs between fuelwood and charcoal consumption in terms of energy efficiency and use of forests. There is a heavy emphasis on the increasingly critical magnitude of the problem of fuelwood consumption. In the foreseeable future, there will be no generally available fuel substitutes, especially among the rural poor who are almost totally dependent on wood for energy. The article also contains an extensive discussion of the importance of government supported and locally managed, fuelwood plantations as the most effective way of meeting demand. Also discussed is the need to increase efficiency in fuelwood use through improvements in fuel preparation and in the design of cooking pots and stoves. There is a useful methodological note on the measurement of fuelwood use. (This review appeared previously in Barnett et al, 1982).

2. Barnett A. "Rural Energy needs and the Assessment of Technical Solutions." In A. Barnett, R.M. Bell, and K. Hoffman, Rural Energy and the Third World. A Review of Social Science Research and Technology Policy Problems, Pergamon Press, 1982.

This item provides a valuable discussion of the problems of research aimed at understanding rural energy needs and assessing technical solutions drawing upon an extensive review of the literature. Factors which are likely to inhibit the diffusion of rural energy technologies, but which have often been neglected, are identified and discussed, after briefly clarifying what is meant by 'the rural energy problem'. Four specific methodological defects, which help to explain why understanding of rural energy systems lag behind understanding of energy related technology, are outlined. The chapter then concludes with a discussion of how social and economic appraisals of alternative rural energy technologies can be carried out.

3. Eckholm, E. The Other Energy Crisis: Firewood. Worldwatch Paper, no. . Worldwatch Institute, Washington, D.C., 1975.

This short paper has proved highly influential in attracting attention to the problems of growing firewood scarcity in Third World countries. A number of examples of firewood crises are given and the alarming ecological consequences which can follow from fuelwood gathering and over grazing are outlined. The relationship between fuel scarcity and the productivity of land is emphasized, and the author points out the problems associated with the increasing use of substitutes such as dung or kerosene. The political, cultural and administrative difficulties which will be encountered in dealing with the crisis are discussed, and long term planning perspectives and community participation mentioned as important elements in any solution. The argument concludes with an appeal for changing attitudes towards fuelwood scarcity, and re-emphasizes the urgency of recognizing the links between fuel extraction and environmental damage.

4. Jean Paul Lanly. Tropical Forest Resources. FAO Forestry Paper No. 30/UN 3216. 1310-78-04 technical report 4, 1982.

This is the fourth in a series of technical reports from the FAO/UNEP Tropical Forest Resources Assessment Project. Drawing on data assembled from investigations in 76 countries, it has two major aims. The first is to outline the present situation and major trends with regard to natural and planted woody formations. The second is to develop a common framework of categories and concepts which will enable information to be treated in a more consolidated fashion than has generally proved possible in the past. The defects of earlier methodologies are discussed, and the details of new procedures by which they have been replaced are spelled out. Of particular interest in this connection are the sections in which the problems of assessing stocks and flows of fuelwood (as opposed to timber) are reviewed. Summary tables, organized on a regional basis, provide data on a number of subjects of direct relevance to the planning of rural energy research, including the ownership of forests, their legal status, and the ways in which they are managed and used. The discussion of trends of deforestation, degradation, and replanting help to identify areas where fuel shortge seems likely to be particularly acute.

5. FRIDA. Domestic Energy in Sub-Saharan Africa: The Impending Crises, its Measurement and the Framework for Practical Solutions. London, FRIDA, 1980.

This report is based on 18 months desk and field work in the semi-arid region of sub-Saharan Africa. It covers eight West and East African countries, including Mauritania, Senegal, Mali, Upper Volta, Niger, Sudan, Ethiopia and Toga. Data were collected through a crash program of

short visits and with the help of local collaborators who gathered information according to a pre-determined format. Results are presented from a family fuel use survey, as well as from studies of reforestation projects, charcoal production and solar cookers. Although their methods are admitted by the author to have been somewhat rough and ready, and in spite of particular problems with the sampling procedures employed, the ability to draw simultaneously on broadly comparable data sets from a number of different locations, leads to certain unusual and potentially important conclusions. Of particular interest are the relationships established between community size, distance over which fuel has to be transported, methods of extraction and transportation, and the gender division of labour with regard to fuel related activities.

6. Gamser, M. "The Forest Resource and Rural Energy Development." World Development 8 (1980): 769-780.

This general discussion which draws on several examples from FAO forestry papers makes a number of important points in the course of a discussion of the political economy of forest energy development and community forestry. Ambiguities and shortcomings arising in relation to much of the existing data are pointed out. The common assumption in discussions of community forestry, that a 'community' is a homogenous group of people sharing common interests, is also criticized.

7. Hoskins, M. "Community Participation in African Fuelwood Production." Discussion paper prepared for workshop on Fuelwood and other Renewable Fuels in Africa. Paris, 1969.

This paper provides a valuable discussion of community participation in energy development projects, raising issues which have generally been neglected by the rural energy literature. Drawing upon examples from a number of African countries, it criticies "top-down" tendencies in the planning of forestry projects, and advocate instead a local community development approach as the only effective means of solving woodfuel problems. Discussion is not only confined to fuel production, however. The paper investigates the processes of fuel transformation, including harvesting, charcoal making, transportation, drying and storing, and it is these aspects which are of particular interest in terms of establishing a context within which energy research may be carried out.

8. Howe, J.W. "Energy for the Villages of Africa. Recommendations for African Governments and Outside Donors." Draft. Overseas Development Council, Washington, D.C., 1977.

This report examines local level sources of energy for the villages and farms of sub-Saharan Africa, and makes recommendations for national policy makers and aid donors. The first chapter presents an overview of the African energy situation, making particular reference to village energy and considering the utilization of energy in production, processing (including cooking), marketing and services. Research on small scale renewable energy hardware, and on software and institution building are then discussed, and an attempt is made to relate various forms of hardware to the types of end use identified at an early stage. Six particulr areas are identified where research will be required if hardware is to be properly utilized. Possible forms of institution building are also explored. Although widely cited and apparently influential, this report has been criticized for a rather rigid and technocratic approach which overlooks the complexity of the social, economic and political contexts within which change must take place, and assumes too dominant a role for western suppliers of technology.

9. Ibrahim, M. "Women's Role in Deforestation." In Women and the Environment in the Sudan. Papers presented at the workshop on Women and the Environment. University of Khartoum, Institute of Environmental Studies, 1981.

This short paper seeks to establish how the domestic, income-generating and agricultural tasks performed by women are contributing to environmental deterioration in a region of the Sudan. The nature of the agricultural operations in which women engage are explored, and there are also accounts of fuel collection, salt extraction, house construction and the grazing of livestock. Women's own perceptions of deforestation are also investigated, although not described in any detail; and a series of recommendations regarding areas in which additional research is required are outlined.

10. Islam, M.N., R. Morse, and M.H. Soesastro, Rural Energy to Meet Development Needs: Asian Village Approaches, Boulder, Westview Press, 1984.

The items from this collection which are most relevant to the methods of rural energy surveys have already been individually reviewed (See Soesastro, Planning Service, and Chiraratananon), so only a brief overview of this as a whole is present here. Its purpose, as stated in an introductory paper, is to report methods and results of a cross-section of Asian policy, technology and development research, linking energy and rural development issues; and to derive from this a new agenda of research and methods which will enable rural people to organize

energy resources and technologies to meet their needs. The early chapters are devoted to reviews and descriptions of rural energy surveys conducted in Bangladesh, Indonesia, the Philippines, Thailand and India. These are then followed by discussion of possible technical interventions in the form of stove, forestry and biogas programs. There is also an interesting discussion of a piece of action research carried out in Nepal, where attempts were made to enable rural people to articulate their own technological preferences. The book concludes with more general chapters dealing with the types of information required for energy planning and the way in which research can be organized so as to become more relevant to people's needs.

11. US AGENCY FOR INTERNATIONAL DEVELOPMENT

The Socio-Economic Context of Fuelwood Use in Small Rural Communities A.I.D. Evaluation, Special Study No. 1. by DEVRES. Bureau for Program and Policy Coordination, USAID, Washington D.C. 1980.

This consultants report describes and analyses the socio-economic aspects of fuelwood and charcoal use in rural communities, and is intended primarily as an aid to those communities, and is intended primarily as an aid to those designing and implementing community fuelwood programmes. It is based on an extensive literature search (reflected in a very useful bibliography) and on discussions with very large numbers of individuals and organisaios with interests in this area. Sections on firewood and charcoal deal respectively with sources and availability, access; harvesting/production, transport, distribution and consumption, and lead on to an attempt to draw out implications for community programmes and more general conclusions. The initial accounts are comprehensive in their coverage of issues; and whilst the form adopted precludes any serious considerations of linkages between themes, and hence of social dynamics, they provide a very useful overview of the range of issues which might be taken into account in any piece of rural energy research. In relation to the types of programme considered, three guidelines are singled out for particular emphasis: the importance of local participation; the need to consider specific socio-economic and ecological characteristics; and the need for constant and critical consideration of alternative plans and approaches.

12. OLADE

Energy Balances for Latin America Latin America Energy Organisation, Quito, Ecuador, 1981.

This item has been included as an example of the extensive Latin American literature on energy balances. It consists mainly of tables, graphs, and other illustrations relating to 22

out of the 26 members of the Latin American Energy Organisation, which are presented for individual countries as well as in sub-regional aggregates. The main emphasis is on 'commercial' energy, but simple surveys were carried out on wood and other non-commercial fuels, and information on these is also included. In an introductory section the definitions and methods used in constructing the balances are described, and information is then given for each country and sub-region according to a common format. The principle trends and characteristics of the energy sector are summarisied, and data is presented on sources of energy supply and final energy consumption by sector. Brief conclusions and recommendations are made in a final section.

13. **SRINIVASAN, M.**

The Contributions by Women in the Development and Use of Energy, and the Potential Impact of New Energy Technologies and Systems on Women in Rural Areas. Technical Policy and Assistance Council, Centre for International Technical Cooperation, American University, Washington D.C. 1980. (mimeo).

This paper provides a preliminary statement of the contribution made by women in the development and use of energy in the rural third world. A number of specific studies are referred to, but the discussion remains, for the most part, at a rather general level. The central thrust of the argument is that the important roles played by women in obtaining, converting and conserving energy, and hence their vital interest in energy technology innovations, have been neglected by researchers and policy makers. The importance of a wider concept of energy which includes animate sources, is also pointed out.