ENERGY, EMPLOYMENT, AND RURAL DEVELOPMENT IN THE MOUNTAIN AREAS OF INDIA

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ENERGY, EMPLOYMENT, AND ALLOCATION OF TIME

Energy consumption and its impact on employment can be studied along several lines. Though the linkages between these two variables are reasonably clear, there are several sectors in which the relationship appears more direct, as in the case of industrial activity where technology is the major determinant of employment. Furthermore, in the rural and relatively unorganized developing countries, the lack of proper markets and the preponderance of household production over organized industrial production necessitates careful analysis of this complex set of linkages.

In a publication explaining the role of energy in household time allocation for production and consumption activities, this author investigated these relations, differentiating between commercial and noncommercial forms of energy (Pachauri 1983). The explicit inclusion of noncommercial energy becomes crucial in a study of this subject, given the fact that energy is increasingly scarce in much of the developing world, and households are having to devote more time to collecting fuelwood, animal dung, and other fuels for household consumption. Nowhere is this problem more acutely evident than in the mountainous and sub-mountainous areas of the Himalaya and the Hindu Kush ranges.

Production within the household and allocation of time, as published by this author, are summarized by the following relationship:

$$p_i X_i + w\, t_i + (w\, t_{in} + p_c E_{ic}) = S$$

Where

X_i = the quantity if the ith good purchased for consumption by the household

P_i = price of good X_i

t_i = input of time required for good X_i

w = average wage rate of household

t_{in} = time spent in collection of noncommercial fuels for X_i goods

p_c = price of commercial energy

E_{ic} = quantity of commercial energy consumed for X_i goods

S = total potential income of the household if all available hours spent in earning wages

When the reallocation of time resulting from a change in any one variable is interpreted, it is evident that an increase in the time allocated for collection of noncommercial fuel, such as t_{in}, results in a decrease in production of wage

goods and other market activities. The increase in energy scarcity leads to a spiral effect in which the household sinks deeper into poverty with its lowered earnings and faces increased hardship because of difficult access to fuelwood or other energy resources. Programs and schemes dealing with these situations must, therefore, address the challange of breaking the spiral at the appropriate stage so that the household can sustain its productive activities.

ENERGY AND AGRICULTURAL EMPLOYMENT

The demand for energy in agriculture is growing with increased mechanization, irrigation, and use of fertilizers, all of which directly or indirectly require larger inputs of energy. This is particularly the case with the Green Revolution, which has largely been experienced in the plains. Whether these higher energy inputs are initially labor-saving or labor-demanding in mountain agriculture is not clear, since few studies have been carried out. However, going by evidence from other regions, some facts can be gleaned.

In a recently published study, Chaudari and Das Gupta analyzed the growth of agricultural output and inputs in Punjab, and found that agricultural output rates were constantly ahead of labor input rates, indicating that increases in output were preceded by increases in land, labor, and capital (Chaudari and Das Gupta 1985). There is some evidence of labor being displaced with larger inputs of capital and energy at the margin due to the technologies employed in Punjab, shown by the fact that land per worker declined while capital per worker and per hectare increased during the period covered. Modernization of mountain agriculture may thus initially have a positive effect on labor demand. An intensification of techniques using greater capital and energy is unlikely to result in any significant displacement of labor because agriculture in the mountain regions of South Asia is still remote from the modernization process that has taken root in the plains.

PERSPECTIVES ON NON-FARM EMPLOYMENT

Even more significant is the analysis of rural non-farm employment in the villages, since the constraints in the expansion of acreage and the low income levels of mountain farmers require that employment generation extend beyond agricultural activities. In a study carried out at the Asian and Pacific Development Centre, Kuala Lumpur, Mukhopadhyay and Chee investigated rural employment in the non-farm sector in the countries of the Asia and Pacific region (Mukhopadhyay and Chee 1984). Their work supports the fact that the concept of total employment is rooted firmly in the model of allocation of time.

Typically, macro-economic estimates of rural non-farm employment derived from statistical data bases underestimate the extent of such employment. Mukhopadhyay found that in Bangladesh, while the residual for rural employment from broad macro-estimates was only 5.7 percent (determined by subtracting the actual employment in all other sectors from the total employment

figures), this figure was as high as 46 percent on the basis of microstudies of time allocation. In the Phillipines, she reports that a quarter of all rural labor and about 50 percent of the female rural labor can be identified as non-agricultural. This figure applies only to non-farm households, but when the non-farm labor of farm households was added, the author found more than half of all rural agricultural labor time is spent on rural non-farm employment. It should be emphasized that macrolevel policies derived from national aggregated data are likely to be misleading, since a number of the non-farm productive activities which are of vital importance in economic development at the decentralized level are not specifically taken into account when planning at the national level.

Mukhopadhyay also deals with the problem of segregating employment data for the rural non-farm sector in India from available statistics, because data on village industries and modern small-scale industries located in urban areas are not separated. There is also the unaccounted production that takes place in households, which is never included in official statistics. Mukhopadhyay estimated that the output generated in India during 1980 to be approximately Rs. 88 billion for the rural non-farm sector, Rs. 580 billion for the modern small-scale sector, with a total employment of about 44.18 million.

The category of rural non-farm employment includes such activities as manufacturing, construction, trade, commerce, and other services. Agriculture-related activities, such as food processing, appear to be the most dominant activity in several countries, but other forms of manufacturing such as textiles and handicrafts are also important.

FOREST ENERGY, FORESTRY, AND EMPLOYMENT

Forestry-related activities are a particularly relevant form of employment in the mountain regions, yet not many studies document the changes that have taken place in employment dependent on forest and forest-related activities. One study evaluates changes in the work force that have taken place in two densely populated forest districts of Karnataka (Nadkarni and Samuel 1985). The authors looked at changes in population, labor force, and forest and forestry-related activities. The study shows that the work force in the primary forest sector has been decreasing, but this is only a small part of the work force in the total forest sector. In North Canara, only 5.7 percent of the males and 4.0 percent of the females were enagaged in forest and forest-based activities in 1971. In the same year, the secondary forest sector accounted for 67.7 percent of the work force in North Canara and 77.5 percent of the male workers in Shimoga. In both areas, the female workers were a growing percentage of the work force. Further, the authors show that not only does deforestation lead to a tendency towards lower employment potential within non-farm activities, but it also leads to a reduction in forest-related employment, of which the largest effect would be on secondary forest activities. Based on the fluctuations and changes observed, the major brunt of this effect is on the female work force.

Some of the linkages and cause and effect relationships involving all these variables are shown in Fig. 1. In this figure AB represents the energy budget line for the household, which includes expenditure on commercial energy forms as well as the opportunity cost-based expenditure on noncommercial fuels. In the lower quadrant of this figure is the physical quantity of fuelwood collected as a function of time spent on collection, Et_{in}, which shifts from WW' to a lower level W_1W_1' after deforestation (Pachauri 1983).

The preceding analysis indicates that merely accounting for formal employment as recorded by official statistics is not adequate for studying rural development and employment. Since a large share of employment is in the form of non-farm activities, rural development and employment must focus on the forces that influence the activities of the rural household. The role of women and the effects of various factors on the allocation of their time is a central part of this question.

FEMALE LABOR AND WELFARE

Sufficient evidence indicates, at least in India and other parts of South Asia, the burden of rural poverty is disproportionately high in its impact on women. This is seen in the daily food intake of the members of the household, which is overwhelmingly biased against women. It was found that for an agricultural household in Kerala, a housewife's caloric intake, even when both husband and wife are employed as agricultural workers, is considerably lower than that of the husband (Gulati 1978). In a study carried out in Bangladesh, it was found that the caloric intake for females was considerably lower than for males (Chen et al 1981). This observation is valid even when differences in body weight and nutritional requirements between the sexes are taken into account. One can hypothesize, therefore, that energy scarcity leads a vicious cycle of effects. Women and children have to travel long distances to collect fuelwood and therefore expend larger portions of their time on this activity. This reduces the extent of time that they can participate in household productive activities, resulting in a drop in household earnings. This is further accentuated by the increased scarcity of forest products on which several productive activities are dependent. With the reduced earnings, there is a reduction in caloric intake for the household, already at a subsistence level of living, leading to a disproportionately high reduction in the nutritional intake of the housewife. With a lowered caloric intake, the housewife suffers a further reduced level of work output and spends less time on productive work and fuelwood or related energy collection activities.

This cycle becomes more acute as each of these conditions becomes more severe. The availability of energy is, therefore, a major determinant of the economic well-being and employment patterns of rural mountain households. More importantly, the increasing female drudgery and lower nutrition lead to lower productivity even when the actual number of hours worked does not decline.

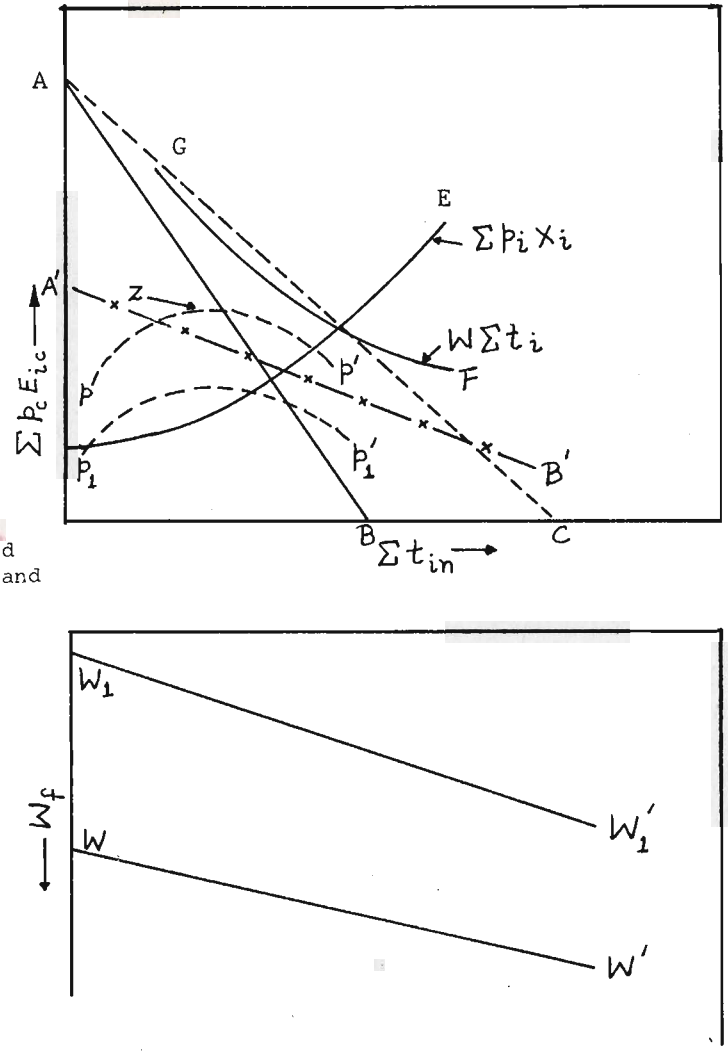

Figure 1

A model of household energy consumption and production.
Note: Not to scale.

AB - Energy budget line before deforestation
A'B' - Energy budget line after deforestation
DE - Money spent on market goods ($\Sigma p_i X_i$) before deforestation
FG - Opportunity cost of fuel collection ($W\Sigma t_{in}$) before deforestation
WW' - Fuelwood collected for time Σt_{in} before deforestation
W_1W_1' - Fuel wood collected for time Σt_{in} after deforestation
pp' - Production function of goods & services for household consumption before deforestation
p_1p_1' - Production function of goods & services for household consumption after deforestation

RESOURCE ALLOCATION FOR RURAL ENERGY PROJECTS

Most programs for rural development concentrate on agriculture. This is understandable in view of the differential between population growth and agricultural output, and the history of famines in this region. However, a concentration on agriculture alone may not optimize overall benefits for the community. The effect of energy on agricultural employment, therefore, needs to be investigated within a broader framework which incorporates more than these two variables.

In general, the resources allocated for agricultural development are directed at projects that use natural resources in the area which are considered to be unutilized or underutilized. Frequently, resources identified as unutilized in remote areas are actually limited in their development potential. Allocation of funds, therefore, does not yield commensurate returns, merely fulfilling weak targets and incorrectly identified goals without long-term benefit to the community. For example, study following a number of small irrigation projects in India would show that they have not provided the expected benefits. These investments, if undertaken in isolation, often do not lead to greater employment generation or a significant increase in output. The development of resources has to be planned and viewed in the overall context, and not necessarily tied in with the development of a single sector, such as agriculture. Government departments are largely biased in favor of inputs in the form of final outlays for specific schemes, whereas much greater benefit can be derived from the provision of technology, technical knowledge, or manpower development, using the same or even smaller financial resources.

The vital area in which major gaps exist in development programs is the dissemination of relevant technologies. The Green Revolution in India has been confined to the plains of India, using technology developed years ago. Given the importance of energy inputs for various activities, the need for innovations extends beyond farming practices and should cover the whole range of use of renewable sources of energy. These technologies require propagation, and therefore deserve special attention.

BIOGAS PLANTS

In the lowlying areas of the Himalaya and the Terai regions, biogas plants can be used for extensive periods during the year. The Tata Energy Research Institute (TERI) developed a shallow solar pond-assisted biogas plant which makes it possible for this technology to work more or less year-round even when the ambient temperatures reach low levels. The involvement of local communities and the setting up of decentralized organizations to service such a program are critical. The establishment of biogas plants would certainly ease the burden on the forests in lowlying areas where population densities are generally high. There is potential for employment generation during the construction and establishment of these plants and their subsequent maintenance.

IMPROVED *CHULAS*

The efficiency of energy use by cookstoves used in the mountainous areas of northern India is generally low, and a large-scale program for propagation of improved stove designs has not been successful. This technology cannot be justifiably imported from large towns in the area, but requires development of local knowledge and infrastructure. In the Kashmir and Ladakh regions, the traditional *bukhari* stove, which is used intensively during winter months, could be used with increased efficiency. This can be brought about through very simple improvements in construction and design. Any investment, if implemented with the involvement of local communities, would be worthwhile on the basis of savings in forest resources and in the related benefits of reduced siltation and denudation from their current levels.

SOLAR HEATING

Solar heating is economically viable and can be used directly for a large number of applications such as water heating, space heating, and crop drying. Significant improvements in dwelling conditions are also possible through the use of improved insulation in buildings and the use of large-scale passive solar heating. These devices can be produced by local industry, leading to increased rural employment.

HYDROPOWER

Traditionally, grinding and milling operations were carried out through the use of watermills. These are vanishing in most of the mountain areas and are being replaced by electric and diesel devices. These technologies are not economically suitable given the cost of centralized power supply in remote areas and the growing dependence on diesel fuel imports. Unfortunately, subsidies of electricity and diesel fuel have obscured the uneconomic nature of these forms of energy. In addition, there is an institutional gap at the local level which has resulted in suitable sites for hydropower being exploited at a sub-optimal level. Local problems in generating electricity on a decentralized level have also acted as barriers to the spread of small hydropower.

The examples given above are purely illustrative and would require a fresh and innovative approach in energy planning at a decentralized level. Whereas each of these schemes would require investments of physical capital and the development of human capital through training and education, the benefits are likely to substantially outweigh the costs.

In the formulation of the Seventh Five-Year Plan, some of these problems were taken into account. Under the Special Area Development Programs, the Plan calls for a Hill Area Development Program, incorporating many of the points referred to above. The Plan discusses the basic needs of hill people and has suggested a set of policies regarding energy, fuel and fodder supply, drinking water supply, health care, and education. The Plan has been conceived as a comprehensive set of actions which would bring about improvements in the environment. The Hill Area Development Program focused

on beneficiary-oriented schemes during the earlier plans, but in the Sixth Plan Period, ecodevelopment was emphasized, without appreciably changing the general content of the Plan.

It remains to be seen whether the Seventh Plan will make a major departure from the past, and whether some of the institutional issues that are so crucial to the success of planning in these regions will be tackled in a satisfactory manner.

CONCLUSIONS

This analysis is purely exploratory and is based on studies done in the general subject area. There is little direct empirical evidence available on the mountain regions of India from which definite conclusions can be reached regarding the nature of energy, employment, and economic development in the rural areas. Nor can direct conclusions be made regarding the specific directions of policy interventions and programs required to foster the development of these regions.

On the basis of the evidence produced above and a discussion of the concepts explored, some tentative conclusions useful for implementing a suitable plan of action for the development of rural societies in the mountain regions can be made, focusing on energy development. The following points summarize the issues discussed:

1. The primary effect of energy shortages in the household sector is on the allocation of time for production. Energy scarcities result in a drop of household productivity, which normally dominates economic activity in mountainous rural areas.

2. While production and employment suffer from the reallocation of time for productive work, a further and more serious effect is produced with depletion of forest resources which provide the major raw material and capital inputs for non-farm activities.

3. Agriculture in the mountains has still not been modernized. While technological changes in agriculture in the plains show evidence of being labor-saving, this is unlikely to be the case in most mountain regions of India. Thus, with modern inputs, agricultural output could increase substantially, leading to higher incomes and improved economic well-being of these societies. At higher levels of income, technological change becomes more acceptable. It is entirely possible that with modernization of agriculture, improvements in the efficiency of energy-using devices, such as *chulas* and *bukharis* would be seen. This could also lead to the adoption of technologies which would result in the harnessing of local and renewable energy resources.

4. Energy and overall development planning in the mountain regions should incorporate investing in new technologies to harness local energy resources. The cost advantage of local energy resources over centralized power supply is currently obscured by the practice of subsidizing commercial energy.

5. The availability of power and energy would improve the general well-being

of households suffering from fuel scarcity. It would also provide productive employment in the form of small industries and improved agriculture which would result from the introduction of decentralized energy production. Incomes of the communities would naturally increase over time.

6. The availability of technologies for harnessing renewable forms of energy provides an opportunity for bringing about a second Industrial Revolution in rural areas. Since the introduction of these technologies would require the establishment of necessary skills and related industries for manufacturing and maintenance, employment potential of this strategy is enormous.

7. The capital-intensive nature of centralized power generation and the burden of oil imports limit the large-scale spread of consumption electricity from centralized sources and the large-scale use of petroleum products. Hence, the denudation of forests and their downstream effects will continue unabated unless the efficiency of energy use in the mountain areas is improved and renewable forms of energy are harnessed for local consumption.

8. This strategy would improve the role of women and the weakest members of rural societies. The key to development lies in improving their nutritional and social status, since a large share of productive activity takes place in the household. These developments would also have a favorable effect on education for children and the development of human resources.

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