RURAL FUEL SHORTAGES IN BANGLADESH: THE EVIDENCE FROM FOUR VILLAGES

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This paper reports the findings of an investigation into the extent, underlying causes, and effects of biomass fuel shortages in four Bangladesh villages. Shortages are found everywhere, and are becoming more severe; but the problem is particularly pronounced in peri-urban locations. The landless have been affected much more seriously than other classes, and the implications for landless women are particularly unfavourable. This situation derives from the combined effects of unequal access to resources and rapidly increasing population within the rural areas. Increasing demand for biomass products from industrial and urban consumers has also played an important part. A number of possible solutions are explored. These include: increasing the supply of biomass fuels; improving the efficency with which they are converted; the introduction of substitutes; and the creation of additional sources of income for those most in need.

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GLOSSARY

B. aus	Broadcast early monsoon paddy crop.
B. amon	Broadcast deep water paddy crop.
Bat	Ficus spp.
Bepari	Traders-cum-contractors.
Boro	Irrigated winter paddy crop.
Boroi	Ziziphus jujuba.
BRAC	Bangladesh Rural Advancement Committee.
Dalal	Intermediaries serving bepari.
Dhoincha	Sesbania.
Ghoita	Fuel made of dung dried on jute sticks.
Hat	Major market, typically takes place once or twice a week.
Kalai	Lentil.
Karati	Small traders-cum-contractors.
Kher	Relatively tender straw from upper part of paddy stem.
Kuta	See kher.
Mandar	Erithryna indica.
Nara	Courser straw from lower part of paddy stem.
Peara	Psidium guyava.
Pitraj	Amoora rohituka.
Simul	Salmalia malabarica.
T.amom	Transplanted main monsoon paddy crop.
T.aus	Transplanted early monsoon paddy crop.

UNITS

1 maund	=	0.037236 tonnes = 37.236 kgs.
1 seer	=	0.933 kgs.
1 taka	=	$ 0.03

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INTRODUCTION

Throughout the Third World, the great majority of rural people rely upon biomass - trees, plants and dung - as their major source of fuel. A growing body of evidence now suggests that this important resource is coming under increasing pressure; and that shortages, with important implications for the nutrition, time utilisation and general well-being of large numbers of rural people, are becoming more common (Howes 1985).

This paper reports the findings of a field investigation conducted in four locations in the Mymensingh District of Bangladesh during April 1985. It explores the extent of fuel shortages; asks who is affected; identifies underlying causes; and draws some preliminary conclusions about the forms of remedial action which may be appropriate.

METHODS

Data were collected as part of a research methods training course attended by 16 participants, all of whom were men. Additional support was provided by four women and two men students from the Agricultural University. Eight days were spent in the field; with a further 24 days being devoted to planning, processing, analysis, and preliminary presentation.

The limited time and resources available mean that it is impossible to draw any firm conclusions about the issues explored. What follows should rather be seen as an attempt to map out some of the major features in the 'landscape' in a way that will be helpful to future researchers, to those responsible for shaping energy policies, or to those taking decisions in related areas of resource utilisation. Particular caution is necessary in the interpretation of any numerical evidence. Problems of definition, recall and seasonal variation have made the estimation of fuel use a hazardous occupation wherever it has been attempted in the rural Third World, and it would be unwise to attach any significance to individual statistics which were not supported by other evidence.

Four villages were studied. All had to be accessible from the Agricultural University at Mymensingh, where the fieldwork part of the course was held; but within this limitation, an

attempt was made to incorporate as wide a range of situations as possible. Selection was based on two criteria. The first was the extent to which a village was prone to flooding, since it was felt that this would influence biomass availability through an effect on the average size of homesteads, on cropping intensities, and on the risk of crop loss. The second criterion was distance from a major urban centre. It has been observed in many studies elsewhere that rural fuel shortages tend to arise first in peri-urban locations, with their concentrations of demand by lower income urban domestic consumers and industrial end users, and it seemed probable that these factors would also be influential in Bangladesh.

Combining the two sets of criteria gave the following typology:

- flood-prone and peri-urban (henceforth FPPU);
- flood-free and peri-urban (henceforth FFPU);
- flood-prone and remote (henceforth FPR);
- flood-free and remote (henceforth FFR).

Working on the assumption that the supply of fuel materials would be greater and more reliable on higher, flood-free land, it could then be hypothesised that, where other things remained equal, any fuel shortages would be experienced most severely in type 1 communities; to a lesser extent in types 2 and 3; and least of all in type 4. The actual villages selected to represent these categories are described in the next section.

For purposes of data collection, the course participants were divided into two groups of eight. One group worked in the two flood-prone, and the other in the two flood-free villages. In each case, seven days were spent in the peri-urban village from the pair, and only one in the more remote location. This division was dictated by the requirements of the course, and was not ideal as a means of exploring the problem itself. The day spent in the remote villages did, however, come nearly at the end of the fieldwork phase, and was designed in a way which reflected mistakes made and experience gained earlier on.

The investigations in the peri-urban villages involved a number of stages. The first two days were spent walking around the villages observing topography, land/crop associations, the distribution of settlements, the types of housing, the organisation of homestead space, and the ways in which fuel was being processed, stored and used. During this initial period, knowledgeable key informants were identified and consulted about cropping patterns, fuel use, and social and economic relationships. Some were leading male members of

their communities; but care was also taken to consult women, and men of lower socio-economic status. Key informant interviews were also conducted with local officials of the Forestry Department, the Bangladesh Rural Development Board, the Krishi Bank, and the Agricultural Extension Directorate.

In the next phase, more structured methods were used. The emphasis switched from qualitative to more quantitative forms of data; and attempts were made to explore sensitive matters with a bearing upon fuel availability and distribution, such as the ownership of land.

This phase started with a series of case studies. In each village, patterns and determinants of fuel use were explored in four households, which were chosen to represent the major economic classes outlined below. The influence of lineages and other social institutions on the distribution of fuel were also investigated; together with the significance of demand for village fuels by external commercial enterprises.

The study in the peri-urban villages was then concluded with a questionnaire survey. This included items on ownership and control of fuel related resources; the use of different fuels for cooking and parboiling; the sources from which fuels were obtained; the types of labour involved in collection and processing; changes occuring through time; and the factors by which these changes could be explained.

The selection of households for case studies and for the final survey was based on the system of classification suggested by Brammer and Clay (Directorate of Agriculture 1978: 43). This distinguishes:

- large farmers, who rely mainly on the labour of others to cultivate their land through share cropping or direct hiring arrangements;

- owner-cultivators, who live mainly by cultivating their own land;

- sharecroppers, who rely mainly upon land taken in tenancy to support themselves;

- landless, who rely mainly on self-employment or labour for others.

Since one of the major purposes of the research was to identify those most severely affected by fuel shortages, and since it was felt likely that the major impact of any fuel problem would be borne by the landless; this class was then further sub-divided into households owning and not owning homestead land, on the one hand; and into male and female headed households, on the other. The combined application of these two criteria gave four sub-sections, and increased the

total number of class categories to seven.

In the final survey, five households of each type were purposively selected in each of the four villages, to give a total of 35 respondents per village. Subsequent analysis revealed few significant variations between the four landless classes, however; and in the interests of simplicity, these data sets have been combined and presented as a single category.

The numbers of households interviewed corresponds only approximately to the actual distribution of classes, and for this reason, the presentation of results aggregated at the village level has generally been avoided (1).

Other data collection methods employed included:

- Kelly's grid (Richards 1979: 31); which was used to elucidate villagers' perceptions of fuel quality;

- group interviews, where attitudes towards different possible solutions to the fuel problem were explored;

- physical measurement of the weight of different fuels as a check on the accuracy of verbal responses.

In the remote villages, a shortened version of the questionnaire was used. Once again, 35 informants, drawn from the seven different social classes, were selected in each case.

THE VILLAGES

The villages will be described in the sequence outlined earlier, starting with the one assumed most likely to be affected by fuel shortages, and ending with the one considered least at risk.

Char Iswardia (FPPU)

Char Iswardia was selected to represent the peri-urban flood-prone category. It is located on the banks of the Old Brahmaputra opposite Mymensingh, 1.5 kilometres from the the town centre. Small river boats carry passengers back and forth from the northern part of the village, where data were collected. There is a major ferry terminal a snort distance to the south, which is used by buses, lorries and foot passengers wishing to travel between Mymensingh and towns lying across the river to the north-east. Immediately adjoining the ferry is a sizeable bazaar, and a little beyond that, the road

passes a large jute mill and some other factories.

The village is very low-lying, and in the past suffered severe flooding. The situation has improved considerably since the construction of an earthen embankment alongside the river in 1980, but about 70 per cent of the total area is still liable to flooding. This no longer represents a threat to life and property, but cultivators are restricted to a single local boro paddy crop on this land. The remaining 30 per cent is of medium height, and generally not flooded. Here the major crop is early monsoon jute or b.amon. Much of this area also supports a winter crop, which may be oilseed or sweet potato. Soils are generally of low fertility, ranging from sand through sandy loam to clay loam, and very little land is under irrigation.

The combination of single cropping and low soil fertility is reflected in relatively low densities of population, and fairly high average per household land holdings of 1.3 hectares (see Table 1). This figure, however, conceals a very heavy concentration of land in the hands of a small number of big farmer households. Owner cultivators, on average, have little more land at their disposal than those from villages where conditions are considerably more favourable; although a comparatively large amount of land is available for sharecrop.

In the absence of natural high land, homesteads have to be built up above the highest normal flood level. Most are concentrated near to the road and alongside the river embankment, with those belonging to landless households tending to be more clustered, and forming larger compounds. Average size is around a quarter of an acre; and only big farmer households have enough homestead land to grow substantial numbers of trees.

About 10 per cent of all households fall into the big farmer category; with owner cultivators and share croppers accounting for a further 15 per cent each; and the balance of 60 per cent being landless. The landless figure has almost certainly been inflated by households settling in the area with the intention of obtaining off-farm employment in factory or town.

It was difficult to build up a clear picture of production relations in the time available. Where men are hired, the most common arrangement appears to be the daily contract with all payment being made in cash; but meals, or meals and uncooked rice are often also provided during periods when the most intense physical input is required. For women, the norm is payment in meals and rice, with cash hardly ever changing hands. Several types of sharecropping contracts were reported, with the most usual involving a 50:50 division of non-labour inputs and outputs, including residues. A number of instances of cash renting of land were also encountered.

The possibility of factory employment for the landless has already been mentioned, and in addition, many households from this class also have members working as rickshaw pullers, boatmen or petty traders. Some landless women are able to partially support themselves through the sale of fuel; whilst certain landed households, especially members of the big farmer class, engage in paddy and jute trading.

Uzan Ghagra (FFPU)

Uzan Ghagra was chosen to represent the peri-urban, flood free category. It lies immediately to the east of the Mymensingh to Fulbaria road, adjoining Dapunia Bazaar, eight kilometres to the south-west of the town. The road is metalled and regular bus services pass along it. A network of paths criss-cross the village itself, and a canal, which is navigable when the flood waters rise, passes along the southern and eastern boundaries.

About 80 per cent of the land is flood free, and double or even triple cropping can be practised. A t.amon paddy crop is generally preceded by jute or aus, and may be followed by mustard or kalai in the winter season. Most of the remaining land is of medium elevation and irrigated by deep tubewell. This supports an HYV boro crop, which may be followed by t.aus in the early monsoon, or a main monsoon t.amon crop. There is a very small area of flooded land, where only local boro can be grown. Soil types range from loam, through silty loam and silty clay, to clay; and are generally of higher fertility than in Char Iswardia.

Population densities are higher here, and the average figure of 1.08 acres of cultivable land per household, is substantially lower than in any of the other villages surveyed. By contrast with Char Iswardia, there are very few large holdings, and the average amount of cultivable land owned by big farmers is slightly less than 2.5 hectares. This is reflected in the much smaller amount of land given in sharecrop or other forms of tenancy.

The predominance of flood-free land means that homesteads tend to be rather more scattered, although with a tendency for concentration around the highest land on the north-eastern and south-eastern sides of the village. Average homestead size is again around 0.1 hectares, but the gap between big farmers, who average 0.4 hectares or more, and the share cropper and landless classes, is more pronounced. Again it is only the big farmers who have sufficently large homesteads to permit the growing of substantial numbers of trees.

The class structure is slightly less differentiated here. The proportion of big farmers, at just over ten per cent, is similar; but the number of owner cultivators, who account for

about a quarter of all households, is substantially higher. This is reflected in the lower number of sharecroppers, who make up less than ten per cent of the population, and of landless; although the latter still remain by far the largest group, accounting for about half of all households.

Male labour is usually hired on a daily basis, and paid in cash with meals provided. Simple cash payments occur less frequently. Women generally work for cash.

The structure and incidence of off-farm income generating and employment opportunities are similar to Char Iswardia, but the major opportunity outside the village here is provided by the brickfields, which lie alongside the Mymensingh road, and operate continuously throughout the drier part of the year. These compete with domestic consumers for village wood fuel, and will be discussed from this point of view a little later.

A final feature of Uzan Ghagra, which distinguishes it from all of the other villages, is the accessability of government and other institutions. Upazilla offices, agricultural extension staff, and banks are all within easy reach. The Bangladesh Rural Advancement Committee (BRAC) also has an office, and is very active.

Bon Para (FPR)

Bon Para was selected to represent the remote, flood prone category. It is located ten kilometres beyond Fulphur Bazaar, which itself lies 40 kilometres to the north-east of Mymensingh town. The village is approached by an unsurfaced track, and is about five kilometres from the nearest metalled road. Whilst perhaps not 'remote' in any absolute sense, it is sufficiently far removed from sizeable urban centres to be denied good access to markets, government services, or substantial opportunities for off-farm employment.

Like Char Iswardia, most of the land is low lying, although it has never been subject to quite the same degree of deep flooding. Deep and shallow tubewells, and low-lift pumps are used extensively for irrigation, and the major crop is now HYV boro, which is grown in the winter season. On medium land, this is followed by a t.amon crop. Prior to the introduction of irrigation, the major rotation on medium land was jute followed by t.amon; whilst on lowland, either jute or b.amon would be grown. Jute has now been almost entirely displaced. Soils are mainly clay loam, and are both better drained and more fertile than in Char Iswardia.

The relatively lower overall productivity of flood-prone land is again reflected in population densities which are substantially below those found in higher locations. The average amount of cultivable land available per household is

1.04 hectares, but households are slightly smaller than in Char Iswardia, and there is little difference between the two villages in per capita terms. The distribution of land between classes is also very similar, with a heavy concentration in the hands of a small number of big farmer households; but there is less tenancy in Bon Para. This reflects the smaller number of absentee landlords, and the better returns which can be secured from the crops which are grown. The proportion of landless, at about 50 per cent of all households, is also rather lower here.

The absence of any elevated land in the village means that average homestead size is the lowest for all of the four communities studied, at only 0.06 hectares. The holdings of big farmers are generally no more than equivalent to those of owner cultivators elsewhere; although the aggregate figure conceals substantial variations.

The concentration of land holdings means that only a small number of households take on hired labour. When men are hired, payment is generally by a combination of cash and meals. Women, on the other hand, tend to be paid partly in kind, receiving jute sticks or paddy.

Chila Gai (FFR)

Chila Gai was chosen to represent the remote, flood-free category. It is located in the same area as Bon Para; lying in an equivalent position on the other side of the surfaced road. Topography and cropping patterns correspond closely to those found in the peri-urban flood-free village, although slighly less jute and irrigated HYV boro are grown here. Soils range from loam to sandy loam.

The average area of cultivable land available per household is 0.67 hectares; indicating a population density which is substantially lower than in Uzan Ghagra, but well above that of the two flood-prone villages. The distribution of cultivable land by social class follows a similar pattern to Uzan Ghagra, although the holdings of big farmers are, on average, marginally higher, and a little more land is available for sharecropping. Households, on average, have marginally more homestead land here than elsewhere, and Chila Gai is a little unusual in the amount of homestead land available to members of the owner cultivator and share-cropper classes, which in both cases averages just over 0.2 hectares.

Labour is usually paid by a combination of cash and meals, but when people are hired to process jute, they receive jute sticks instead.

FUELS: PROPERTIES AND USES

A range of biomass fuels may be used by different people in different places at different times of the year. In this section an attempt will be made to identify the major characteristics of the ones which are most important.

Village people use a number of criteria to differentiate one fuel from another, and are broadly agreed as to which are more and less desirable. Following their expressed preferences, it is possible to identify three broad categories:

- those most favoured, which include fuelwood and jutesticks;

- an intermediate 'satisfactory' category, incorporating branches, twigs, and paddy residues;

- those regarded as undesirable, which will only be used when no other option is open; which include leaves, weeds and dung.

Any more precise ranking within categories is rendered difficult by the existence of multiple criteria. A fuel which is regarded as superior in terms of the ease and comfort with which it may be used could, for example, also be unpopular on the grounds that it takes longer to collect, is more difficult to store, or has some valued alternative non-fuel end use. Thus whilst the sequence in which materials are described proceeds broadly from superior to inferior, the exact point at which an item appears may not always be of particular significance.

Fuelwood

The trunks of many types of trees may be used as fuelwood. Traders indicated a preference for the 10 species listed in Table 2; but a number of others, including: jeelapi gas, bamboo, coal, coconut, banana and peara, may also be used. Big farmer households are the main consumers, and will normally hire labour to chop down trees and cut trunks and major branches into pieces. (For a breakdown of the kinds of labour employed in the collection and processing of fuels, see Table 3.) The wood will then be left to dry for about a month and stored on a platform in a small, specially constructed hut. Where poorer households use fuelwood, it will normally be dried and stored on a shelf immediately above the cooking stove in the main family house.

Wood is preferred above all other biomass fuels for a number of reasons. It burns slowly and requires relatively little time to be spent tending the fire. It emits relatively little

smoke, and has a low moisture content. Where a sufficient supply is available it will be used throughout the year; but the most common pattern is for use to be concentrated in the wetter months, when crop residues have been used up, and when other fuels with a lower density (i.e. with a higher volume per unit weight) are difficult to keep dry and store.

Availability is restricted by competing end uses. Wood of a sufficient quality for furniture making, or for construction purposes, will not normally be considered for use as a fuel anyway, although it still competes for scarce homestead land space with trees commonly used for fuel. Brickfields, urban users and local restaurants, on the other hand, all exert demand for village fuelwood, and can make substantial inroads into the amounts available for domestic consumption in certain localities. These competing 'external' sources of demand are explored in more detail in a subsequent section. Even where such competition is not an important factor, it is not unusual for woodfuel to be commercially transacted. Richer households may contract for the purchase of whole trees, whilst the poor, in so far as they are able to enter the market at all, will tend to buy their wood already chopped and in smaller quantities.

Jute Sticks

Jute sticks have traditionally been regarded as a useful by-product from fibre making, but in recent years have grown in importance as a commodity in their own right. Once the jute has been separated from the stem, the sticks are carried back to the homestead. They are initially dried in small bundles, and then transferred to simple open-air platforms, which are generally constructed from bricks and bamboo. Drying takes about 15 days in all, after which sticks are ready for storage. As with fuelwood, richer households tend to use separate sheds for this purpose. Poorer landowners, with smaller amounts to store, rely on unutilised space in their dwelling houses. Storage usually takes place in July or August, shortly after the harvest, and the sticks are then normally used as the main fuel until they run out; which generally happens by the onset of winter.

Jute sticks ignite easily and are widely used as kindlng. This is a popular fuel, but has a number of disadvantages compared with wood. Labour is required to transport it from wherever retting has taken place, whereas fuelwood actually grows around the compound where it will be used. It is also bulky to store and burns very quickly, requiring someone to be almost constantly at hand throughout the cooking process.

Its availability is restricted to some extent by competing end uses as fencing, cattle shed walls, and as a construction material for the walls of the dwelling houses of poorer

people; but it can still be utilised as fuel after it has deteriorated to the point where it can no longer serve these purposes. Poorer households, without jute land of their own, generally have to purchase their requirements, but the normal pattern is for the sticks to be used by the owners, or by the tenants of the land on which they are produced. Where they are transacted, they may be sold in bundles of different sizes, at an average price of approximately 1 taka per seer ($0.03 per kg.). Poor women are sometimes employed to complete the final stage of stripping the fibre. Where this happens payment will often be in the form of sticks rather than cash.

Branches and twigs

Small branches may be obtained as trimmings from trees of high quality species, where the trunk is to be used for furniture or construction. They may be cut at the same time as trees which themselves will be used as fuelwood; or they may be cut or broken from growing trees. In the first two instances, the work is concentrated in a short period, yields a relatively large amount of material quite quickly, and is almost invariably performed by men. Where branches are cut or broken, the return per unit of time expended will be substantially lower, and the work is more likely to be performed on a regular basis by women. Where small fallen branches and twigs are gathered, this will normally also take the form of regular work performed by women and children, and may take up as much as two or three hours per day.

Branches and twigs are stored in the same ways as wood fuel, although their greater bulk makes it less convenient for them to be kept in quantity over extended periods of time. They are also less convenient to use, burning rather more quickly, and making it neccessary for more time to be spent tending the fire. The seasonal pattern of use is similar to that of fuelwood.

Bundles of branches will sometimes be sold, particularly by women and children from the poorest households, to whom this can provide an important source of income. A bundle weighing two to three seers (1.9 to 2.8. kgs) would fetch 5 taka ($0.15), but it is far more common for these types of fuel to be collected by household members for their own use.

Paddy Residues

Paddy straw is the other major residue which can be used as fuel; but not all varieties are used in this way. In many cases, a distinction must be drawn between the relatively tender upper straw (kher or kuta), which is cut and carried to the homestead with the grain for threshing; and the

relatively coarse lower portion (nara), which will normally be left in the field.

Much also depends upon the hierarchy of competing end uses for straw. The most tender, best quality materials are invariably used as fodder. In descending order of preference, these include: kher and nara from long stemmed t.amon varieties; and kher from short stemmed t.amon varieties, b.amon, aus and boro. The slightly inferior straw provided by the courser portions of long stemmed t.amon nara, and short stemmed kher, is used for roofing. Very little straw which is suitable for fodder or roofing will now be used as fuel, since even if a household had no immediate need for it for these purposes itself, the price which it would fetch would substantially exceed its fuel value.

The straws of inferior quality left for use as fuel include: b.amon nara; and kher from aus, traditional and HYV boro, where these have become too damp to be used as fodder. Where b.amon nara is not required for fuel, it will be burnt off in the field to provide soil nutrients. Aus and boro nara, which by harvest time are generally too rotten to be used as fuel, are simply ploughed back into the soil.

Where straw is to be used as fuel it has to be carried back from the field to the homestead, and then left to dry for about a month. Thereafter it is stored in a similar manner to jute sticks. Since it is bulky, it is difficult to store in large quantities, and this helps to explain its relative unpopularity. Other drawbacks include the fact that it burns very rapidly, and is much smokier than wood or jute sticks. It is generally used in the period immediately following harvest and drying, and seasonal consumption patterns differ subtantially between locations, reflecting such factors as variations in topography, the availability of irrigation and cropping systems.

There is a market for higher quality straws, but no evidence was found of fuel quality straws being commercially transacted. Although a number of households were beginning to consume wheat, most of this was being obtained through food for work programmes, and very little was actually being grown. Where wheat straw was available, it was mainly used for roofing. It would occasionally be used as fuel, but was rather smokier than paddy straw. Poor households would sometimes also use millet straw and mustard stems for fuel.

In addition to paddy straw, rice husks can also be used as fuel, once they have been separated from the bran which is used as poultry feed. Taken by themselves, they create too much smoke; but they are well suited for parboiling, where this is not a problem. If mixed with cattle dung, they can then be used as a fuel for normal cooking purposes.

Leaves and weeds

Leaves and weeds are gathered by women and children from homesteads and surrounding fields, and left to dry for short periods in the area immediately surrounding their homes. Small quantities may be stored in baskets, but because these fuels have by far the lowest density and take up the greatest space, they will generally only be collected shortly before they are required. The difficulty in storing these fuels was illustrated by landless householders, who reported that, in order to prepare two meals each day, it was neccessary to use five or six baskets of leaves and weeds, weighing three to four seers; (2.8 to 3.7 kgs.) compared to only two to three seers (1.9 to 2.8 kgs.) of branches or woodfuel.

An additional disadvantage with leaves and weeds is that the ratio of collection time expended to useful energy obtained is very high. They also burn very quickly, and create a lot of smoke; but give off relatively little heat, which prolongs the time required for cooking. For all of these reasons, they are generally regarded as being among the lowest quality fuels.

Bamboo roots are also used from time to time, and fall into the same category. All of these lower quality fuels tend to be used in the hotter drier months, when drying and storage is less of a problem, to fill in the gaps when crop residues have been used up.

Dung

The other fuel in widespread use is dung. This may be gathered either from cattle stalls in the immediate homestead area, or as droppings from the fields and pathways. But in practice, dung from homesteads is generally retained by the cattle owner to be used as fertiliser, and it is only droppings which are collected for fuel. Once again this is a task which falls almost exclusively to women and children, and the expenditure of time per unit of useful energy obtained is comparable with leaves and weeds.

Once the dung has been gathered, it is either combined with husks or with bamboo branches and jute sticks, in which form it is known as ghoita. It is dried in the sun for about two weeks before being stored. This takes place throughout the drier part of the year, but the work tends to be concentrated in the weeks immediately preceding the onset of the rains. The fuel is stored in the same way as jute sticks.

Dung burns relatively slowly, but is fairly smoky, and some people believe that it impairs the flavour of certain dishes. An additional disadvantage is that its use as a fuel deprives the soil of important nutrients, at a time when land has to be

farmed with increasing intensity to keep pace with the needs of a growing population.

Whilst dung is normally used by the collector's household, there is a small market for ghoita, and this provides a valuable source of income to a minority of landless women. Ten sticks weigh approximately 1.5 seers (1.4 kgs.) and sell for two taka ($0.06).

STOVES

Many different types of stove are in use (2). All are made from clay, or from mixtures of clay and cowdung. Most are made by the users themselves, but women who are particularly skilled at this work may sometimes help out others, and will sometimes be paid for their services.

Some are built directly into the ground and cannot be moved. Two basic designs of this kind were found. Both have hollowed out underground combustion chambers, with single holes through which fuel can be fed, and external dimensions of about 30 centimetres square. One has a flat top, stands about 15 centimetres above ground level, and can be used both for cooking and parboiling, although richer households tend to have a separate stove for parboiling. The other has three ridges on which pots can be balanced, and can only be used for cooking.

Where weather conditions permit, most women prefer to cook in the open air so as to minimise the pollution and discomfort caused by smoky fuels. Under these circumstances, it appears that both stoves are adaptable to use with any of the fuels discussed above. But provision also has to be made for cooking under cover in the rainy and windy times of the year. Better off households, with homestead space to spare and access to construction materials, normally build separate huts for this purpose, whilst others have to make do with stoves constructed within the dwelling house itself. In these cases, there is a preference for the flat-topped stove, which emits less smoke, and a tendency to avoid the use of inferior, smokier fuels.

As an alternative to these relatively inflexible, fixed-location stoves, some wealthier households favour portable earthen versions, which can be used either inside or outside, according to preference and weather conditions. These are circular, stand some 30 - 40 centimetres above ground level, have flat tops, and from one to three holes in the sides, through which fuel can be fed and smoke can escape. They are usually rather smaller than fixed-location stoves, and are again generally built by users themselves, although not everyone has the necessary skills. As with the second of

the two stoves described above, these tend only to be used with better quality, less smoky fuels. Richer households generally also have larger versions of the other stoves, which are used when hired labourers have to be fed.

In addition to cooking, most land operating households also use fuel to parboil their paddy prior to husking, in order to reduce milling losses, improve flavour, prevent sprouting and enhance nutritional content. Larger land owners, with substantial quantities of paddy to process, have special utensils which are used exclusively for this purpose. The operation is performed in the open air on a simple stove comprising three bricks, with paddy straw or rice husks mixed with dung or jute sticks generally being used as fuel. These stoves may also be used for heating water for washing and other purposes. As an alternative to the three brick stove some households construct large, rectangular, flat-topped ovens, with holes at either end for feeding in the fuel.

Apart from parboiling, husks may sometimes be used for cooking on flat toppped stoves, but have no other end uses as far as land operating households are concerned. They therefore see no need to adopt more fuel efficient methods.

In addition to the traditional models which have been described, new types of stove, designed by BRAC, were found to be in use by a very small number of households in Uzan Ghagra. One- and two-holed models were being experimented with and a number of fuel saving features had been incorporated. The stoves had been designed to be used with the full range of village fuels. BRAC had trained local women to build them, and the cost of production was 30 takas ($0.95) each, although they were being supplied to users for only five takas, in an attempt to encourage adoption. They seemed to be popular with users, but so few had been installed that it was too early to arrive at any clear-cut judgement regarding their suitability.

THE FUEL TRADE AND COMPETING END USES FOR VILLAGE FUELS

Having seen how fuel and fuel materials are used within villages, something must now be said about the fuel trade and competition from external sources, since both have a substantial bearing upon the supply available for domestic users within the villages themselves. Distinctions will need to be drawn between different types of wood and parts of trees, and the range of fuel and non-fuel end uses for which these are suited. Local and wider trading circuits will need to be differentiated, and the roles of various intermediaries spelt out. Local markets will be explored first.

Even within the confines of the local circuit, wood in

general, and wood fuel in particular, may follow a number of different courses in the journey from grower to end user.

As will already be apparent from earlier discussion, petty traders-cum- processors have their part to play. At the very bottom end of the market, landless women and children gather, or sometimes purchase, small branches, which they then sell at daily markets or hats. On average, a trader of this kind, who must carry fuel to market herself, might be able to sell a headload weighing between 10 and 25 seers (9 and 23 kgs.) in one day.

One rung further up the ladder are the karatis who contract with owners to fell trees, and then chop up, transport and sell them themselves. Once again, these activities are confined to local markets. Karatis specialise mainly in the species which are unsuitable for use as timber, which include: mango, pitraj, mandar and bat.

These two types of petty trader together account for only a small part of the wood market, and mainly supply local domestic consumers. They do not compete for village produced biomass, but should rather be seen as a minor component in the intra-village distribution system. Their significance lies not so much in any influence which they may have on the aggregate amount of fuel available to village consumers, as in the possibility which they represent for the creation of new livelihoods for the most depressed groups in rural society, in a general context of reduced fuel availability.

The greater part of both the fuel and non-fuel sectors of local wood markets are controlled by beparis, who have the capital to purchase trees on a more extensive scale, and who often operate on credit. The beparis do not normally deal directly with sellers, but rely on intermediaries known as dalals, who have little capital of their own. The dalals identify potential sellers, negotiate a price and then take a percentage for their services. The beparis hire labourers to cut the trees and then arrange transportation, normally using hired ox-carts.

If the trees are only suitable for use as fuel, then they are likely to go to the brickfields, which are by far the most important locally based consumers. Brickfields operate during the dry part of the year from December to April, and on average consume 25,000 maunds of woodfuel each season. This is equivalent to 1,000 metric tons and sufficient to produce about 800,000 bricks. Household homestead trees are a major source of supply, although fuel also comes illegally from the Madhupur forest. A single enterprise will generally obtain most of its supplies from about three villages; and where this is the case, some 250 trees need to be cut in each village each year to satisfy present levels of demand. Even with a large village like Uzan Ghagra, this would be sufficient to

use up all existing trees in less than 20 years if there was no replanting, and no use of wood for any other purpose.

Not all of the fuelwood traded locally goes to the brickfields. Some, including branches trimmed immediately after felling from trunks which will be used as timber, finds its way from beparis to retailers at local markets. The retailers then employ labourers to cut it to size before supplying it, in turn, to tea shops, restaurants and domestic consumers. Small additional amounts of fuel also find their way to retailers, or direct to end users, in the form of trimmings from local saw mills producing timber for construction purposes, and from small furniture-making enterprises. Species favoured for these purposes include: jackfruit, blackberry, koroi, and rain tree.

Apart from these locally based consumers of village wood, there are also competing end users further afield. Dalals and beparis again serve as the initial links in the chain from producer to consumer, but the major intermediaries in this instance are truck owning contractors, who purchase from local dealers, and supply large urban fuel traders and construction enterprises. Substantial quantitites of wood move through this channel to Mymensingh town. Some also goes to Dhaka, carried at low marginal cost by vehicles which have brought goods up from the capital, and which otherwise might have had to return empty.

It was impossible to determine the amount of wood, or of woodfuel, which was entering these wider trading circuits. The likelihood is, however, that quantities are substantial, although probably not yet of the same magnitude as flows to the brickfields. It also appears highly probable that the peri-urban villages, with their better communications, have been affected to a far greater extent than their more remote counterparts. The large quantities of wood which could daily be observed awaiting transport across the river to Mymensingh from Char Iswardia, in particular, provide strong impressionistic evidence in support of such a conclusion. It is also clear that the brickfields themselves have had a much greater impact here, since there are no less than ten alongside the few kilometres of road seperating the two peri-urban villages, compared with only three in the locality of Bon Para and Chilagai.

FUEL AVAILABILITY AND USE: THE CONTEMPORARY SITUATION

This part of the paper explores the forms in which fuel shortages appear, and identifies who is affected, and how. But first the concept of shortage itself needs to be clarified.

The Meaning of Shortage

In principle, it is possible to look at shortage either in absolute, or in relative terms. Absolute shortage might be taken to refer to a situation where a household was unable to obtain sufficient fuel to prepare what was regarded as a minimum acceptable quantity of food, and to meet any other essential requirements. This would raise further questions of definition, and would in any case only really be workable where the possibility of substitution downwards to inferior materials did not arise. For these reasons, a relative assessment is preferred.

Two types of relative criterion will be employed. The first involves a simple comparison between the present circumstances of different households. In this sense, a household will be deemed to be suffering from shortage if it is unable to obtain an adequate supply of the preferred biomass fuels commonly used by others in the same area. The second criterion rests on an understanding of changes taking place through time. In this sense, a household which has had to 'substitute down' or to reduce its consumption of a preferred fuel, may be regarded as suffering from shortage.

Relative shortage may, however, also be indicated in a number of other ways. A certain standard or level of consumption may be preserved in the face of reduced availability, through an increase in the amount of time spent gathering fuel, through increased care and labour time in the cooking process, or through the purchase of fuel where it was previously possible to collect it at no financial cost. Any of these things may happen by themselves, or in combination with the other types of changes already outlined.

From this, it will be apparent that the notion of relative shortage is not a simple one to apply, and that a number of different types of evidence may need to be reviewed before it is possible to arrive at a proper assessment of the degree of deprivation arising in the case of different locations, households, and family members.

A further complication also needs to be taken into account. This is that many of the indicators which have been discussed: for example, a reduction in the quantity of preferred quality fuel consumed, may reflect a general deterioration in the economic condition of the household in question, rather than any decline in the availability of fuel. For this reason it will be important not only to find what differences exist between households now, and between the past and present condition in individual cases, but also to ask why these variations have arisen.

For all of these difficulties, the relative criterion will be

retained, since it comes closest to reflecting rural peoples' own perceptions of what shortages mean.

Inter-village Variations in Fuel Consumption

Tables 4 and 5 help to provide an overview of the present situation in the four villages. Both list the fuels used in a sequence which proceeds from the most to the least favoured. Table 4 shows the percentage of households in each community who have ever used particular fuels during the last year, whilst Table 5 gives the average daily quantities consumed. Taken by itself, Table 4 is potentially misleading in so far as it gives equal weight to households consuming very small and very large quantities of the same fuel; but when it is considered in conjunction with Table 5, a clearer picture emerges.

Strong evidence of shortage is immediately apparent. Less than a third of all households have ever used fuelwood or jutesticks, the preferred fuels, for cooking at any time during the last year; whilst more than three-quarters have had to resort, at some time or other, to leaves and weeds - the least favoured fuels.

When the position of the four villages is compared, no clear overall pattern emerges, but certain potentially significant variations may be detected. With the consumption of superior fuels, there seems to be little significant difference between flood-prone and flood-free, or peri-urban and remote locations, although the virtual elimination of jute from the cropping system in Bon Para is reflected in the disappearance of jute sticks as a fuel. More pronounced contrasts do, however, emerge with inferior fuels. This is particularly so in the case of dung, where the pattern of use conforms very closely to that anticipated in the earlier ranking of villages. This fuel is hardly used at all in Chila Gai (FFR), whilst the number of households which rely upon it at some time during the year rises to 31 per cent in Bon Para (FPR); 51 per cent in Uzan Ghagra (FFPU); and 80 per cent in Char Iswardia (FPPU). But even these figures fail to reveal the full extent of the contrast, since the actual quantities consumed in Char Iswardia are virtually three times as great as in Uzan Ghagra.

This evidence suggests that peri-urban areas, where the pressure of competing external users for good quality fuels is far more intense, tend to be more severely affected. Shortages are also being experienced more severely in flood-prone locations, since homesteads here are on average smaller. This reflects the fact that they have to be built up, at considerable expense, to above the flood water level, which leaves little land spare to grow trees. In addition, crop residues are in less abundant supply. At the same time, it is

also apparent, as the case of jute in Bon Para makes clear, that cropping patterns are by no means purely a function of degree of flood-proneness, and that the actual fuel supply and consumption situation is a good deal more complex than the simple four-fold village typology might imply. In Bon Para, for example, it might be supposed that paddy straw would be in relatively short supply and thus not used very much as a fuel; but in fact straw consumption here is appreciably greater than elsewhere, as a result of the non-availability of jute sticks.

The pattern of fuel use for parboiling is slightly different. In the first place, it only involves land operating classes. There is also a tendency to use fuels of lower quality - paddy straw and husks in particular - since the operation is always performed in the open air, which reduces the significance of smoke as a consideration. Nevertheless, people would still prefer to use wood if they could, and would certainly prefer to avoid the use of dung, leaves and weeds, in view of the time which these take to collect. The fact that these inferior fuels are being used for the parboiling of amon, aus and boro paddy, therefore once again provides a clear indication of fuel shortage. It is also significant that the extent to which these inferior fuels are being used in different communities again conforms to the anticipated pattern.

At the same time, it should be noted that the consumption of inferior fuels in Bon Para (FPR) reaches levels comparable to those of Char Iswardia (FPPU) in the aus and boro seasons. This reflects the influence of cropping patterns on levels of activity, and indicates clearly the dangers of overlooking seasonal fuel shortages, which are liable to be far more pronounced in flood-prone, residue dependent locations, than they are elsewhere.

Inter-class Differences in Fuel Availability and Use

Further indications of shortages are provided by variations in the access to, and use of, fuel enjoyed by different households. Relevant data are summarised in Table 5, which shows average daily consumption of fuels of different qualities by social class; and in Table 7, which distinguishes the sources from which fuels are obtained.

Households may be in a position to use resources - homestead land, crop land or cattle - over which they themselves have direct control. Or they may be obliged to seek access to the privately owned resources of others; or to gather fuel on public land, or to purchase it on the market.

This sequence may be seen as a hierarchy. A household's use of its own resources represents the most desirable state of affairs in the sense that access is guaranteed, and that the

time which must be devoted to collection can be kept to a minimum. If everyone were able to obtain their fuel in this way, and particularly if they were able to satisfy all of their fuel and non-fuel needs from trees growing on their homesteads, then it would be difficult to argue that any shortages existed.

Reliance upon the fuel resources of others implies shortage in that the time required to gather fuel is likely to be extended by the need to forage in a wider range of locations; but such a state of affairs could still co-exist with aggregate self-sufficiency at the community level. Stronger evidence of shortage is presented where collection takes place on public land, since the only materials available here are likely to be inferior ones: twigs, leaves, weeds and dung. But given the very limited access to cash incomes enjoyed by most households, and the high proportion of income spent on food, the strongest evidence of all is presented where fuel has to be purchased.

Table 7 suggests that it is still possible for most households to satisfy all of their requirements from within their own villages, without recourse to the market; and that comparatively little gathering on public land takes place. But within this general picture, there remain very marked differences both between and within locations.

Big farmers are able to rely exclusively on their own resources, satisfying their requirements almost entirely from their homestead and crop land, and using only very small quantities of intermediate and inferior quality fuels. Almost every household in this category will at least have a surplus of crop residues, which can be made available, in various ways, to others who are in deficit.

Most owner-cultivators are also self-sufficient, although they use relatively less superior, and relatively more intermediate and inferior quality fuels. But the fact that a minority of households within this class rely, to some extent, upon the resources of other people, suggests that modest surplus gives way to deficit at the poorer end of the spectrum. This tendency is a little more pronounced in the two peri-urban villages, where the general problem of shortage is greater, and where the average amount of land owned by members of this class is slightly lower than elsewhere.

Sharecroppers depend rather more on the resources of others than owner cultivators, but even here, most households are close to self-sufficiency. Recourse to the market only occurs under fairly exceptional circumstances, although a higher proportion of inferior fuels is used.

Dependence upon others is far greater with the landless, who control hardly any resources from which fuel may be obtained.

Access to the homestead and crop land of wealthier households is of primary importance, but dung gathered on public grazing land, and cash purchase both begin to figure prominently. This provides clear evidence that it the landless who are affected first when shortages arise. Typically, the previous surpluses of the relatively rich become absorbed by the growing requirements of their own households; and access which was formerly offered to those in deficit is progressively withdrawn. It is noticeable that this process has gone substantially further in Uzan Ghagra (FFPU), and Chila Gai (FFR), where the average land holdings of big farmers are subtantially lower than in the other two villages; and where the quantity of surplus fuels available for distribution to those in need is accordingly lower.

In addition to the effect which they have upon the types of fuels used, shortages also influence the frequency with which households eat and cook (see Table 8). Big farm households normally take three meals a day, nearly all of which are freshly prepared. At the other extreme, the landless eat, on average, only twice a day, and consume a higher proportion of their food cold.

It would be incorrect to suppose, however, that these differences could be explained exclusively, or even primarily, by differential access to fuel. Access to food itself will clearly be of critical importance as well. It should also be remembered that members of poor households in general, and the landless in particular, will sometimes be given meals when they work for others, and that non-employed members will often forgo their own cooked meal under these circumstances. Where women themselves work for other households, this may limit the time available for cooking at home.

These qualifications notwithstanding, explanations given by poorer people themselves make it clear that fuel availability very often is a central determinant of the frequency with which they eat and cook. Along with their other consequences, fuel shortages thus directly affect the nutritional intake of the poorest people. The effect may not always be negative. Sometimes cooking food less may improve its nutritional content. On the other hand, where food is cooked and a part of it then left several hours to be eaten cold at a subsequent meal, it is more liable to harbour bacteria, to cause diarrhoea, and lead to nutrient loss.

The Effect on Women and Children

Differential access to fuel by social class interacts with the division of labour within households in such a way that the effects of any shortages fall unevenly upon different members.

Table 3 shows how the responsibility for the collection and

processing of fuel is allocated between adult male, adult female, child and hired labour in households of different social classes(3). With big farmers, the bulk of the work, which involves chopping trees or collecting crop residues, is performed by hired labour. With owner cultivators, some hired labour may be used to carry residues, but most of the work is performed by household members, with men playing the major part as cutters of wood and clearers of residues. As with big farmer households, women, and to a greater extent, children also have a role to play, but in most instances this is confined to the collection of small quantities of kindling which takes relatively little time.

With sharecroppers and landless households, an increasing proportion of fuel has to be gathered. Men hardly ever participate in this activity, and women must take the responsibility, assisted by their children. The poor access which landless households have to fuel, and the fact that two to three hours each day have to be devoted to its collection, thus translates directly into an additional burden for these household members, and perhaps reduced opportunities to engage in income generating activities. When it is considered, in addition, that the types of fuel most frequently used are of an inferior quality, which extend the length of the cooking process, increase the intensity of labour input required, and are associated with greater health risks; then it becomes apparent that shortage is, above all, a problem for landless women.

CHANGES IN FUEL AVAILABILITY AND USE

It was suggested earlier that relative shortage might appear either as an inability by certain households to consume the preferred types of fuel used by others in the same communities or as a decline in the quantity or quality of fuel consumed by individual households through time. This section of the paper explores the extent to which the second type of shortage had arisen, and looks at the underlying factors responsible for change.

The Determinants of Change

Central to any account of social and economic transformation, and the consequences which follow from this for biomass fuel availability and use, is an understanding of the part played by the rapid growth in population. This has had a number of more or less direct effects.

Extra people have created a demand for extra housing, which has had to be built on homestead land. In principle, this

might have been satisifed by constructing new homesteads on land which was previously used for growing crops, but because crop land itself is in short supply, this has only happened in a very small number of cases. A recent national survey, covering the period 1951-1974, has, in fact, shown that although population increased by 58 per cent, the area of land under homestead grew only by 0.4 per cent (4). This means that more houses are being built on existing homesteads, with the seemingly inevitable consequence that more of the area which was previously used to grow trees has now had to be cleared. The first major consequence of population increase has therefore been a sharp reduction in the quantity of fuelwood at the disposal of rural households.

The second has been a reduction in the per capita availability of crop residues, as average land holding sizes have declined. This tendency has often been reinforced by otherwise beneficial changes in cropping pattern, which have substituted lower for higher fuel yielding varieties and species. This has been seen most clearly in Bon Para, where the introduction of an irrigarted HYV boro crop has entirely eliminated jute. The same thing has happened in Uzan Ghagra, although not to the same extent. In Char Iswardia, b. amon has disappeared from the rotation as a part of the series of changes set in motion by the embankment; although in this instance, the extended possibilities of double cropping more than compensate for any losses from individual crops.

The subdivision of land in the upper reaches of the class system has cut directly into the biomass surpluses, which would formerly have been available for redistribution, at the same time as increasing numbers of households are becoming impoverished and moving into fuel deficit. As the average size of landholdings has declined, there has been a corresponding increase in the number of households moving towards the brink of landlessness, and being forced to liquidate assets in order to repay debts, or to satisfy short term consumption requirements. Under these circumstances, trees are frequently cut down and sold, often before the point has been reached at which the best economic return could be achieved.

The progressive subdivisiion of the largest holdings has been reflected in a reduction in the amount of land allocated to sharecroppers, thus denying them automatic access to crop residues. In those instances where land is still made available to tenants, the stronger bargaining power of the landlord, and the growing scarcity of biomass, have led to the modification of arrangements, where the tenant now has to surrender half of the residues, as well as the customary half of the crop. Grazing land has also been placed under pressure, leading to a reduction in the cattle population and the supply of dung; although this particular development has been counteracted to some extent by the emergence of new forms of animal sharing arrangement, where the person responsible for

looking after the animals assumes a right to any dung produced.

The increasing numbers of households which have been forced into landlessness have lost all independent access to fuel, other that which they can obtain from their homesteads. At the same time, their consumption requirements may have been reduced in so far as they now receive cooked meals as partial payment for the work which they perform for others. But landowners who hire labour, faced with fuel problems of their own, are now becoming less inclined to provide cooked food, prefering to switch to a simple cash payment system, or at most to provide uncooked rice. This may mean that the long term landless now require more fuel than before, although their overall position depends partly upon the amount of work available. Although employment opportunities have been reduced by growing competition from the new landless, increasing opportunities have, at the same time, been generated by changes in cropping patterns in certain locations.

Parallel to these economic changes are a series of broader social changes arising from the interplay of growing population and increasing general impoverishment, which have also had an influence upon fuel. Case study investigations revealed that quite extensive mutual support systems continue to function within the villages, usually organised around kinship ties within patrilineages. Several informants reported, for example, that in times of flooding and crop loss, small, interest free loans of residues would be made to those in need. But at the same time, it was recognised that this kind of support was offered less frequently now than had been the case in the past.

The supply and use of fuel has also been influenced by changes affecting the other purposes for which biomass is required, as well as by growing demands from outside users. A few years ago, when the pressure of population was less acute, poorer land would not be cultivated, but would be left to a high quality grass called <u>san</u>, which could be used for thatching the houses of poorer households and the cow sheds and outhouses of richer families. Now that this land has been brought under cultivation, the grass is no longer available. For similar reasons, fodder is in far shorter supply than hitherto, and prices have risen sharply. Paddy straw which would previously have been available as fuel is now required as a substitute. Bamboo has also become more expensive, forcing poorer people to turn increasingly to jute sticks to build the walls of their houses, once again squeezing an important source of fuel.

The rapid growth of urban centres in the recent past has helped to exert further pressure. Most urban households still require fuelwood, as do tea shops and restaurants. Increasing

quantities of wood and bamboo are now also needed for the construction of buildings and for furniture, and there has been a particularly rapid expansion in demand for bricks, and hence for fuelwood, reflected in a tripling in the number of brickfields in the Mymensingh area during the last ten years. As a result of all these changes, the rate of tree cutting in villages has also increased. In the case of good quality timber, trunks would not have been used for fuel if they had stayed longer in the villages, but even here, branches could have been pruned, and other by-products would also have been available for longer periods.

Changes in fuel use

The combined effects of these changes on fuel use in the four villages can be seen in Tables 4,6 and 8.

Table 4 shows the change in the percentage of households using different fuels now, compared to ten years ago (5). There is a clear tendency for the number of users of fuelwood and jutesticks to decline and for that of dung and leaves users to increase, with the use of 'intermediate' fuels (branches and paddy straw) also increasing to some extent. This indicates a process of downwards substitution, with the best fuels being replaced at the margin by those of intermediate quality by the wealthier households, and a corresponding, although somewhat less pronounced, shift from intermediate to inferior fuels in the lower reaches of the class system. A similar process appears to have been at work as far as the use of fuel for parboiling is concerned (see Table 6), although the aggregate picture here conceals marked differences between villages.

Downward substitution is only a part of the picture. Apart from switching to inferior fuels, most households have also reduced the quantity of fuel used (see Table 8). This is reflected both in reductions in the number of meals consumed per day, and in the frequency of cooking per meal eaten; and is particularly noticeable in the case of the poorest households. In a pattern which repeats itself consistently across the range of villages investigated, big farmers and owner cultivators behave in much the same way as they did ten years ago, and sharecroppers show a minor reduction in the average number of meals eaten. But in the case of the landless, the number of meals eaten has fallen by more than 20 per cent, and the frequency of cooking per meal consumed by almost ten per cent. The contrast becomes all the more striking when it is recalled that the proportion of landless households is now substantially greater than it would have been ten years ago.

Not all of this change can be attributed to fuel shortages. As was noted earlier, a declining capacity to obtain food itself has also played a large part. But there can be little doubt

that fuel availability has been influential, and that the effects of shortages have been experienced far more acutely by the landless than by any other class.

Aggregate figures never tell the whole story, and it is certainly not the case that all poor households are worse off than they were ten years ago. A minority have been able to secure larger landholdings, more work or higher incomes, and this has generally been reflected in better access to fuel. But for each such case, it is possible to identify another where something approaching catastrophic decline in economic status and security has taken place; leaving the overall picture as one of general and disturbing decline.

This is true of each of the villages, but it is apparent that the extent of the problem, and the rate at which deterioration is taking place, vary substantially. Leaving aside the effect of the elimination of jute from the cropping system in Bon Para (FPR), the rate at which households have had to substitute out of good quality fuels for cooking is more rapid in the case of the peri-urban villages (see Table 4). More striking, however, are the changes taking place at the other end of the spectrum, where substitution into the least preferred fuels is proceeding far faster in the peri-urban than in the remote villages. No clear pattern emerges from the comparison of flood-prone and flood-free locations, but if it had not been for the construction of the embankment at Char Iswardia (FPPU), then it is likely that the former would also have shown higher rates of downward substitution.

Changes in fuel use for parboiling (see Table 6) have followed a similar pattern. With aus, boro, and amon, peri-urban villages show marked tendencies for substitution out of the best quality, and into the inferior fuels. Remote villages, on the other hand, appear far more stable, retaining much the same pattern of use of straw as a fuel they had a decade ago; although with more pronounced signs of decline in Bon Para (FPR).

Whilst it is dangerous to generalise on the strength of observations in such a small number of villages, particularly where so many contributory factors are at work, some tentative conclusions are possible:

- the comparison of the present situation of different households, and of the position of the same household ten years ago with that obtaining today, suggests fuel shortage is a problem in all locations, and that it is getting worse.

- the extent of the problem, and the rate at which it is deteriorating are most pronounced in peri-urban locations, which reflects the greater strain imposed by external competitors in these areas.

- there is rather weaker evidence to suggest that flood prone locations are more vulnerable, and more subject to deterioration than those which are flood free. To the extent that this is the case, it most probably reflects the greater insecurity of cultivation, and hence of residue availability in the former.

- of far greater significance than any variations arising between locations, are the differences within locations between rich and poor. Landless households everywhere feel the effects of shortage much more severely than other classes, and have had to make far greater adjustments in terms of the quality and amounts of fuel used, as shortages have begun to take effect.

- within poorer households in general, and landless households in particular, it is the women who have been most severely affected. As the availability of good quality fuels declines, they have had to take on increasing responsibility for meeting their households' fuel needs, have had to spend greater amounts of time collecting each unit of fuel consumed than members of other households, have had to spend more time cooking per meal produced, and have had to put up with the inconvenience and discomfort of using relatively smoky fuels.

SOLUTIONS

The major objectives of this investigation have been to determine the extent to which fuel shortages are a problem in the rural areas, to establish the forms in which they are appearing, and to identify the people affected. Given the time and the resources available, this has proved a rather ambitious undertaking, and it has not been possible to deal adequately with all of the issues which ought to have been explored. From this it follows that what can convincingly be said about potential solutions must also be rather limited. What follows should be regarded as only a preliminary attempt to distinguish more desirable from less desirable alternatives in the light of the fuel needs which have been identified, and to form an initial impression of how feasible various courses of action might be.

The problems which have been outlined appear, in principle at least, to be amenable to a range of solutions. Measures could be taken to increase the supply of biomass fuels available in the rural areas. The efficiency with which biomass is converted into useful energy might be improved, or pressure on the existing biomass base might be relieved by various forms

of fuel substitution.

Some of the potential solutions to be discussed could take years to come to fruition. Given the rate at which transformation in the rural areas is presently taking place, this makes it important to form a view of the potential situation which might arise five or more years ahead, if no remedial action were to be taken.

The Future

A worst case scenario would start from a recognition of the inevitability that population will continue to increase rapidly within this period, and that this will lead to further reductions in the area of homestead land under trees. Leaving aside, for the time being, the prospect of the introduction of more productive cropping systems, increased population will also reduce the per capita availability of crop residues. The number of landless households will increase more rapidly than population itself, the area of land offered for share crop will be reduced, and conditions offered to remaining tenants will decline, further restricting their access to fuel. The reduction in the size of larger landholdings will progressively eliminate any fuel surpluses available for distribution. There will be pressures for an increasing proportion of cultivable land to be used to grow food crops, and hence for a reduction in the jute acreage and the supply of sticks. An increasing number of sticks will be required for housing and fencing as other construction materials become harder to obtain, and an increasing proportion of straw will be required for roofing. Demand from brickfields and from urban domestic consumers is likely to continue to grow rapidly and with improved communications and higher prices, the catchment areas of towns and cities will extend further into the rural areas. Mutual support systems within the villages will play a declining part in the distribution of fuel.

All this will lead to fundamental changes in fuel consumption within the villages. Wood will cease to be used as fuel by all but a very small minority, and jute sticks will be used much less than at present. The dwindling numbers of big farmers and owner cultivators will come increasingly to rely on their own straw and other residues to satisfy their needs, and any remaining surpluses will be sold, rather than being available for collection by those in need. The majority of landless households, with insufficient cash to purchase residues, will have to spend longer foraging for inferior fuels, with this activity taking up an increasing proportion of the time of women and children in particular. Theft will become more frequent, and owners will be less likely to turn a blind eye to it than they do now. The increasing use of dung may adversely affect soil fertility, leading to at least marginal decline in yields and straw availability. Women will suffer

increasingly from respiratory diseases and eye infections as they come to depend more exclusively on smokier fuels, even in the rainy season, when cooking has to be done indoors. The number of meals prepared each day in landless households will continue to fall, and more and more meals will be eaten cold, thus increasing the danger of disease.

Peri-urban locations will be worst affected in the short run, but the types of changes already observed in these villages in the last ten years seem likely to be repeated in their more remote counterparts in the next decade. Flood prone villages, where there is always the risk of heavy crop loss, and more rapid impoverishment of those in marginal positions, are likely to decline more quickly than the flood-free. The landless, who within a decade will constitute upwards of two thirds of all households, will be most vulnerable, with the problems of women and children paramount.

This, at least, is what might be anticipated in the absence of new technology; but in reality, change on this front is likely to be considerable. The area under irrigation and flood protection schemes will both grow, increasing yields and cropping intensities, and probably also improving residue supply in most locations; although this will not always be the case. The area under wheat cultivation is also certain to grow, but with less readily predictable results for aggregate fuel availability and requirements. These and other possible changes, the precise effects of which might usefully themselves become the subject of careful empirical investigation, seem on balance likely to counter, at least to some extent, the negative trends anticipated earlier.

But to avoid some of the possible outcomes which have been outlined, fuel specific interventions on a substantial scale, and of a carefully thought out nature will also be required. The possibilites of increasing biomass supply will be considered first.

Increasing the supply of biomass

Possibilities exist for increasing the supply of biomass from homestead, crop and public land.

The utilisation of homestead land does not fall neatly within the conventional boundaries defining the professional interests of either foresters or agricultural researchers, and has, as a consequence, tended to be ignored by both. Relatively little is therefore known, in any systematic sense, about the way in which members of different classes manage this resource in different locations. Questions need to be asked about the multiple end uses which homestead products serve, the relative priorities which are attached to these

under varying circumstances, and the production strategies which follow as a result. Only with this basic information to hand will it be possible to determine whether scope for improvement might exist through the incorporation of new trees and plants into existing systems, or through changes in the use of elements already present. Given the complexity of homestead management, all that can be said at this stage, is that any potential which may exist will be realised only through forms of research and development which involve rural people themselves to a much greater extent than has normally been the case in the past. This is an area in which substantial progress may well be achieved, but only in the medium-to-long term and with the commitment of a considerable research effort.

The situation with regard to the potential of crop land shares some of the same central features. Although a great deal of research has gone into the subject of crop improvement in recent years, and although this has been successively broadened to encompass cropping, and now farming systems, the use of residues for fuel has still not become established as an important item on the agenda. This deserves to take its place alongside food, fodder and other end uses in the determination of research priorities, so that trade-offs can be explicitly considered, and proper assessments made of the costs and benefits of alternative courses of action. Attention should also be given to questions of distribution, since an innovation offering increased grain production to a fuel surplus household might, at the same time, create or deepen problems for its dependent fuel deficit households elsewhere in a community.

Research institutions with a capability to deal with these issues are already in place, and the additional burden on extension services would not be very great. This suggests that progress on this front should be relatively easy to achieve. Consideration might also be given to the possibility of introducing crops intended primarily for use as domestic fuel, although the widespread use of jute, and the common practice of growing dhoincha on field boundaries, suggest that cultivating households already have means at their disposal to pursue this option should they find it desirable to do so. More important would be broader research initiatives, which incorporated homestead land into the farming system, and sought to develop comprehensive packages for the satisfaction of the fuel and other needs of different types of rural household.

The prospects for significant progress on communal land are less favourable, primarily because so little of it is available, particularly in lowland villages. Nevertheless, most communities have certain areas, perhaps by roadsides or along embankments, where trees for fuel and other purposes could be planted. The Forestry Department has already started

programmes in some of the communities studied, but these seem to have been unsuccessful as a result of the lack of any clear system for allocating responsibility for protecting trees from animal and other damage. Social or community forestry initiatives also raise potentially complicated questions of ownership and access, and will often require substantial institutional innovation if they are to succeed. By contrast with other possibilities of increasing biomass supply, which at best offer indirect benefits to the landless through increasing fuel production on other people's land, (6) these options do, however, hold out some prospect of direct assistance to those most in need. As such, it is desirable that they be pursued further, at least on an experimental basis, where a capacity for the neccessary institution building exists.

Improving Conversion Efficiency

The efficiency with which existing supplies of biomass are utilised could be improved through the introduction of biogas plants or improved cooking stoves.

Biogas allows dung to be converted into methane and fertiliser. It appears particularly attractive under cirumstances where increasing quantities of dung, which would previously have been available as fertiliser, are now being burnt as fuel, and where smoke in the cooking environment is a growing problem. But there are a number of drawbacks. An initial investment cost of at least 3,000 taka is well beyond the means of all but a handful of individual rural households, and would only be possible in the case of those already in fuel surplus. About five cattle are needed to supply the amount of dung required to operate the smallest economically viable unit, which again rules out the great majority of people if individual ownership and operation is assumed. Substantial maintenance is also required, and the technology is unlikely to function successfully in the longer run unless back-up technical support is available to users.

Each of these problems could be overcome. The Bangladesh Krishi Bank has indicated its willingness to provide credit to cover initial capital costs, and there is no reason, in principle at least, why institutions allowing the collective ownership and/or operation of the units should not be developed. Taking account of these factors and of the potential contribution which biogas could make, not only to fuel availability, but also to health, there does seem to be a case for experimental programmes. But the available evidence suggests biogas is unlikely to have much impact for the forseeable future, and that the prospects for bringing direct relief to those most in need, are not particularly good.

The picture is rather more optimistic as far as improved

cooking stoves are concerned. Stoves of the kinds presently in use typically have an efficiency in the range of 8 to 10 per cent; and against this base, there is now evidence to suggest that fuel savings equal to about 30 per cent of present consumption may be possible. As mentioned above, BRAC has already introduced new designs into one of the villages studied, and these appear to be popular with the landless in particular. It is relatively easy to train people to make the stoves, and they can be installed at a cost of about 30 taka ($0.95). This still represents a sizeable investment for landless people, but subsidies for large numbers of households could be provided at modest overall cost. Once the stove has been installed maintenance requirements are minimal, and easily carried out by household members themselves.

Unlike any of the other options discussed thus far, improved stoves therefore hold out the prospect of directly easing the fuel constraint on households most in need, without either high initial investment costs or the need for institutional innovations which may be difficult to implement. Provided further research takes proper account of user needs, and is not unduly laboratory centred, then progress may be anticipated on this front, particularly in areas of acutest shortage, where growing numbers of people are forced to purchase their fuel requirements.

Substitution

Apart from producing more biomass for fuel and utilising existing sources more efficiently, there may also be scope for relieving shortages by using other materials. Direct fuel substitution does not appear to be very promising. Increasing numbers of villages will be electrified in the course of time, but electricity will be many times more expensive than biomass and quite infeasible for the great majority of rural households. The same will be true of kerosene, unless very heavily subsidised. The prospects for less direct forms of substitution seem rather better. Supplying gas connections or cheap coal to brickfields might well prove feasible, and would very substantially reduce pressure upon woodfuel resources in peri-urban villages in particular. There may also well be scope for using similar devices to reduce biomass consumption by urban based domestic consumers.

Income Generation

It was noted earlier that the problems faced by poorer households were as much a function of general deprivation as of any particular shortage of fuel. It follows that solutions need not be specifically centred upon fuel itself. The creation of new income generating opportunities, which would

make it easier for the landless and others to purchase their fuel requirements, may under many circumstances, provide the best way forward. It is clearly beyond the scope of this paper to explore this possibility in any detail; but sufficient to say that the landless have many ideas about livelihoods which they would like to pursue if modest amounts of credit and other forms of assistance could be made available. These include fishing, animal rearing and the provision of services to agricultural producers. Organisations like the Grameen Bank have already begun to illustrate what might be achieved. With patron client relations beginning to disintegrate under the dual pressures of population and market penetration, circumstances are also increasingly favourable for the formation of landless and women's groups. These, in turn, can serve to extend the range of production possibilities - social forestry and larger scale biogas plants included - in which the poor may participate.

Conclusion

In spite of claims which are frequently made to the contrary, it is apparent that there is no one solution to the problem of fuel shortage. Measures which directly improve the access to fuel enjoyed by poorer households will have to be combined with others which increase the supply of biomass from the land of the relatively better off; reversing existing trends of downwards substitution, and indirectly making more fuel of intermediate quality available to those who need it most. Approaches promising substantial improvement in the short to medium run will need to be complemented by experiments, particularly in the area of institution building, with the potential for longer term pay-offs. Initiatives dealing directly with fuel will have to be supported by more general efforts in the area of income generation. Proceeding simultaneously on each of these fronts, and permutating from them the measures best adapated to the possibilities and constraints of particular environments, is likely to prove the most effective strategy.

Table 1 Ownership of resources

Resource	Class	Char Iswardia (FPPU)	Uzan Ghagra (FFPU)	Bon Para (FPR)	Chila Gai (FFR)	Overall
Homestead land (hectares)	Big farmer	0.24	0.41	0.16	0.37	0.30
	Owner cultivator	0.10	0.12	0.15	0.21	0.15
	Share cropper	0.14	0.05	0.05	0.21	0.11
	Land-less	0.07	0.02	0.01	0.02	0.03
Cultivable land (hectares)	Big farmer	7.29	2.24	5.75	2.94	4.56
	Owner cultivator	1.42	0.77	1.36	1.44	1.25
	Share cropper	0.43	0.04	0.15	0.30	0.23
Number of cattle	Big farmer	5.8	4.0	7.0	5.4	5.6
	Owner cultivator	4.8	2.6	4.0	3.6	3.8
	Share cropper	2.0	2.2	-	2.2	1.1
	Landless	-	0.2	-	0.6	0.2

Table 2 Trees most frequently sold for fuel

Types of tree	Age at maturity	Weight of wood when mature (tonnes)	Weight at normal age of purchase
1. Mango	20	1.49	20
2. Blackberry	30	1.12	20
3. Raintree	10	0.93	20
4. Boroi	15	0.75	15
5. Jigar	15	0.75	10
6. Pitraj	15	0.75	15
7. Jackfruit	25	1.12	20
8. Bat	40	3.73	30
9. Mandar	5	0.56	10
10. Simul	20	0.75	15

Table 3 Percentage of households using different types of labourers for collecting fuel

Class	Type of labour	Char Iswardia (FPPU)	Uzan Ghagra (FFPU)	Bon Para (FPR)	Chila Gai (FFR)	Overall
Big farmer	Adult male	40	-	20	80	35
	Adult female	-	40	-	-	10
	Child	-	80	-	40	30
	Hired labour	100	60	100	80	85
Owner cultivator	Adult male	40	60	60	80	60
	Adult female	80	20	-	20	30
	Child	80	60	80	40	65
	Hired labour	-	40	40	60	35
Share cropper	Adult male	40	60	20	60	45
	Adult female	60	80	60	20	55
	Child	60	40	40	40	35
	Hired labour	-	-	-	20	5
Landless	Adult male	30	10	25	35	25
	Adult female	65	45	85	80	69
	Child	60	75	55	50	60
	Hired labour	-	-	-	-	-

Table 4 Percentage of households ever using major types of fuel for cooking during the past year

Quality of fuel	Type of fuel	Char Iswardia (FPPU)	Uzan Ghangra (FFPU)	Bon Para (FPR)	Chila Gai (FFR)	Overall
Superior	Firewood	31 (-43)	37 (-35)	26 (-7)	34 (-37)	32 (-34)
	Jute sticks	37 (-24)	34 (-37)	- (-100)	54 (-5)	31 (-41)
Intermediate	Branches	14 (-30)	49 (+32)	46 (+35)	60 (+11)	42 (+27)
	Paddy straw	31 (+35)	37 (+85)	63 (-9)	51 (+6)	45 (+14)
Inferior	Dung	80 (+48)	51 (+122)	31 (+82)	2 (-)	42 (+29)
	Leaves and weeds	80 (+33)	94 (+74)	40 (-33)	77 (+17)	72 (+21)
	Other	8 (-)	9 (-)	6 (+100)	31 (+35)	13 (+27)

Figures in brackets indicate percentage change in percentage of households in each category over the last 10 years.

Table 5 Average quantities of major types of fuel used for cooking per household per day. (Quantities in kgs. unless otherwise stated)

Class	Quality of fuel	Type of fuel	Char Iswardia (FPPU)	Uzan Ghagra (FFPU)	Bon Para (FPR)	Chila Gai (FFR)	Overall
Big farmer	Superior	Firewood	3.5	3.8	11.2	5.8	6.1
		Jute sticks	5.1	5.4	-	2.3	3.3
	Intermediate	Branches	0.7	1.0	-	0.5	0.6
		Paddy straw	0.7	3.5	8.1	0.7	3.3
	Inferior	Dung*	0.8	-	-	-	0.2
		Leaves & weeds	0.9	3.6	-	1.6	1.5
		Other	-	-	-	2.6	0.7
Owner cultivator	Superior	Firewood	1.2	1.8	4.9	3.0	2.7
		Jute sticks	2.8	1.6	-	2.5	1.8
	Intermediate	Branches	1.0	0.8	-	1.3	0.8
		Paddy straw	0.7	2.5	8.2	2.9	3.6
	Inferior	Dung*	25.4	1.7	-	-	6.8
		Leaves & weeds	1.2	2.5	3.0	1.0	2.0
		Other	-	0.3	-	1.8	0.6
Share cropper	Superior	Firewood	0.1	1.0	0.9	3.3	1.3
		Jute sticks	1.1	-	-	1.4	0.7
	Intermediate	Branches	0.7	0.6	-	1.4	0.7
		Paddy straw	1.6	0.9	4.6	1.0	2.1
	Inferior	Dung*	27.7	6.4	1.6	-	8.9
		Leaves & weeds	1.4	5.6	3.5	1.8	3.1
		Other	-	-	-	0.3	0.1
Landless	Superior	Firewood	0.3	0.5	-	0.2	0.3
		Jute sticks	0.2	0.3	-	0.2	0.2
	Intermediate	Branches	0.1	1.0	1.2	1.1	0.8
		Paddy straw	-	0.2	10.5	0.9	3.0
	Inferior	Dung*	16.4	9.1	6.5	-	8.0
		Leaves & weeds	3.6	2.7	9.5	3.8	4.9
		Other	-	0.2	-	0.2	0.1

*Number of sticks

Table 6 Percentage of households ever using major types of fuel for parboiling during the past year.

Season	Quality of fuel	Type of fuel	Char Iswardia (FPPU)	Uzan Ghagra (FFPU)	Bon Para (FPR)	Chila Gai (FFR)	Overall
Amon	Superior	Wood & branches	40 (-45)	33 (-38)	- (-)	7 (-)	20 (-39)
		Jute sticks	27 (+38)	27 (-33)	- (-)	- (-)	14 (-6)
	Intermediate	Paddy straw	93 (+55)	93 (+133)	93 (+8)	93 (-)	93 (+33)
		Husks	27 (-)	40 (+50)	- (-)	13 (-)	20 (+23)
	Inferior	Dung	7 (+100)	- (-)	- (-)	- (-)	2 (+100)
		Leaves & weeds	33 (+200)	40 (+200)	20 (+50)	- (-)	23 (+136)
Boro and Aus	Superior	Wood & branches	73 (-22)	67 (+25)	- (-100)	47 (-22)	47 (-25)
		Jute sticks	53 (+33)	27 (-20)	- (-)	7 (-)	22 (+11)
	Intermediate	Paddy straw	40 (+20)	67 (+67)	100 (+25)	80 (+10)	72 (+27)
		Husks	13 (-)	40 (-)	- (-)	20 (-)	18 (0)
	Inferior	Dung	33 (+67)	- (-)	13 (+100)	- (-)	12 (+70)
		Leaves & weeds	7 (+100)	33 (+150)	33 (+25)	- (-)	18 (+63)

Figures in brackets indicate percentage change in percentage of households in such category over the last ten years.

Table 7 Percentage of households obtaining fuel from different sources

Class	Source	Char Iswardia (FPPU)	Uzan Ghagra (FFPU)	Bon Para (FPR)	Chila Gai (FFR)	Overall
Big farmer	Own resources					
	Homestead	100	100	100	100	100
	Cropland	100	100	80	100	95
	Cattle	20	-	-	-	5
Owner cultivator	Own resources					
	Homestead	100	80	100	100	95
	Cropland	100	80	80	100	90
	Cattle	80	40	-	-	30
	Others' Resources					
	Homestead	-	20	20	-	10
	Cropland	-	40	-	-	10
	Market	20	-	-	-	5
	Public land	20	-	-	-	5
Share cropper	Own resources					
	Homestead	80	60	60	100	75
	Cropland	80	-	100	100	70
	Cattle	100	40	20	-	40
	Others' resources					
	Homestead	-	20	40	40	25
	Cropland	20	40	20	20	25
	Public land	20	-	-	-	5
	Market	-	-	20	20	10
Landless	Own Homestead	10	25	15	35	21
	Others' resources					
	Homestead	100	30	95	35	65
	Cropland	80	35	85	40	60
	Cattle	80	20	15	-	29
	Public land	10	15	-	10	9
	Market	10	35	5	40	23

Table 8.1 Average number of meals consumed daily

Class	Char Iswardia (FPPU)	Uzan Ghagra (FFPU)	Bon Para (FPR)	Chila Gai (FFR)	Overall
Big farmer	3.0 (-)	2.8 (-)	3.2 (-)	2.8 (-)	3.0 (-)
Owner cultivator	2.8 (-)	2.9 (-)	2.8 (-)	2.7 (-4)	2.8 (-1)
Share cropper	2.8 (-)	2.6 (-7)	2.2 (-4)	2.5 (-14)	2.5 (-4)
Landless	1.8 (-25)	2.1 (-22)	1.8 (-22)	2.1 (-16)	2.0 (-21)

Table 8.2 Average number of times cooked per meal eaten

Class	Char Iswardia (FPPU)	Uzan Ghagra (FFPU)	Bon Para (FPR)	Chila Gai (FFR)	Overall
Big farmer	0.97 (-)	0.92 (-)	1.00 (-)	0.90 (+2)	0.95 (+1)
Owner cultivator	0.93 (-7)	0.80 (-14)	1.00 (-)	0.93 (-7)	0.92 (-7)
Share cropper	0.90 (-)	0.77 (-4)	0.91 (-5)	0.90 (-7)	0.68 (-4)
Landless	0.87 (-13)	0.95 (-5)	0.82 (-11)	0.87 (-8)	0.87 (-9)

Figures in brackets show percentage change over last 10 years.

NOTES

1. In the absence of reliable census records, this problem could only have been avoided by a full enumeration of all the households in the study villages. This, in itself, would have taken up all of the time available for the investigation.

2. We were particularly constrained here by the lack of full time women participants on the course. Our women student helpers did very well given the time available, and the limited briefing which could be provided; but our own lack of access to the homesteads of wealthier households where strict purdah was observed, left important gaps in our understanding. These could only adequately be filled by a far better prepared, more time consuming, and better staffed piece of research.

3. Like those in Table 4, these data suffer from the limitation that "ever" can encompass a very small, or a very large input of time. The figures also fail to give any indication of the precise types of work performed; or of whether work was seasonally concentrated, or carried out regularly throughout the year. Thus in Uzan Ghagra, the Table indicates that 80 per cent of big farmer households use child labour, for example, when this almost certainly reflects the collection of very small amounts of leaves and twigs to be used as kindling; and can in no sense be regarded as comparable with the work performed by hired labour. But in spite of these limitations, certain important tendencies can still be identified.

4. Hugh Brammer, personal communication.

5. There are obviously problems of recall here. Consumption figures need to be treated with particular caution, and can, at best, only be used to identify broad trends.

6. This assumes that although substantial numbers of landless households own some homestead land, this will be insufficient to make any substantial contribution to the satisfaction of fuel needs. This assumption may not be correct and needs to be tested.

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