MICRO-EXPERIMENTS AND MACRO-APPLICATIONS FOR RURAL ENERGY PLANNING AND IMPLEMENTATION IN THE INDIAN HIMALAYA

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INTRODUCTION

Rapid dissemination of rural energy innovations to meet development needs is emerging as an important issue in the Indian Himalaya. Though generous subsidies have been instituted by the government to propagate these technologies, achievements have been poor in many states (GOI, DNES 1985). The failure rates and social, economic, and environmental impacts of these technologies are not well documented. Voluntary and participatory action for energy development are incapable of substantially replacing the present and potential role of government. However, by strengthening governmental abilities, complementary roles for such action may evolve.

Based on discussions with planners and implementers of rural energy projects, and visits by specialists to 17 developing countries, the problems of diffusion of biomass energy technologies have been reviewed (National Research Council 1984). Although not specifically oriented to the mountain region, this study led to the identification of opportunities, limitations, and recommendations for improving technology diffusion to meet development needs. The experience gained from the review is incorporated in the approach developed in this paper.

Major constraints for rapid diffusion of rural energy innovations in the Indian Himalaya are the heterogeneity in the local and site-specific physical, social, and economic characteristics and relative inaccessiblity to the towns and metropolises which are dynamic centers of energy innovations. Furthermore, a great deal of local experience regarding technical, economic, financial, cultural, and political aspects are required to make informed judgements about the potential for improving diffusion, major opportunities, constraints and above all, the contribution to regional energy budget and economy. These are very much lacking in the Indian Himalaya.

The methodology adopted is to visualize actors and processes which connect micro-experiments in the Himalaya with macro-applications for extension and implementation. This is presented as a feedback system (Figure 1). Further elements of these processes and the knowledge, experience, and data bases are discussed. This paper attempts to outline proposals for the implementation of micro-macro linkages in rural energy.

Actors and Processes related to the Micro Experiments and Macro Application for Rural Energy Planning and Implementation in the Mountains.

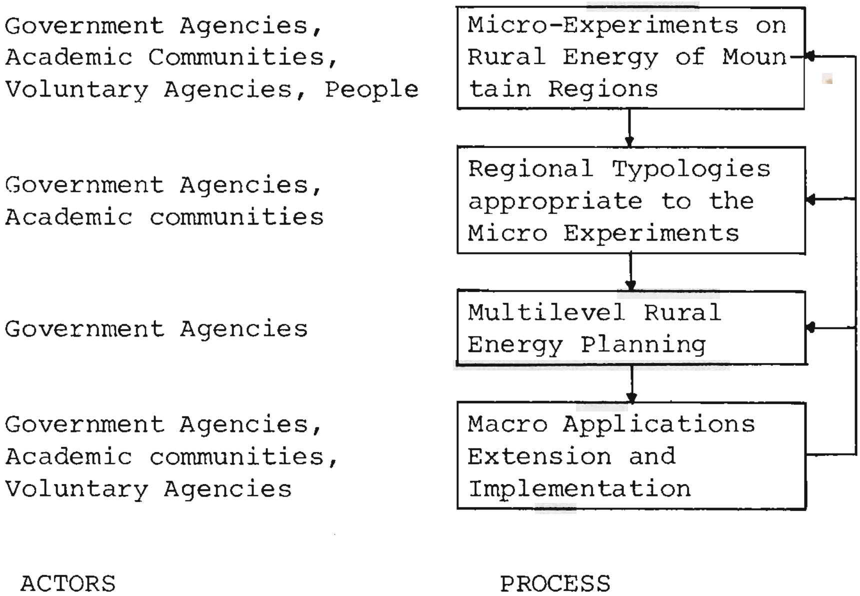

Figure: I

MICRO-EXPERIMENTS IN RURAL ENERGY

Micro-experiments in mountain area rural energy are trials carried out for improving industrial and agricultural production, and delivery of basic needs and their impact assessment to gain new knowledge regarding their applications. Physical, social, political, organizational, economic, financial, and environmental dimensions of these micro-experiments are important to establish one-to-one relationships between the interacting variables. Once statistically valid relations between variables are established, then they can be confidently applied where the environments of micro-experiments are similiar.

Applications of energy technologies require knowledge regarding the physical and socioeconomic aspects of mountain environments. For example, with rise in elevation, growth patterns and water requirements for crops vary considerably. This has not been adequately documented; therefore, it would not be possible to design a command area for windmill irrigation at a particular elevation in the Himalaya even if wind velocities were known. The Manual on Irrigation Water Management (GOI, Ministry of Agriculture and Irrigation 1979) has prioritized the plains, as have many engineering investigations. Inaccessibility, comparatively high expenditure on surveys, and lesser proportion of population served, have been constraints.

Typology of Micro-Experiments

Community studies, field surveys, and the Rural Energy Systems Research and Design Approach are useful tools for micro-experiments. The community study explores the intricate relations and unique interactions of critical variables in a particular setting, but the findings cannot be generalized. While field surveys can be designed to represent a population with known probabilities of error, the depth of understanding derived from the community study cannot be obtained by a field survey. Ideally, field surveys should be designed using insights derived from community studies. The Rural Energy Systems Research and Development Approach is analogous to Farming Systems Research and Development (FSR and D) of Shaner et al (1981). This pertains to a system defined by physical, biological, and socioeconomic setting, including the rural households' goals, access to resources, choice of productive activities, and management practices. On-farm research and analysis of FSR and D are analogous to micro-experiments.

Micro-experiments can give solid evidence of causality and then can be generalized from sample to the universe which it represents. Time-series experiments are very significant for the study of temporal change due to the application of energy technologies.

Before and After Approach

Villages in mountain environments can be classified and then random samples selected, where impact of existing energy flows are studied before and after the energy technologies are implemented. Based on the lessons learned, a policy of macro-application of energy technologies may be formulated.

In another approach, by random sample selection, experimental and control groups of villages are selected. Before and after observations are made on pairs of villages. Influencing factors that are not part of the experiment must be taken into account. "With significance tests, the probability can be assessed of any observed differences between experimental and control groups that are due to random causes." (White and Hursh-Ceasar 1976).

Rural Energy Systems Research and Development Approach

Researcher-managed trials. In researcher-managed trials, even though research is conducted in the field, many conditions and procedures are typical of those encountered in experimental stations or laboratories. The objective of the researcher-managed trial is to develop appropriate rural energy technologies for a specific group of villagers, and thereby perfect an approach of planning for macro-application. Characteristics of the research area, including types of beneficiaries and conditions, can be screened to assist the team in recognizing the gap between current supply and potential demand of energy by source and use. The team is able to work with the villagers, learn from them, and experiment with riskier and more difficult approaches, since the farmers' welfare is not at stake during experimentation.

The general methodological approach for researcher-managed trials is: selecting the microregion, identifying farmers/beneficiaries, planning experiments, monitoring progress, and analyzing and reporting experiments.

Villager-managed tests. These tests provide valuable insights to determine how new technologies fit into villagers' lives. Here the researcher acts as advisor and villagers as executors, with resources usually available to them. They are left to alter the approach. This provides the basis for modifying technologies and identifying areas for further research.

This method has several limitations:

- Experimental conditions cannot be controlled
- The number of experiments are limited
- Only simple energy technologies can be tested (complex ones require adequate infrastructural support which may not exist in the village)

Superimposed trials. Superimposed trials are researcher-managed experiments applied across a range of farmer-managed conditions. These trials may be single or multifactor experiments.

Analysis of Results

The purpose of analysis is to determine whether the new experiment is better than traditional methods, to measure social, economic, environmental, and quality of life changes, and to establish that these changes have not taken place by chance alone. The three types of experiments can be analyzed separately and in combination to derive the environmental, economic, financial, and organizational feasibility of micro-experiments and to understand villagers' reactions.

Wherever benefits and costs can be quantified into monetary units, the marginal rate of return can be computed. A high level of marginal return will generally interest farmers in change. As these levels decrease, farmers become less interested. At some point, they would no longer be willing to incur additional variable cost. We call this point the farmers' minimum acceptable return. Further sensitivity analysis can be utilized to test the stability of the results by looking into alternative possibilities for some of the other values affecting net benefit.

Micro-experiments can provide sufficient data to conduct economic and financial analysis. The best alternative economically may not be financially feasible. Energy technology in many cases is a long-term investment.

The Agricultural Science and

Technology Institute, Guatemala, has developed methods of assessing acceptability by defining an acceptability index (Hilderbrand 1979). The index is obtained by multiplying the percentage of farmers who adopt the new technology by the percentage of the unit so affected, divided by 100. Thus if 60 percent of the farmers adopt an energy technology and apply it to 50 percent of their crops, the acceptability index equals 30 (50 x 60 / 100). Any index larger than 25 is enough to justify for recommendation.

PROBLEMS ENCOUNTERED IN THE MACRO-APPLICATIONS OF MICRO-EXPERIMENTS IN RURAL ENERGY PLANNING

Replication of micro-experiments at the national level requires low research investment and suggests easy answers, and is thus attractive to the government rural energy planners. However, uninformed application ultimately leads to large amounts of time, money, and energy being wasted on ineffective programming (White and Hursh-Ceasar 1976). This paper suggests a strategy of staged, local adaptation.

Nature of Potential Rural Energy Technologies

Many of the rural energy technologies for mountain development involve specialized labor, materials, and capital. To reap the harvest of economy of scale, it may be necessary to mass produce these. The additional cost of distribution and marketing may proscribe affordability for the predominantly poor mountain people. Community-owned and community-operated rural energy technologies may be affordable, but the organizational input required to locate, manage, and finance such plants may require specially skilled community organizers and local leaders. Some energy technologies are commercialized, but the information regarding sources of suppliers, and requirements for labor and skill, may not be available locally.

Subsidies and credits are available for rural energy technologies. Richer farmers are the first to take advantage of such benefits; landless and marginal farmers have no access to institutional finances or availability of biomass energy resources at a constant supply rate.

Incremental innovations and preventive measures (e.g. insurance against failure of energy technologies to avoid a possible loss of a desired value in future) can be part of rural energy diffusion (National Research Council 1984). Likewise, when an energy innovation is changed by the adopter in the process of implementation, reinvention (adaptive technology) can be involved.

Variability of Mountain Environment

Changes in elevation and orientation of slopes create distinctly different Himalayan environments. Energy demands of the mountain people are related to the activity cycles and biotic and climatic environments. Large urban agglomerations in the valleys differ dramatically from the dispersed, semi-nucleated, and nucleated settlements in the mountains. The type of energy technology that can be integrated within towns and villages depends upon the morphology and typology of human habitation.

Problems of Lack of Infrastructure and Institutions

Availability of physical infrastructure lowers the cost of energy technologies in the mountains. The transportation and communication infrastructures to accelerate marketability are largely missing in the Himalaya.

No organization has been assigned the task of propagating rural energy technologies at the village level. Block development offices propagate biogas and other technologies on a limited scale, while fuelwood programs are looked after by the Forestry and/or Social Forestry Departments in India. The village-level workers are overburdened and it is doubtful they can provide the technically competent manpower, with effective communication capacity, and constantly updated training mechanisms necessary for rural energy extension. Individual agencies that give technological advice and subsidies are apex organizations with no grass roots-level cadre.

IDENTIFYING AREAS OF POTENTIAL SUCCESS FOR ENERGY TECHNOLOGIES

Regionalization for Rural Energy Planning

The goal of regionalization is to evolve an area-specific rural energy strategy by classifying the Himalaya into homogenous, polarized, and program regions. These approaches can be utilized for land assessment, fuelwood plantation, and classification of land areas into those currently unattractive for plantation efforts, areas heavily forested enough to receive secondary attention, and ones where immediate effort could make the difference between rapid deforestation and indefinitely sustained fuelwood yield.

However, it is easier to assign land use than to implement it. The quantity and quality of land available for fuelwood plantation are under competition from other uses. In areas of subsistence farming, land areas able to support heavy growth of trees will probably already be fully utilized for grazing or crop growing. In most cases, land available for tree plantation will be not only marginally suitable for agriculture, but also marginal for growing trees. Land-use planning which establishes beneficial combinations for farming, grazing, tree growing and making use of marginally productive land, may be one prerequisite for successful implementation of fuelwood plantation. Intercropping techniques where fuelwood plantation is used to provide beneficial windbreaks, shade, and soil enriching mulch is an alternate strategy. Fuelwood trees can be planted in combination with fruit and/or fodder trees and grasses for grazing. There are examples in which *leucaena leucocephala* have been intercropped for shade with coffee, cocoa, cinchona, pepper, and vanilla.

By map-sieving operations, it is possible to identify wasteland with potential for upgrading. Knowing the soil, rainfall, elevation, and climatic characteristics, it is possible to select weed trees which can grow in such wasteland. The planting of special, fast-growing fuelwoood species is especially attractive in areas with acute land shortages because the rates of wood production on a plantation can be more than five times the production of indigenous forests. The feasibility of committing land to tree growing alone will depend on village common land and government policy, and whether wealthy land owners can be persuaded to grow trees for the village on their land or to dedicate the required land area to a village plantation project. Regionalization in terms of homogenization gives a broad basis for fuelwood afforestation.

For biogas development in the hills, information on temperature variations, livestock census, population census, and settlement patterns are important. From the livestock census and animal dung production capacity and collection efficiency data, a weighted index of human and animal population ratio can be utilized to indicate favorable and unfavorable areas for biogas application. This can be mapped on an area for macro-application. Only where homesteads are scattered over hill terrain can individual biogas plants be utilized. In nucleated or semi-nucleated settlement areas, community biogas plants are a possibility. Community biogas plants give better access to landless and marginal farmers.

Mountain areas are generally characterized by low temperatures. The optimum temperature for methane-producing micro-organisms is 30°-35°C. Production of gas reduces with temperature unless other remedial measures are taken. Mean monthly temperature superimposed on a map can be utilized to determine areas feasible for biogas development.

Polarized regions are identified by functional linkages and flows. This represents a functionally interdependent system of settlements characterized by spatial interaction which can be measured by flow of commodities, persons, money, and information. These spatial interlinkages and inter-dependencies are critical for the spread of micro-experiments. Polarized regions can either be mapped as a flow diagram superimposed on transport networks or as straight lines where flows are plotted in scale to their volume connecting their origin and destinations. It can also be represented as an origin-destination matrix indicating, for example, number of telephone calls or number of buses running per day. Analysis of these data may be utilized to find out the hierarchy of settlements and their dependent villages.

The Village and Town Directory in the Indian census gives the list of services and facilities located within the settlement of significance for evolving a network of service centers for production, delivery, and servicing of renewable energy technologies. Existing institutions, like engineering colleges, agricultural colleges, polytechnics and local workshops, are nodes within the polarized regions which can be functionally utilized for macro-application of micro-experiments. Intermediate centers for production and services can be small towns having fabricating facilities. By proper locational planning, a system of service and production centers can be strengthened for rural energy application.

Program regions are areas having identical policy and implementing space for rural energy development. Policy for energy development can emanate from central government or state government. Policy incentives and politico-administrative structure for the macro-application of micro-experiments can be identified from program space to formulate suitable implementing strategies.

Multilevel Planning: The Current Status of Practice

For rational rural energy development, decentralization of the planning and decision-making power structure is required. India conducts planning at the national and state levels. Limited planning at the district and sub-district levels is now being conducted in an ad hoc manner, generally without legal basis or effective feedback mechanisms.

"The capabilities for decentralized planning have to be assiduously built up, the right procedures and suitable structure have to be evolved and necessary technical and administrative changes, including attitudinal changes, have to be brought about among the bureaucrats and the politicians. For decentralized planning to make headway, institutional mechanisms have to be made more broad-based with the active involvement of local resentatives and endowed with a greater autonomy in local decision making." (GOI. Planning Commission, 1984, para 3.4. and 3.8.)

A multilevel planning framework identifies the hierarchies of geographical space for decision making and action related to energy development. These are different, for example, for cooking stoves, community biogas, hydrams, and small hydels. Decision making and action space also differ in a program of substituting diesel pumpsets with windmills or electric pumpsets.

In multilevel planning there are opportunities to formulate the regional and subregional policies and strategies on the basis of local details at several levels (Sundaram 1980). This gives opportunities to relate plans for decision making at the appropriate financing and implementing levels; it relates decisions to the levels at which functionaries are empowered to make administrative, technical, and financial decisions.

While the strong point of multilevel planning is the local data base, the weak point is the inaccessibility or lack of knowledge of energy technology hardware and software appropriate to the local situation. Therefore, multilevel planning in conjunction with regionalization and selection of appropriate micro-experiments related to the regional typology gives the necessary base. Then these micro-experimental models can be modified to arrive at locational and siting decisions, and budgeting, implementing, and operating details.

Micro-experiments are useful in multilevel planning, especially from the point of view of manpower availability. There is a dearth of qualified planners to work below the state level in India. Micro-experiments will help them to simplify the planning task. A methodology for planning change in resource flow at the village cluster-level is given below. (Kumar 1985, 1986)

MULTILEVEL PLANNING PROCESS AT VILLAGE CLUSTER LEVEL

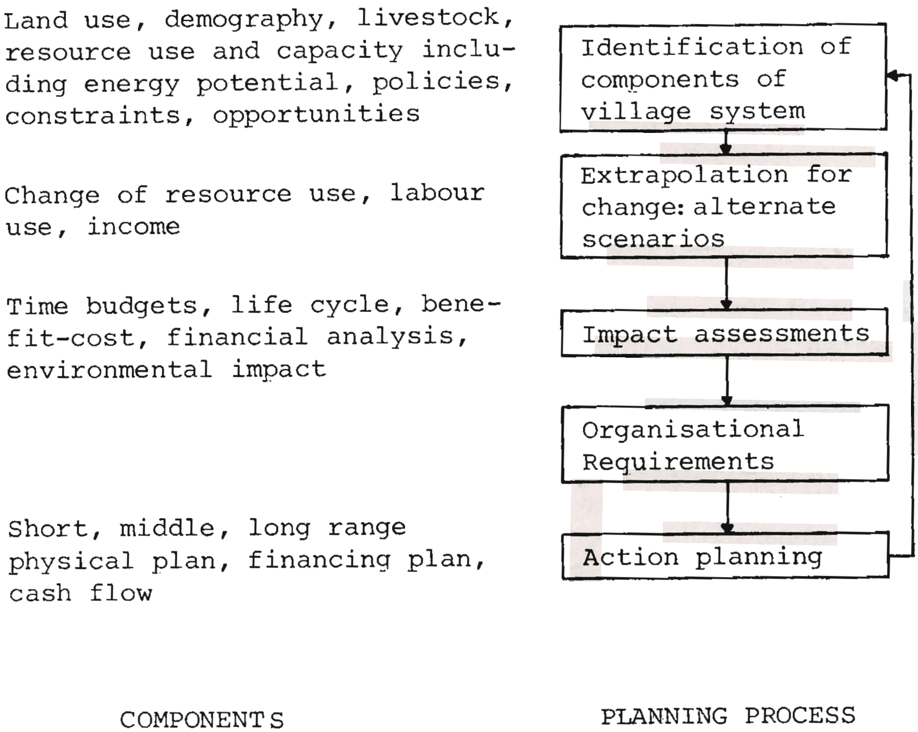

Figure: II

Data Required for Selection of Areas for Macro-Application

Data required for classifying areas for regionalization are mostly secondary data and maps. This is expected to cover the total environment which includes physical, biological, and socioeconomic environments, and production systems and land use. Data requirements can be further classified in terms of those required for delineating homogeneous regions, polarized regions and program regions. For homogeneous regions, physical and biological environment need to be defined spatially. This includes rainfall zones; maximum-minimum temperature zones; monthly wind velocity zones; number of sunny days; soil characteristics, including, physical, chemical, and hydrological conditions; topography, including elevation, land types like summit, side slopes, plateau, wet land, dry land, plains, bottom land, river terraces, land utilization and major crops; and irrigation status, including source, quality, and frequency of supply. Biological environment includes human and livestock census and phytogeography. For polarized regions, data on settlement services and facilities, transport networks and flow of people, goods, and communications is required. For program regions, state, district, block, *taluka* (revenue unit) boundaries, and boundaries of action of energy-related organizations and credit institutions are required.

For multilevel planning, both secondary and primary data are required. Secondary data may include performance characteristics of energy technologies, capital, and maintenance costs, and additional data on environment and sample household survey or census.

MACRO-APPLICATION AND EXTENSION OF ENERGY TECHNOLOGIES

The role of extension is the diffusion of the tested micro-experiments to the intended beneficiaries. This may involve communicating hardware and software to the rural communities, or acting as a catalyst to facilitate replicating tested energy technologies. Mao formulated his idea of decentralized diffusion and was successful in the massive dissemination of biogas technology in China. He wrote that one should "*take the idea of the masses (about their needs and possible solutions) and concentrate them (through study into more systematic innovations), then go to the masses and explain these ideas until the masses embrace them as their own, carry them out and persist in this on their own; then test correctness of these ideas in action" (Mao Tse-tung 1954*).

In India, the progressive, rich, and educated farmers get access to technology, technicians, credit schemes and are in a position to demonstrate application. The poor cannot take advantage of these benefits unless they are asisted by a well-organized extension system.

The role of extension service more specifically is to promote dependable rural energy technologies that effectively articulate countries' resource positions and development policies. They are expected to test and implement workable energy technologies and to suggest necessary changes in technology-support services, within the carrying limits of the resource and environment.

The methodology of rural extension has been improved considerably in the Training and Visit System (Benor and Harrison 1977). Farming Systems Research and Development has illustrated how a new technology can be quickly diffused to a large number of farmers. Here an Extension Specialist in the farming system instructs and supervizes extension agents in the new technology. Each of these agents transfers the technology to 10 local farmer leaders, and each one of them diffuses the technology to four groups of 25 farmers. Therefore, with the help of 10 extension agents and 100 local farmers, 10,000 households can be reached by one Extension Specialist in farming systems.

The Training and Visit System, which also incorporates effective feedback, reaches a similarly large number of people. However, in the Nepal Himalaya, the experience of implementing the Training and Visit (T and V) System, through the Hill Food Production Project, has proved that geographical and topographical factors do not allow faithful implementation of this model (Qamar 1985). Adjusting the model to suit the mountain condition creates drastic changes and leads to something different from the T and V, or FSR and D, models of extension.

State of Experience of Rural Energy Extension

India's experience with rural energy extension is limited but diverse. For example, Khadi and Village Industries Commission (KVIC) has one officer per district and one liasion officer at the *taluka* level who propagates biogas technology. Farmers can apply for loans and subsidies through the district officer. National banks provide loans and KVIC arranges suitable contractors if required to install the plant and service it for a year. KVIC makes payments to the contractor on behalf of the farmer and compiles information regarding the completion of the number of plants and the costs incurred and transmitted to the state level to release the subsidy for the farmers. The progress of KVIC implementation of biogas technology has been rather slow. Action For Food Production (AFPRO)--a non-profit, voluntary agency--has embarked on systematic promotion, transfer and extension of a low-cost fixed dome biogas plant known as the Janata Plant which has been developed by Gober Gas Research Station, Ajitmal, U.P. AFPRO launched this project in January, 1980, (Myles 1983, 1984) with the convening of a national seminar of grass roots-level agencies to promote biogas plants, and then constructed pilot demonstration Janata digesters, with varying soil conditions, to work out comparative costs and determine possible causes for failures. A team consisting of a supervisor, master masons, and masons was employed and given practical training for a month at headquarters before constructing "demonstration-cum-training Janata biogas plants" in different areas. There was widespread impact of these demonstrations. Several grass roots voluntary organizations requested technical assistance and guidance for construction.

In expanding this program, AFPRO came to the realization that the key to the program's success was a well-trained, professional mason who can read engineering drawings. Construction-cum-training workshops on Janata plants organized for selected professional masons have been given in states and union territories of India. Refresher training programs are planned in such a way that small groups of master masons would construct one to three plants under the close scrutiny of AFPRO technical experts. The Government of India adopted a multimodel and multiagency approach for biogas extension and was influenced by AFPRO's experience. AFPRO tried to identify competent grass roots-level voluntary agencies for extension of biogas technology. A five-year program was launched by AFPRO in 1983. In the first year, AFPRO was able to develop and involve 26 organizations. with 30 biogas centers, and in the second year, it covered 16 voluntary organizations with 20 biogas extension centers.

The Organization of Rural Poor (ORP) owns a well-equipped windmill workshop at Ghazipur. Once a request to install a windmill is received, ORP can institute a production-cum-training program at their workshop for local blacksmiths, fitters, and polytechnic or engineering graduates. These technicians and supervisors can install the windmill and undertake all servicing. ORP is more capable of undertaking small-scale jobs than large-scale dissemination.

The Government of India, state governments, and autonomous bodies continue to encourage such organizations for extension of rural energy technologies, and decentralization of implementation process. From their experiences, the government is able to formulate more workable extension approaches. Vertical functional linkages, grass roots-level organizational linkages, abilities to produce sufficient numbers of competent technicians to install and service the installations, and above all, adoption of the most appropriate technologies, are factors which help in the extension of some of these rural energy technologies.

General Problems Faced by Extension Activities in the Mountains

Rural energy extension in the Himalaya is a difficult task. The first problem faced by extension in rural energy is the lack of a proper holistic orientation. Propagation of any one energy technology without micro-experiments is not going to benefit the area or intended beneficiaries. An approach in which the energy system allows many options to meet the local needs more efficiently calls for extension agencies to deal with a package of rural energy technologies.

Extension is not generally integrated adequately with research establishments; neither can function effectively in isolation. Since extension agents work in a different domain, there is generally no scope for benefiting directly from the field insight of the research workers. From the farmer-managed and researcher-managed micro-experiments, extension workers can derive valuable insight for rapid propagation of energy technologies.

Training is often inadequate for extension workers. Knowledge of rapidly changing energy technologies including reinvention improves productivity and effectiveness in field operations. Theoretical knowledge should be adequately complemented with field training in fabrication.

There is a problem of extension agencies becoming highly centralized. Decisions made at the apex may be implemented at the grass roots-level with no questions asked. Extension can be more useful with constant feedback and changes of approach based on field adaptation.

A well-planned supervision and monitoring schedule is an integral part of rural energy extension. Generally, a low budget is provided for extension which results in low morale and inadequate reach. Inadequate training and extension aids limit effective extension. Extension can be effectively executed by private voluntary agencies or consulting firms in addition to the government organization.

Capability of Extension Agents in Rural Energy Planning and Development

At least two options are available to extend rural energy planning and development:

1. A group of extension agents, each specializing in one rural energy technology can work together in a village. This may be more difficult to organize and less feasible.

2. One extension agent who is capable of extending the entire spectrum of rural energy options may work in designated villages. For logistics and manpower, this is more feasible in mountain regions.

Such an energy extension agent requires several capabilities:

- Skilled understanding of the nature of macro-area related with appropriate micro-experiments

- Ability to select cooperative farmers, households, or beneficiaries

- Ability to conduct surveys, and monitor records and climatic data

- Ability to evaluate results of research in field conditions and form an integral part of the energy technology development process which is a combination of physical and social engineering

- Administrative ability to coordinate work of technicians and arrange delivery of credit and inputs for extension

- Ability to learn new energy innovations

Structure of Energy Extension System Proposed (Figure III)

In proposing an Energy Extension System structure, government machinery is not allowed to proliferate, but is limited to one district energy extension agent and one block energy extension assistant each, at the district and block levels. At state or regional levels, a Regional Rural Energy Extension Agency may exist, preferably along with Energy Development agencies. This agency shall employ, on a permanent or part-time basis, a group of professionals to continuously advise and train according to regional characteristics and needs. At the national level, a National Rural Energy Extension Agency may be located within the Department of Non-Conventional Energy Sources, to develop policies, educational programs, training programs, materials, and publications. A rural energy services and extension center may be located below block level at suitable market centers to serve the markets and their clusters of villages. This may be manned by a supervisor and group of technicians (master

Multilevel Planning Levels, Extension Function and Extension Structure for Rural Energy Planning, Extension and Development.

PLANNING LEVEL	EXTENSION FUNCTION	EXTENSION STRUCTURE
NATIONAL	To develop policies, educational programme, training programme materials and publications in all languages	National Rural Energy Extension Agency
REGIONAL (STATES)	Expert group to advice and train according to the regional characteristics and needs. Preparation of training and extension aids.	Regional Rural Energy Extension Agency
DISTRICT	Relates Extension to the needs of the district according to five year plans. Monitoring and Evaluation	District Rural Energy Extension Agent
BLOCK	Achieve annual plan target for rural energy extension, identify and service village leaders on rural energy. Monitoring and Evaluation	Block Energy Extension Assistant
SERVICE CENTRE	Establish rural energy service and extension centres, record keeping. Supervision of field activities. Research and extension supply of inputs.	Energy Service Centres managed by voluntary Agencies/Panchayat
VILLAGE	Village Experiments & Innovations in rural energy	Farmers

Figure: III

masons, fitters, etc.) who can undertake fabrications, servicing and recordkeeping. It can even run a nursery for tree plantation. These centers may be operated by local voluntary agencies or *panchayats* and have to be developed to be self-supporting within two to three years. Training and extension aids shall be provided continuously. Certain financial and technical sanctions for rural credit may be vested with these centers and proper vertical linkages with block energy extension assistants may be established. These service centers should keep linkages with the villagers and farmers, and propagate rural energy innovations by enlisting the support and participation of farmers.

IMPLEMENTATION (Figure IV)

The implementation process integrates both project and program approaches. Micro-experiments call for a project approach. Universities and technological institutions can be mobilized to conduct these micro-experiments in predetermined environments as and when needed. Regionalization, multilevel rural energy planning, and extension components of macro-application can be considered part of a program approach. This calls for creating new organizations in extension and strengthening existing or proposed multilevel planning systems with a focus on integrated resource development at the district level.

Rural energy extension needs to be organized as a separate activity within the existing structure at block, district, state, and national levels. Then this important activity will not be constrained by competing interests. The block rural energy extension assistant may have similar status and location to the agricultural extension worker in the block development office, but can be vertically integrated with a rural energy development agency. This is required because macro-application calls for interdisciplinary teamwork and development of special skills.

Evaluation studies may be conducted to compare the socioeconomic and environmental impacts with those visualized in the plans. These programs of action can be refined and extended by complementing, supplementing, or joining existing programs as well as through comparison with ongoing programs.

Every rural energy intervention should be considered an experiment, and all extension, experimentation on a large scale.

Institutionalisation of Micro Experiments and Macro Application for Rural Energy Planning and Implementation

PROGRAMME INPUTS

Creation of Special Institutions

Programme Funding

Programme Staffing

Programme Infrastructure

DELIVERY OF OUTPUTS

Hardware and software implemented, money spent, training

SERVICE OUTCOME

Increase in production, employment, income and better social, cultural and environmental quality.

PROGRAMME REDESIGN AND FEEDBACK

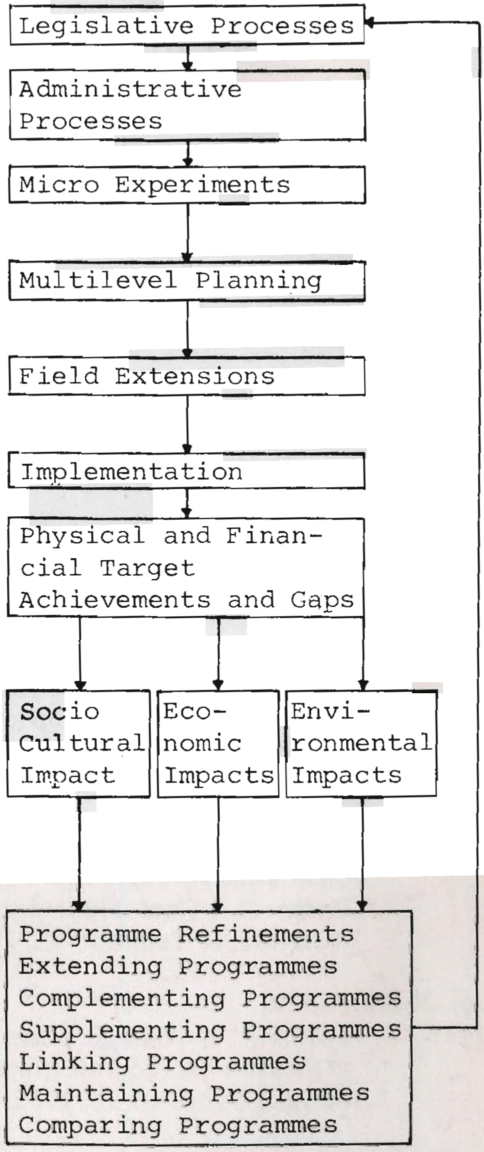

Figure: IV

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