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IMPLEMENTATION ASPECTS OF RURAL ENERGY PLANNING WITH SPECIFIC REFERENCE TO NEPAL

Ganesh Ram Shrestha
Deepak Bajracharya

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Ganesh Ram Shrestha is Executive Director, Centre for Rural Technology, Kathmandu, and Deepak Bajracharya is Division Head, Mountain Population and Employment Division, ICIMOD.

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PREFACE

This paper was prepared for the Food and Agriculture Organisation of the United Nations, Rome, and was also presented at the Regional Training Workshop on "A Comprehensive Approach to Energy Assessment and Planning for Rural and Agricultural Development", organised by FAO/ESCAP/UNDP, and held in Beijing, China, 24-30 September, 1989.

The paper focusses on the specific problems and prospects of rural energy planning in the context of Nepal. It examines the state of energy programmes in the country, analyses implementation approaches - their problems and prospects, discusses institutional implications for effective energy programmes, and, finally, suggests prospects for a more effective approach to planning and implementation in the light of the existing circumstances. The authors hope that the ideas expressed herein will be of relevance, particularly in the current democratic political context of Nepal, and that the political will towards inclusion of users' and beneficiaries' perspectives in programme planning and development will materialise in a more meaningful way than was possible before.

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BACKGROUND AND IMPORTANT ISSUES

Background

There is unanimity in the two basic objectives of rural energy planning and management:

- to increase energy input into the rural production system, thereby enhancing its quality and quantity and consequently improving the living conditions of rural residents, and
- to maximise the efficiency of energy use for maintaining the quality of the natural environment but without undue effects on the production and productivity in rural areas.

The challenge lies, however, in programme implementation. Rural areas and rural residents have for long been neglected by decision-makers and planners. The following statement by Desai in 1982 is no less true today: *"rural fuel supply does not pose a large enough problem for any organised or influential group in rural areas to make a fuss about."* Arguments are often put forward that the inadequacy of a database hinders policy decisions and effective programme designs. An emerging concern, therefore, is the apparent contradiction between the critical nature of rural energy problems, which demand quick solutions, and the complex rural energy patterns, requiring detailed, time-consuming studies. A middle path has to be worked out. A more important point is that the socioeconomic desperateness and disparities in the villages prevent the energy options from reaching the poor who need the most help. Furthermore, alternative energy technologies have often been introduced without sensitivity to the perceived needs of women who are, after all, the primary fuel collectors and end users in the rural areas. These are some of the fundamental problems in the implementation of rural energy programmes (for a more detailed expose, see Bajracharya 1985)

Rather than talk in generalities, this paper concentrates on the specific problems and prospects of rural energy planning in the context of one country, Nepal. The issues and constraints are indeed real and are discussed in greater detail in the remaining part of this section. The prospects for a more effective approach to planning and implementation are suggested in light of the existing circumstances (Section IV). Prior to that, the state of energy programmes in the country is described in Section II. An analysis of implementation approaches-- their problems and prospects -- constitutes the core of Section III. Subsequently, the institutional implications for effective energy programmes in Nepal are discussed in Section V. The final section is devoted to the main conclusions drawn from the Nepalese experience and to an examination of their relevance to other countries.

Important Issues in the Nepalese Context

Nepal is characterised by a predominance of the rural population (about 94% of the total population) whose lifestyle centres around subsistence economic activities. Ninety per cent of the economically active people are engaged in agriculture which contributes to about 70 per cent of export values and 65 per cent of the GDP. The modern sector is very small indeed. This economic

structure mirrors the energy consumption pattern in the country. Table 1 is a summary of the energy consumed in different sectors by various types. It is evident that Nepal's energy consumption is one of the lowest in the world. The annual per capita consumption averages 14GJ (860kg of fuelwood equivalent). Fuelwood is clearly the principal source (76%). Together with agricultural residues (11%) and dried animal dung cakes (9%) the traditional forms of energy contribute to 96 per cent of the total energy. Futhermore, the domestic sector dominates the energy scene (95.5%). The consumption in the agricultural sector is in the form of diesel. The very small amount (0.6 million GJ [13,000t]), which is concentrated in the *Terai* (the southern plains' region of the country) contributes directly to productive activity in the rural areas. The other three sectors (i.e., industrial, commercial, and transport) are the domain of mainly the urban areas.

Table 1: Energy Consumption in Nepal (1985/86)

Sector	F.Wood	Ag. Res.	Dung	Total Trade	Coal	Per. Prod(1)	Elec.	Total Comm.	Total Energy	Percentage
Domestic	180.7	26.9	20.5	228.1	0.0	2.2(2)	0.6	2.8	230.9	95.5
Industrial	3.1	0.0	0.0	3.1	1.3	0.8(3)	0.5	2.6	5.7	2.3
Commercial	0.5	0.0	0.0	0.5		0.5(4)		0.6	1.1	0.5
Transport	0.0	0.0	0.0	0.0		3.4(5)	0.1	3.5	3.5	1.4
Agriculture	0.0	0.0	0.0	0.0	0.0	0.6(6)	0.6	0.6	0.3	
Total Cons	184.3	26.9	20.5	231.7	1.4	7.4(7)	1.2	10.0(7)	241.7	100.0
% of Total energy	76.3	11.1	8.5	95.9	0.6	3.0	0.5	4.1	100.0	

Source: Adapted from WECS 1986.

Note:

1) Petroleum products include kerosene, diesel, gasoline, jet fuel, fuel oil, and LPG
2) Includes kerosene (= 2.11 million GJ) and LPG (= 44,000 GJ)
3) Includes diesel (= 449,000 GJ) and fuel oil (= 326,000 GJ)
4) Includes fuel oil (= 326,000 GJ) and kerosene (= 111,000 GJ)
5) Includes diesel (=1.95 million GJ), jet fuel (= 791,000 GJ), and gasoline (= 670,000GJ)
6) Includes diesel only
7) Because of rounding off error, the total does not add up exactly.

From the rural energy planning perspective, the most important consideration is the current supply of fuelwood from rural areas for cooking (181 million GJ or 11 million tons) and for small-scale industries and commercial activities in urban areas (3.6 million GJ or 0.2 million tons). Equally important, but in a different context, is the diversion of agricultural residues (26.9 million GJ or 2.1 million tons) and dried animal dung (20.5 million GJ or 1.9 million tonnes) from their respective use as fodder and manure to burning in the hearth. The consumption of kerosene for lighting (2.2 million GJ or 45,000t) or that of diesel for agriculture (0.6 million GJ or 13,000t) are of second priority considerations only.

The dependence on fuelwood as a major source of energy brings out another important dimension. All of the fuelwood requirements are met from the country's disappearing forests. The current situation is no longer viable for mainly three reasons: (a) the pressure to meet the ever-increasing demand of the growing population; (b) the need to clear forest land for agricultural purposes, thus reducing the possibility of fuelwood supply (Bajracharya 1983); and (c) the excessive pressure caused by the large livestock population (about 16 million head) that creates an inexorable demand on the forest floor to meet fodder and forage needs. There is already evidence that labour use for fuelwood collection is causing additional strain, especially to overworked women in the rural areas. There is also an increasing concern that the problem of deforestation has already caused serious environmental problems such as soil erosion, landslides, greater sedimentation in rivers, disturbance of the hydrological regime and others. The relevant question then is, to what extent can fuelwood use be substituted by another source of energy? and is this a viable proposition? The answer is not easy especially in light of the constraints, e. g., (a) unavailability of commercially exploitable fossil fuels, such as oil, coal, or natural gas, and (b) high costs of distribution of imported fuels to the hills in the context of the lack of infrastructure.

A related paradox in the Nepalese context is the chronic imbalance between the increasing energy needs, on the one hand, and underutilisation of the hydroelectric resource endowment on the other. The country's hydropower potential is estimated at 83,000MW but the currently used capacity stands at 160MW (WECS 1987). Most of the hydropower is currently consumed in the urban areas. Electricity supply to rural areas is insufficient, unreliable, and, at best, limited to a few district headquarters. Is there then an alternative approach that would encourage a greater use of hydroelectricity? relieve the pressure on fuelwood consumption? and contribute to greater productivity in the rural areas?

Another point, to which reference was made above, is related to diesel use in the agricultural sector. What deserves attention here is the increasing trend in its use, especially in the *Terai*, for tubewell irrigation, agro-processing, and operation of farm equipment (such as pumpsets, tractors, and power tillers). Although the use of draft animals for farm power is still dominant, there are currently 2,000 units of two-axle tractors and 400 units of single-axle power tillers in operation. Diesel pumpsets are increasingly gaining popularity for lifting groundwater and surface water. In the *Terai*, where micro-hydro turbines are not feasible, mills for agro-processing are mostly running with diesel. Although small in number as yet, it is evident that they are gaining ground rapidly. The main constraints in diesel use include the high cost of fuel, unreliability of supply, and absence of a sufficient number of distribution points. The cost becomes particularly prohibitive if the current pattern of low-value crops persists. A possible alternative is the substitution of diesel with electricity. This will require, however, an extensive electric grid system that reaches the rural areas. Under the current circumstances, this is an expensive proposition. In the long run, if the demand goes up, the comparative hydroelectric potential of Nepal can be diverted to productive use. In the immediate future, the basic question is whether other alternative energy technologies may be employed to reduce the dependence on diesel.

Over the last decade, there has been a growing awareness of the urgency to tackle the various energy problems outlined above. These concerns have placed a great deal of emphasis on the preservation of remaining forests and the promotion of afforestation. The search has also focussed on alternative energy sources to meet household, agricultural, and other rural needs. Accordingly, various approaches have been tried towards effective implementation of such programmes as community forestry, mini- and micro-hydro development, biogas development, and improved stove installation. Despite these efforts, energy supply from these programmes has remained small, and little enhancement in the rural energy supply and the quality of life has been achieved. Local people seem hesitant to readily accept the prescribed solutions and approaches.

Re-examination of implementation strategies is, therefore, a critical necessity. A number of important issues and questions that are directly concerned with rural energy development are given below.

- Socioeconomic viability and sustainability of energy programmes. To what extent is technological diffusion based on such assessment?
- Forward and backward linkages of rural energy with development sectors. How can the use of energy be compatible with local production systems?
- An integrated approach in the use of energy. How can different energy technologies (e.g., micro-hydro, afforestation, cooking-stoves, biogas) be combined together to meet subsistence and development needs in the village?
- Risks associated with technologies. Can they be minimised or eliminated?
- Incentives and motivations for organising local participation. What mechanisms exist for motivating people to action?
- Interaction between technology users, R&D organisations, and private enterprises. Are there ways to strengthen such interactions and to develop better information systems?
- Assessment of government policies and plans. What are the constraints that inhibit effective implementation?
- Coordination and institutional linkages between government, non-government, and rural organisations.

This paper will look into these various perspectives with examples of success as well as failure and derive many important lessons for more effective approaches.

II

THE CURRENT STATE OF RURAL ENERGY PROGRAMMES

Energy options in the rural areas of Nepal are severely limited. As already explained in Table 1 (previous section), energy is predominantly used in the domestic sector (95.5%) and fuelwood is the most important source (78.3% or 10.8 million tons). Next to fuelwood, significant amounts of agricultural residues (2.14 million tons or 26.9 million GJ) and dried dung cakes (1.88 million tonnes or 20.5 million GJ) are consumed in the domestic sector. Together, these three sources contribute to 98.8 per cent of domestic requirements and 95.9 per cent of total energy requirements (when all sectors are considered). In contrast, the consumption of kerosene and electricity for lighting in the domestic sector is 0.9 per cent (or 45,200 tons) and 0.2 per cent (or 168 GWH) respectively. The consumption of diesel in the agricultural sector is low (0.2% or 13,000 tons). Given this structure of energy use, it is not surprising that rural energy programmes in the country are mostly concentrated on (a) relieving the pressure on fuelwood supply for domestic energy needs; and (b) promoting small, decentralised energy sources for enhancing agricultural development and rural industries. From this perspective, the programmes that are of particular significance in the Nepalese context include afforestation, dissemination of improved cooking-stoves, mini- and micro-hydro turbines, and biogas. All of these are renewable energy technologies and are implemented by various government agencies. Unfortunately, their development potentials are not fully realised because of the absence of a coordinating body that could integrate programme planning and implementation in different agencies and streamline the efforts towards meeting rural development objectives. We will return to this point again in Sections III and IV. In this section, we will review mainly the strengths and weaknesses of some important rural energy programmes.

Forestry Programme

Forests have traditionally been the most important source of fuelwood in Nepal. Recent trends in large-scale deforestation have intensified problems associated with the fuelwood and fodder supply of the increasing population. One estimate indicates that forest resources in the country have shrunk from 6.4 million hectares in 1963/64 to 3.34 million hectares in 1983 (UNDP/World Bank 1983). The rate of forest clearance is currently estimated to be equivalent to 100,000 ha a year. The problem of deforestation became worse, particularly after the enforcement of the 1957 Forest Nationalisation Act. Not only did the management of hill forests almost cease, but a substantial amount of forest land was cleared and converted to agricultural land in order to ensure private ownership before the control by the Government became effective (UNDP/World Bank 1983). Recognising the need for better protection and management of forests, a new set of rules was enforced in 1977 which delegated the responsibility for managing 2.2 million ha of forests to local communities and private individuals or agencies (Ministry of Forest 1976 and 1978). This was an important change in policy aimed at mobilising people for the protection and management of forests.

Although a large number of forestry programmes was implemented in the past by the Department of Forests, the performance has clearly been frustrating. A National Planning Commission (NPC) report states that the annual achievement of forest plantation in the Sixth Five Year Plan (1975-80) comes to around 6,000 - 7,000ha (NPC 1984). In order to improve this situation, new forestry

programmes were initiated in the early 1980s. One such programme was the Community Forestry Development and Training Project in 29 hill districts under IDA/World Bank-assistance. Emphasis was placed on the protection and management of ongoing forest areas at the village *Panchayat* level,[1] establishment of nurseries for new plantations, and integration of improved cooking-stoves distribution for fuelwood conservation. During a period of five years, the project succeeded in involving 340 *Panchayats* in the establishment of 430 nurseries and plantations, and protection of 19,060 ha, and distribution of 15,760 improved cooking-stoves. The area planted was, however, much below the target of 39,000 ha. Initiatives have recently been taken at the government level to implement the second phase of the Community Forestry Project and the *Terai* Community Forestry Project with World Bank-assistance. Other programmes of a similar nature include afforestation efforts under the Small Farmers' Development Programme (SFDP) of the Agricultural Development Bank of Nepal (ADB/N), the Nepal-Australia Forestry Project, and other rural development programmes.

Despite these efforts, the current rate of forest plantation is believed to be less than 15,000ha per year against the Seventh Plan target of 35,000ha annually. The important question is whether the current level of effort and performance is significant enough to create the necessary impact in meeting energy needs and protecting the environment (Wallace 1985)? The answer is a clear "No" Forestry programmes are, unfortunately, facing a number of problems, such as:

- o difficulty in acquiring social acceptance from local communities,
- o inefficient management and use of existing forest resources, and
- o administrative hurdles to coordinate programmes in accordance with local needs and priorities.

These points will be dealt with in greater detail in Section III.

The Improved Cooking-stove Programme

The dissemination of improved cooking-stoves (ICS), as opposed to traditional cooking-stoves or open hearths is potentially an effective approach to conserving fuelwood and thus reducing deforestation. The UNDP/World Bank Energy Mission assessment that, in Kathmandu Valley (population of about 100,000 households), an effective ICS dissemination programme could save up to 99,200t of fuelwood per year, and this is equivalent to the annual yield of 13,680ha of forest (UNDP/World Bank 1983). The mission had advocated the immediate initiation of the plan to disseminate 100,000 ICS in Kathmandu Valley (all homes covered) over a five year period. The belief was that the experiment would (a) develop experience in mass production, promotion, and distribution of ICS in a relatively manageable area, and (b) create a significant reduction on fuelwood consumption in the area. The programme, unfortunately, has not progressed as well as expected. The difficulty stems mainly from the absence of proper coordination in the delivery system, including technical assistance, credit support, promotion, and education of the beneficiaries.

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1. A village *Panchayat* was the smallest political constituency and administrative unit in Nepal. Each one had nine wards. Normally, a village *Panchayat* consisted of a population between 3,000 and 7,000 in an area between 10 sq. km. There was a total of 4,000 village *Panchayats* distributed over 75 districts in the country.

Since the early 1980s, many agencies are actively involved in the development and dissemination of ICS in Nepal. The agencies include the Community Forestry and Afforestation Division of the Forest Department, UNICEF, and the Agricultural Development Bank. So far, the total number of ICS disseminated in the country stands at about 30,000, and this is clearly inadequate (WECS 1987). Of these, only 60 to 70 per cent are estimated to be currently in use, partly due to breakage of different parts during transportation and while being used, and also due to abandonment when the stove fails to meet local requirements. Advocates claim that savings on fuelwood averages about 40 to 45 per cent or 460kg per unit per year (Shrestha 1985). Although the claim sounds impressive, the question is how many units are actually installed, used, and maintained regularly? It is difficult to find information on stove performance, monitoring, and assessment of perceived benefits by end users in the long run.

While efforts by various government and non-government agencies are continuing, the progress in stove dissemination is reported to be inhibited by socioeconomic constraints such as:

- inappropriate stove size for family use,
- inflexibility in adjusting cooking pots of various sizes (normally a standard-sized ICS is distributed),
- lack of realisation by local people about the "real" cost of fuelwood in terms of time and money (in most rural areas, fuelwood is considered to be a "free commodity"),
- heat loss through the chimney pipe (it is preferable to heat the room during winter),
- lack of interaction between stove producers and end users,
- lack of appropriate design and on-site training in the use of ICS, and
- lack of an adequate institutional set up for effective dissemination.

In spite of the current difficulties with dissemination, the fact remains that fuelwood saving through efficient stoves is an important consideration. A greater effort is needed to develop several models to suit the various socioeconomic conditions in different agro-ecological zones. A uniform model for use throughout the country is simply not a viable proposition. Emphasis has also to be placed on extension and education so that the stoves are used and maintained properly, while ensuring that repair and other support services are available on a regular basis.

Micro-hydro Systems

Micro-hydro systems have been in use in the Nepalese hills for centuries in the form of horizonal water wheels which are traditionally known as *"Pani Ghattas"*. Some 25,000 of these *ghattas* are estimated to be in operation. However, they have only limited application and produce about 1 horsepower; just sufficient for grinding maize and millet. Other crops, such as paddy and oil seed, are processed in diesel-powered mills. With the development of crossflow turbines in 1961 and multipurpose power units (MPPU) during the early 1980s, the available hydropower is increasingly used for rural applications. Because of the rapid increase in the price of fossil fuels and the problems of distribution in the hills and mountains, the efficient use of water turbines and MPPUs became the focus of attention in rural communities.

Turbines for agro-processing and electricity generation are cost-effective in the hills and are much in demand. Development and installation of crossflow turbines and MPPU provide examples of success when private sector initiatives are supported by public sector organisations such as the Agricultural Development Bank (ADB/N). Installations, in the range of 5 to 50kW, started during the early 1970s. The momentum picked up rapidly after 1982 when ADB/N accorded priority to the financing of decentralised energy schemes for agriculture and rural development with support from the Fourth Agricultural Credit Programme of the Asian Development Bank. A total of 190 micro-turbines were set up in rural locations within 3 years, thus surpassing the target of 160 units (Shrestha 1985). The programme was expanded in 1987 and the target was increased to 450 units under the Fifth Agricultural Credit Programme. So far, 460 turbines (out of a total of 554 units in the country), with a power output of 3,567kW of mechanical power and 166kW of electrical power, are in operation with ADB/N credit support of Rs 57.7 million (ADB/N 1987). Similarly, a number of improved *ghattas* (watermills) and a Chinese lift turbine for irrigation and other rural applications were successfully tested. These efforts have demonstrated the feasibility of using micro-hydro technologies for meeting rural energy needs in hill areas.

According to an estimate, if 3,000 such schemes are installed by 2000 A.D., an energy equivalent of about 100,000t of fuelwood will be generated (ADB/N 1986). At present, these micro-hydro plants are mostly confined to districts in the Central, Western, and some parts of the Mid-western Development regions[2]. The growth of installations has mostly centred around Kathmandu Valley and Butwal where turbine manufacturers are concentrated. The potentials in the Eastern and Far-western Development regions are yet unexplored, although vast potentials seem to exist in these areas.

It has been amply demonstrated that decentralised micro-hydro schemes could play an important role as a viable source of energy. In order to expand this programme to a significant scale, more R&D efforts are required; (a) to lower the investment required for the micro-hydro system by reducing the manufacturing cost of agro-processing equipment, (b) to integrate its use with cottage and rural industries, and (c) to improve the efficiency of traditional *ghattas* and increase the scope of their use. A number of other important issues also need to be addressed: How can its operation be expanded? How can private sector capabilities be enhanced to cope with increasing demand? Is the current institutional mechanism appropriate? How can commercial banks and government departments play a more active role?

Mini-Small Hydropower Schemes

While the private sector approach in the development of micro-hydro systems proved to be working well, the performance of the public sector in mini-hydro schemes has been disappointing. Technical difficulties have been numerous and the management of such schemes has been complex and problematic. The Small Hydroelectric Development Board (SHDB) was established in 1975 to plan and operate mini-small hydroelectric schemes and make electricity available to remote and isolated areas. According to the UNDP/World Bank Energy Sector Mission (UNDP/World Bank 1983), *"Of the 47 projects ranging in size from 45kW to 1000kW targeted for the Sixth Plan Period, 4 are in operation, 15 are under construction and 28 are in the planning stage"*. By the end of the F.Y. 1985/86, the number of mini-hydro projects in operation increased to only 12 units with a total installation capacity of 2,086kW (WECS 1986). Very low load factors and low revenue generation are common characteristics of all mini-small hydro

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2. Administratively, the country is devided into 5 Development Regions, 14 Zones, and 75 Districts. Each Development Region consists of three zones, apart from the Far-western Region which has only two.

schemes in Nepal. Revenue collection is as low as 6.6 per cent of the operation and maintenance cost for Gorkha Small Hydro Plant (WECS 1986). Load factors vary from as low as 4 per cent to a maximum of 33 per cent. The unit cost per kilowatt varies between Rs 45,000 to Rs 80,000 in contrast with the micro-turbine unit cost of Rs 10,000 to Rs 50,000 per kilowatt. Furthermore, the micro-turbines have a high load factor because of the multiple application of power in agro-processing during the day and electricity generation in the evening. Multipurpose application and linkages are often missing in publicly-sponsored mini-hydro plants.

Unlike the micro-hydro systems, which are entirely managed by private sector entrepreneurs on a profit earning basis, the government-owned mini-hydro schemes are operating at a loss. According to the Rural Electrification Task Force Report (WECS 1987), the annual subsidy provided by HMG to run ten small hydro plants is about Rs 8.0 million. The above scenario poses two very important issues: (a) should the Government continue to provide huge amounts of subsidy to micro-hydro plants or find ways to bring these schemes under private sector management to improve the operational performance? (b) how can the private sector be strengthened to own and manage new mini-micro-hydro schemes in remote areas?

The Biogas Programme

The history of biogas development in Nepal began with the fabrication of one prototype unit in 1955 using an old 200 litre oil drum and a gas holder made of mild steel sheeting. Thereafter, one or two private owners built biogas units in Kathmandu. However, there was no real interest shown in biogas until the energy crisis of 1973. When the Government designated the fiscal year of 1975/76 as the "Agricultural Year" to boost agricultural production, a special plan for biogas promotion was developed and 199 plants were built that year by various contractors using interest free loans from ADB/N (Gorkhali 1985).

Gobar Gas Tatha Krishi Yantra Vikas Ltd.

Popularly known as the Biogas Company, this organisation was established in 1977 for the organised promotion of biogas plants. This was undertaken as a joint venture investment of the ADB/N, the United Mission to Nepal, and the Fuel Corporation of Nepal. The Biogas Company is backed up by a Research and Fabrication Unit in Butwal and sales and services' centres at strategic locations in the *Terai* and inner *Terai* regions[3]. The company had installed 3,719 units by March 1989, of which about 50 are community-sized plants. Out of the total number of plants installed, more than two-thirds are dome-type digesters, originally developed in India. The community biogas plants are used mostly to run agro-processing and other small-scale industries, while family type plants are used for household cooking and lighting. Efforts to use the slurry in fish ponds and the gas for lift irrigation have remained limited.

Biogas has been looked upon as a potential substitute for fuelwood and kerosene. Operation of biogas plants in the warmer climate of the *Terai* has been relatively free of problems. However, in the hills, where the winter temperature falls below 10° C, year round production of biogas has not been possible. In this respect, research on biogas production in a colder climate and also on the possible use of agricultural residue and other biomass along with animal dung are of relevance.

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3. The *Terai* and Inner *Terai* are lowland belt in the south of Nepal. They are about 50-80km wide and 800km long. Together, they amount to about 25 per cent of the total area of the country.

The biogas programme with its current installation capacity of 600 units per year has still a long way to go in order to make a significant impact on the national energy scene. With the commitment of the Government, in 1988/89, to provide Rs 3.45 million in annual subsidies i.e., a (25% subsidy on the investment cost of each plant), the rate of installation is expected to increase to 1,000 units a year. At this rate, the programme will be able to substitute 37 million kg/year of fuelwood, assuming the operational efficiency of 75 per cent (Chalise 1983).

The increasing cost of installation is one of the main constraints in biogas dissemination. This is in part due to (a) the increasing overhead expenditure of the company and (b) the increasing cost of raw materials. The company has, in addition, a weak base in research as well as in technology development. The limited number of field offices is another factor that hinders widespread dissemination. In addition, very little support was forthcoming from agencies other than the ADB/N. Government support to biogas development in the past has been nominal and related policies have been inconsistent (e.g., irregularities in the provision of subsidies have created confusion and negative effects). These issues and constraints warrant urgent attention before embarking on an extended scheme of biogas development in Nepal.

Solar and Wind Energy

The solar radiation in Nepal, considering its entire surface area, is estimated to be 26.6 million MW (WECS 1988). However, the use of solar power in the country is at an early stage of development. Solar energy is used mostly for water heating with passive solar collector systems. Solar heaters are currently manufactured in local workshops, such as Balaju Yantrashala, Butwal Engineering Works, and many other smaller enterprises. They are becoming very popular for residential use in Kathmandu and other cities. Also, their use has been gradually extended to hospitals, schools, and tourist hotels/lodges. In addition to water heaters, about 600 units of solar crop driers and solar cookers have been installed on a trial basis. A few units of photovoltaic cells are being experimented with for use in water lifting and communication purposes. The basic problem has been the high cost of imported solar panels. Their viable use on a sustained basis is, therefore, questionable.

Small-scale windmills can be used for lift irrigation. The main problem in Nepal is the absence of reliable data for proper assessment of wind energy. Also lacking are R&D efforts to modify imported prototype designs to suit local conditions. Practical applications will be limited in the future unless these problems are overcome.

As is apparent from the above background, the significance of contributions made by rural energy projects is not very great. The degree of success and reliability varies from project to project. Some projects, such as micro-hydro and biogas installations, have certainly contributed towards meeting a small part of rural energy needs at the household and village level. Afforestation, management of forestry by local communities, and dissemination of ICS have been slow. Projects related to solar and wind energy are still in the experimental stage and need further evaluation.

III

IMPLEMENTATION APPROACHES

The last ten years constituted an important period in the recognition of rural energy problems by government and non-government organisations. This has led many agencies to test and adopt various implementation approaches. Broadly, they fit into three categories:

- o external sponsorship
- o private sector initiatives, and
- o participatory village development.

Attempts will be made in this Section to present the main aspects of each approach and thereby examine their usefulness.

External Sponsorship

The approach is characterised by the predetermination and control, by external agencies, responsible for determining the stability of selected technologies to the 'targetted' population in rural areas. Executing agencies decide everything about project selection, development, and implementation. Targets are set to disseminate specific products through uniform directives using inadequately trained extension agents. Very little emphasis is placed on the process of "fine tuning" in correspondence with local circumstances or on market surveys to suit users' preferences. Examples are given below with reference to various projects implemented in the country.

Community Forestry

The Community Forestry Development and Training Project (CFDTP), as explained in Section I, was launched in 1980. In spite of the rhetoric that the project should be implemented with full participation of community members, the top-down implementation style seems to have persisted. District Forest Controllers (DFC) expected the *Panchayat* forestry committees to shoulder the responsibility of forest protection in areas designated as *Panchayat* Forest (PF) and *Panchayat* Protected Forest (PPF)[4]. Following the project period of five years, there was a general feeling that it had not proceeded as well as expected. According to Gautam and Roche (1987), *"In Bhusaphede, Nandu, Lankuri, and Magapauwa panchayats, the villagers themselves used to pay for forest watchers to protect areas of natural forest. Since the project began, some of the villagers have stopped the payment to the watchers".*

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4. *Panchayat* Forest (PF) and *Panchayat* Protected Forest (PPF) were categories of forests under the Forest Regulations introduced in 1978 to encourage local participation in afforestation and conservation of forests PFs were handed over to the village *Panchayat* for planting on barren and denuded areas. PPFs were meant for the planting and protection of nationalised forest where scattered trees still existed. The revenue generated is shared on 50-55 basis between the Government and local groups respectively. Since the cessation of the Partyless *Panchayat* System, the status of these forests has not been determined.

In all the *Panchayats* of Dolakha District, when people were questioned about who owned the forest, the answers varied depending on whether the respondent was the District Forest Controller (DFC), the Forest Ranger, the *"Pradhan Pancha"* (head of the Village *Panchayat*) or "the Swiss" (expatriate officials appointed by the donor). In one detailed survey of a *Panchayat*, covering 40 households, only one person knew anything about the community forestry legislation. No one knew that the plantation area in the village was designated *Panchayat* Forest and had been handed over to the Village *Panchayat* (Khusle and Roche 1986). Another study related to private planting revealed that people engaged in forestry extension activities were not familiar with the legal provisions under the relevant Act (Gautam 1986).

Drawing from the experiences with community forestry within the Integrated Hill Development Project, Gautam and Roche conclude (1987) *"The situation in Dolakha District has become quite serious. We need to stand back and look at the fact that our village-level afforestation programme is now in reality paying the villagers to plant, and also to protect, the area from themselves. The annual bill has already reached Rs 3.5 million and is increasing every year at the rate of Rs 200,000."* The basic concern is the question of effectiveness in community participation and the sustainability of the payment system as pursued in the projects.

A contrasting case from Darchula District is described by Chand and Wilson (1987).

> *"In Hikila Panchayat, a women's committee formed in 1985 has in effect written its own management plan at the suggestion of the District Forestry Office staff. The plan is based on a simply worded protection agreement devised by the committee in consultation with local leaders and women. Because the whole community is aware of this agreement and because most people were involved in its formation, it has unanimous support and implementation has been successful."*

The above illustration shows that, given an opportunity for flexibility and assistance from the DFC, the local committees can assume full responsibility in implementing forestry management plans successfully. This is true especially when local people are involved from the very beginning in the process of planning. Unfortunately, except for a few succesful cases, active participation of local people in forestry programmes is far from being satisfactory. This is, in part, due to insufficient support from the district forestry offices and the lack of trust, on the part of local people in forest officials. In many cases, villagers are skeptical. They believe that when the trees are ready for harvesting, the Government will take away the timber and they will have very little benefit from it. More efforts are, therefore, needed to clarify the issues and gain the confidence of local villagers. Another report (Gronow 1987) points out the two critical factors that currently limit the success of community forestry.

- The approach does not accept that it is the community and not the professional forester that has to develop the management solutions for PF and PPF.
- The Rangers and Community Forestry Assistants are not equipped to facilitate forest management development in the village.

The CFDP approach has put a great deal of emphasis on strengthening the District Forest Controller's Office. However, efforts to strengthen local forestry committees have been inadequate. Attempts to educate people about the provisions under forestry rules and regulations are insufficient. Local communities cannot be expected to participate without a clear understanding of what and how they will benefit. Forest committees are confused about their legal status and their rights and responsibilities. Villagers are uncertain whether tenure of PFs and

PPFs will ever be granted to them. Because of project funds and other inputs, indigenous forest management practices are gradually becoming obsolete. The objectives of CFDP programmes, in terms of procuring more people's participation, need to be communicated to people in simple terms. The beneficiaries must be involved in planning from the very beginning and implementation must take place with full conviction and willing support.

Mini/Small Hydroelectric Installations

The principle objective of the small hydroelectric system (capacity ranging between 100 to 500kW) has been to electrify district headquarters that cannot be reached by the central grid system. The power plants are operated and managed by the Small Hydroelectric Development Department (SHDD) of the Nepal Electricity Authority.

Establishment of the small hydroelectric projects were largely motivated by political considerations and less so by techno-economic grounds. Most of them have been implemented with foreign assistance and rely on foreign engineering, imported turbines, and other equipment. The construction was undertaken by contractors under the supervision of SHDD. The UNDP/World Bank Energy Sector Assessment Report (1983) indicated that several of these small hydroelectric projects were characterised by poor site selection, poor design, inadequately trained staff, maintenance difficulties, and poor administration. None of these projects generate sufficient revenue to keep up with operation and maintenance costs. Government subsidy to run them has reached the level of Rs 8 million annually (WECS 1986).

Improved Cooking-stove (ICS) Dissemination

The dissemination of ICS is undertaken by about eight agencies which include the Community Forestry and Afforestation Division of the Forestry Department, the Small Farmers' Development Projects of ADB/N, the Production Credit for Rural Women (PCRW) programme of the Women's Development Section, UNICEF, and other donor agencies. The usual approach is to buy ICS from the producers in large numbers and distribute them through agency representatives at no cost to the users, except for installation in their own homes. The cost of transporting stoves from the production centres to the users is also borne by these agencies. In most projects, ICS are integrated into the overall development effort. These efforts have served useful demonstration purposes.

The ICS programme in Nepal has not, however, been able to move beyond the demonstration phase. One key reason is that the current implementation approach limits the interaction between the producers and the users. The role of the intermediary agency has been more a deciding factor. By 1984/85, a decade after its initiation, the total number of ICS distributed amounted to just 30,000 units. Subsidies have mainly been used to push the users rather than "create" markets through such mechanisms as advertising, education, promotion of additional production centres, and public support services to meet user requirements. Lack of proper training in stove installation and maintenance is yet another serious problem. A sample survey conducted on the SFDP in Kavre District shows that out of 112 stoves distributed in different villages throughout six *Panchayats*, only 71 stoves were installed. Of the 41 stoves that were not installed, 24 households indicated that the absence of a technician was the primary cause for their inability to have them installed (Basnet 1983).

Experiences from Bhumisthan *Panchayat* showed that the acceptance of ICS increases when the existing design is slightly modified, allowing larger pots to be used for cooking and the chimney

pipe to be regularly scraped and cleaned. These innovations were realised because of the interaction between producers and users with the help of a development catalyst living in the village (Rijal et al. 1987). Another important factor was that the linkage between SFDP and village households was very strong.

Biogas Dissemination

The Biogas Company is the main agency responsible for the promotion and dissemination of biogas technology in Nepal. The plants are fabricated and maintained through 2 regional offices and 11 sub-branches. ADB/N has been supporting the company as a principal financier and also as a promoter. ADB/N helps the company to market its biogas plants through its loan procedure. The Biogas Company selects the site, determines the size, constructs the plants, and provides a 7 year maintenance guarantee. Whenever economic feasibility is assured, ADB/N extends a loan to individuals or groups of farmers. The Bank places the order with the company's field offices on behalf of the clients and the payment is made directly to the company by ADB/N after satisfactory construction of the plant. Emphasis is currently placed on integrated schemes that encourage productive use of the slurry for agriculture or fishery. Also, community plants are installed to run agro-processing mills using the gas in a duel fuel engine and the slurry in farming.

Currently, the Biogas Company undertakes extension, promotion, training, and research activities. Research efforts are mainly geared towards generation of biogas in colder climatic conditions, use of crop residue and biomass waste for gas generation, and cost reduction in the construction of plants. In the absence of the active involvement of other organisations in R&D activities, the company has to stretch its limited resources. There is now the realisation that it may perhaps be more productive to shift the responsibility of construction to the private sector and hence enable the company to concentrate more on R&D, promotion activities, and monitoring of construction activities for proper quality control. An important role that the company could play under the changed circumstances would be to train (a) private contractors on biogas construction techniques and (b) interested users on the operation and maintenance of biogas plants and efficient use of the gas and the slurry.

Private Sector Initiatives

The private sector approach emphasises cost-effectiveness and profitability in operation. The marketing and dissemination of technologies are oriented towards commercial purposes and they have to suit users' requirements and preferences. Successful extension and dissemination of programmes mainly rest on the following four main factors.

- The users and the producers together develop, adopt, own, and manage the technologies.
- Entrepreneurship is encouraged on a private basis.
- Innovation is based on rural needs and conditions.
- Organisational and management arrangements are made in correspondence with the requirements of the different scales of technologies.

The third point that deserves attention here is the essential role of the catalytic agents (Figure 1). Known as the Group Organiser in the Small Farmers' Development Programme or the *Lami* as in the Participatory Action Research Project for Rural Energy Planning (Bajracharya et al. 1987), they assist community members in integrating their knowledge, values, and perceptions with new information and outlooks on development opportunities. While living in the village, they engage in dialogues and encourage the villagers to organise among themselves for more productive and equitable uses of resources and technologies. Furthermore, they carry the villagers' felt needs for acquiring technical information, expert consultation, extension services, and other development opportunities from related agencies. Examples include the dissemination of micro-hydro technologies involving individual entrepreneurs, groups, and communities.

Individual Entrepreneurs

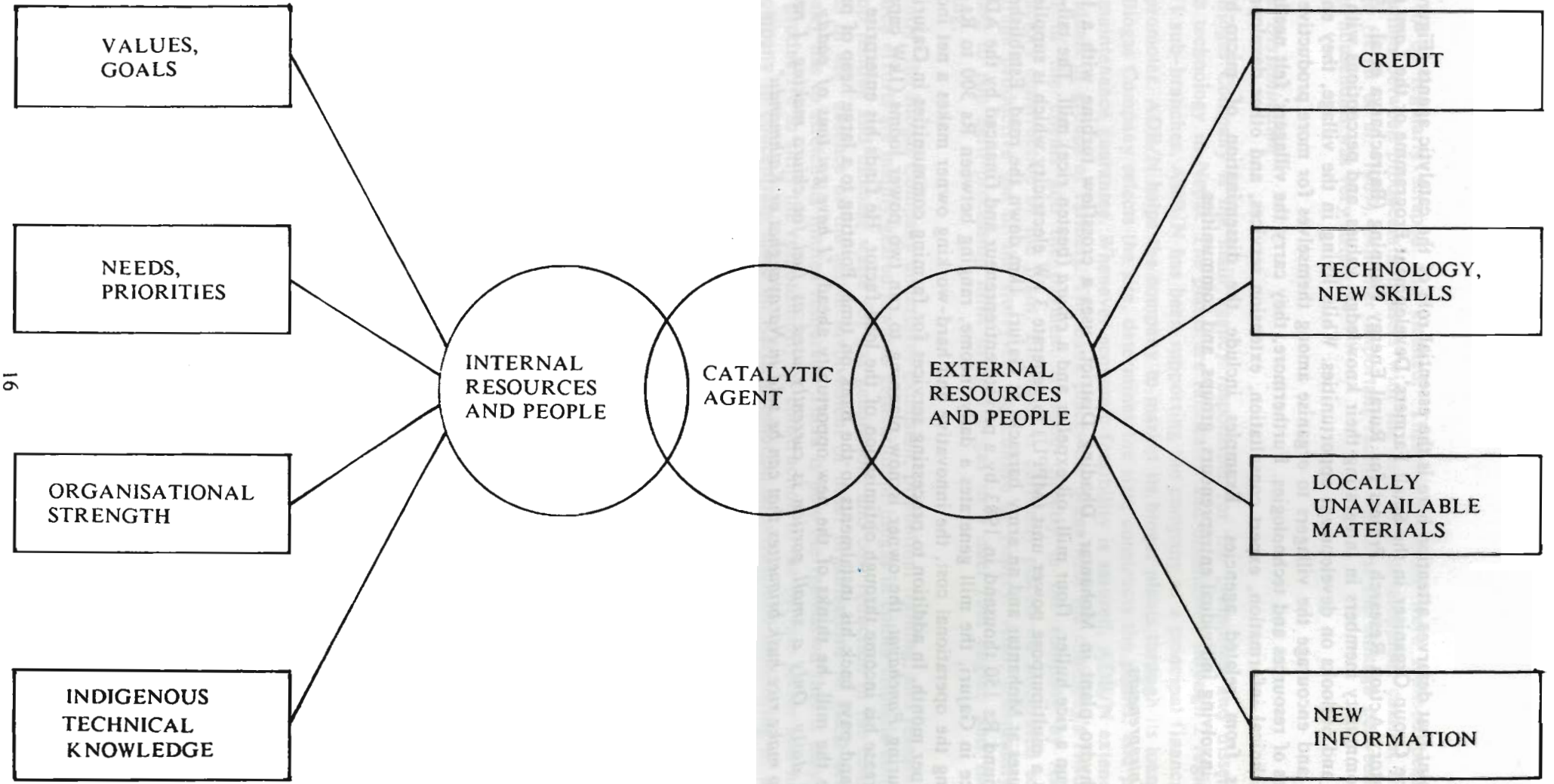
The micro-hydro plant in Mohantar, Dhading District, uses a crossflow turbine with a 13kW capacity to run a rice huller, flour mill, oil expeller and a *chiura* (beaten rice) mill. The tail-race water drives a multipurpose power unit (MPPU) to generate 3 kW electricity which is supplied to about 20 houses at Mohantar and an army barracks at Gajuri, 1km down the road. Established at a cost of around Rs 150 thousand in 1983 by a private entrepreneur and financed by the ADB/N branch office in Gajuri, the mill generates a daily income, ranging between Rs 300 to Rs 400. After meeting the operational cost, the innovative and hard-working owner makes a net income of Rs 8,000 per month. In addition to processing services for farming communities in Gajuri and the neighbouring *Panchayat*. the owner is now planning to run two power looms (1kW capacity each) to increase his income through optimisation of the load factor. He finds his enterprise very worthwhile and pays back his instalments to the Bank on time. Pointing to a large heap of paddy husk outside the mill, he thinks of the new opportunity ahead, *"I have got tons of paddy husk accumulated daily. Only a small portion is currently used as fuel for chiura making. I need a technology to make rice husk briquettes that can be sold in Narayanghat or Kathmandu"*.

Group Efforts

The rural electrification project at Taklung, Gorkha District, has been owned and managed by a group of small farmers since January 1985. It provides energy on a commercial basis. Balaju Yantrashala, a private manufacturer, had installed the water turbine of 10.2kW capacity at Reginas Village in Taklung in 1978 for Hom Bahadur Gurung under ADB/N financing. Technically, the turbine was running very well for agro-processing purposes. However, he could not run it profitably because of poor managerial capability. The condition of the mill was a matter of concern to the owner and the Bank. The owner could not pay back the loan instalments and the delinquent amount had reached Rs 113 thousand by December 1984.

At this stage, 5 members of a SFDP group proposed to run the problematic mill on a group basis and approached the SFDP Group Organiser for help. A meeting was subsequently held among the SFDP group members, the turbine owner, the Group Organiser, and the ADB/N Branch Manager. The owner expressed his readiness to transfer the ownership to the small farmers' group if they were willing to pay back his delinquent loan. Finally, all the partners came to an agreement. The loan was transferred to the SFDP group under the leadership of Ram Hari Khanal and the group started operating the mill in mid-January 1985.

A member of the group (Taman Thapa) was sent for training on operation and maintenance at a turbine workshop in Kathmandu. The group subsequently appointed Taman Thapa as their treasurer. He had to work full time in the mill and keep a proper account of all incomes and



Source : Bajracharya 1986

expenditure. They hired, in addition, an experienced operator and a helper at salaries of Rs 600 and Rs 400 per month respectively. The milling service was maintained at 9 to 10 hours per day and, gradually, the mill started operating at a profit. Once every month, the commodities accumulated from the payment in kind were equally distributed among all the members and the cash income used to repay the loan to SFDP.

As their confidence in mill operating increased, the group initiated the idea of electricity generation, particularly during the night when the mill is usually not in operation. Twenty-five households expressed their interest in buying the electricity. SFDP helped arrange the technical survey to be done by a private manufacturer from Kathmandu. He suggested the use of a 3kW electricity generator that he had developed by integrating the electric motor with the capacitor The estimated cost of installation was Rs 30,000. At SFDP's recommendation, UNICEF provided a grant of Rs 18,000 for the rural lighting scheme. In a month's time, the 3kW asynchronous generator was installed and electricity was distributed to 25 households, the SFDP Office, the local school, and several shops in the market centre. The tariff was based at a monthly rate of Rs 12 for each 40 watt bulb or 20 watt fluorescent tube. With 44 bulbs illuminated every evening, the small farmer's group received an annual revenue of Rs 4,750 in addition to Rs 44,730 from milling (Gorkhali 1988).

Electricity brought about a big change in the village. Many villagers consider electricity to be prestigious. Three women members of the small farmers' group are now operating knitting machines in the evening. The shopkeepers have been able to keep longer shopping hours.

Informal Cooperative Arrangement

The micro-hydro turbine mill at Uppallo Archale, Nawalparasi District, provides an example of the community approach. This mill is cooperatively owned by 182 persons. Because of adequate water resources in the area, in 1980 the farmers and the officials of the United Mission to Nepal (UMN) proposed to set up a rice mill. The cooperative mill was the outcome of this proposal. Each person agreed to buy a minimum share of Rs 200. A "management committee" was formed with representatives from 7 wards of the village. The mill installation took place in September 1980 and operation started in October. Mill operators were chosen from their own community and later sent for training. In December, 150 people received their share certificates at an inaugural ceremony. Another 32 persons joined later. Nine persons were elected for the Management Committee at a general meeting. Each ward selected its own members. Two more were chosen from among the largest shareholders. The Management Committee elects the chairman and the treasurer. The committee meets every month and gives a monthly statement of expenditure and income.

Another example of a community-managed watermill is the multipurpose cooperative mill with 32kW electricity supply system extended to Bhorletar and Karaputar market centres in Lamjung District. This project is financed by ADB/N and is owned by more than 50 members of the farming community from Karaputar.

In all of the above cases, i.e., the promotion of micro-turbines, biogas plants, and improved cooking-stoves, ADB/N plays a supportive role as an intermediary or link organisation. It not only provides the credit support for widespread dissemination of proven technologies but also coordinates the channelling of government subsidies and technical support services to technology developers (manufacturers) and end users (farmers, entrepreneurs). Technology display, training, demonstration, and communication of research findings are conducted through its Appropriate Technology Units (ATUs) at the regional level. At the same time, necessary credit support for the

acquisition of desired technologies is made available through its field network of more than 500 offices in the country. Training on operation and maintenance for operators is imparted through the Bank's regional training network. A number of small blacksmiths' workshops have been established in the *Terai* and the hills through the Bank's support to facilitate the repair and maintenance of energy technologies. The cost-effectiveness, a growing network of local fabrication capability, the increasing availability of maintenance services, and the support from ADB/N, all of these have strengthened the private sector approach, especially in promoting micro-hydro technologies and biogas. This is worthy of further expansion with regard to other technologies and in other countries.

Private Forestry Management

The private sector approach in the management of community forestry holds a lot of promise. Agroforestry activities, recently undertaken by small farmers' groups with ADB/N and CARE/Nepal assistance, demonstrate that community/group management has been able to effectively address problems of fuelwood, fodder, and soil erosion. The programme is integrated with income-generating activities such as fruit tree plantation, livestock development, and irrigation facilities for crop production.

An example of such community forestry management was started in March 1984 by a small farmers' group in Kakarbhitta, Jhapa District. Community forestry development was initiated in the Tiring area of Kakarbhitta with the formation of the *"Sana Kisan Van Vikas Samiti"* (Small Farmers' Forest Development Committee) which consisted of representatives from 14 male groups and 8 female groups. Under the management of the committee, a forest nursery was established, and this is currently producing 40,000 seedlings of fuel and fodder tree species annually. This *"Samiti"* also organises agroforestry activities through the mobilisation of group members. One of the major functions of this *"Samiti"* is to prepare an integrated plan for inter-cropping and fodder production and identify possible sites. The plan is implemented and managed with full cooperation from group members. Ten hectares of "wasteland" have so far been used for agroforestry plantation. The land was divided into 22 blocks and each block was assigned to a group for management and maintenance of the plantation. In the long run, the aim is to generate income for the participating small farmers by producing fodder for their own livestock and eventually by selling timber and fuelwood. In addition, several socioeconomic and environmental benefits (listed below) are also becoming apparent (Shrestha 1988).

- Small farmers have started to grow trees around their farms and in denuded areas. This has brought about environmental improvement in the area and helped control soil erosion.
- The farmers are seemingly pleased by the promising results of inter-cropping systems such as *sisoo* with groundnut and of *dhaincha* and ginger with *sisoo* and *ipil-ipil*. The production and sale of *Khar (Imperata Spp)* for roofing has yielded a net income of about Rs 5,000 annually in the last few years.

The success of Kakarbhitta had a good demonstration effect on a number of other SFDP areas. The prerequisites for the initiation of such group cooperation include technical support, training and credit assistance for inter-cropping and livestock development, and the assurance of a long-term lease for the use of forest land. It is now evident that the group involvement of community members in forestry development is a viable alternative.

Another case study from Tupche Village, Nuwakot District, reveals that several small farmer groups used fallow hillsides for establishing fruit orchards. For ensuring the protection of these areas, the local authorities enforced the rule that a trespasser would be levied a fine of Rs 50. One half of this amount is offered to the person who notifies the authorities about the violation and the other half is deposited in a fund. The smooth functioning of the programme in the village owes much to the supportive role that the local authorities played in legitimising the small farmers' efforts. The village assembly in Tupche went even further in passing a resolution to prohibit outsiders from felling trees from the village forest (Shrestha 1980). Another example of a similar nature comes from Belkot Village in the same district, where local community participation was instrumental in protecting and developing 35ha of forest without the assistance of the Forest Division (Shrestha 1980).

Given the success of private initiatives in forest management and the need to increase the forest cover in the hills of Nepal, the idea introduced by Chalise (1983) is worthy of consideration. The concept is to encourage individual farmers to grow more wood on privately-owned marginal land. Because of the low crop yield on such land, it is possibly more profitable if trees are grown with the explicit purpose of marketing wood in nearly all urban centres. With the income generated by the sale of wood, the food requirements of the household can be supplemented. The success of this proposition would, of course, depend upon the assurance that fuelwood can be marketed and also that an alternative opportunity is available during the years when the farmer has to wait for the trees to mature. These aspects will have to be investigated in much greater detail. The point, however, is that forestry activities have to be seen not only from the perspective of meeting subsistence requirements but also from that of marketing possibilities and, hence, income enhancement opportunities. Forestry can then be easily combined with other activities such as livestock development and dairy products, not to mention minor forest products. Seen in this light, the programme will have to be supported by technical input, training, credit services, and others to strengthen the capability and confidence of the farmer.

Participatory Village Development

The Participatory Village Development Approach emphasises the integration of energy supply to meet development objectives. Small farmers' groups are encouraged to develop their own organisations such as inter-group committees or user groups as a prerequisite to implementing village level integrated programmes. A case in point is the successful implementation of the lift turbine pump project by small farmer groups at Karma Singh *Phant* in Gorkha District. As shown in Figure 2, irrigation and hydropower were the crucial inputs to the initiation of many related activities that contribute to the village development process. This contrasts against the approaches discussed above where, for example, the turbine is used for milling or the forestry activity is geared towards supplying fuelwood or fodder. In Karma Singh *Phant*, the rural community was faced with the lack of water to irrigate their *Tar* land[5] despite the fact that the Daraudi River, flowing a few metres below, could supply plenty of water. Since irrigation by gravitational flow was technically unfeasible, the community was looking for alternative technology options to lift the water to irrigate the *Tar* land. In 1985, the Agricultural Development Bank proposed the "Turbine Pump Installation Project" to the community of 41 small farm families. A precondition, that they must organise among themselves to determine a practical mechanism for water use, and mobilise as much of their resources as possible for the project, was also proposed. With firm commitments assured by community members, the Bank imported a turbine pump from China under a TCDC arrangement (Technical Cooperation among Developing Countries). With active

5. The *tar* is a raised river bed that stands up to 50 metres above the water level of the flowing river.

collaboration among bank engineers, private sector entrepreneurs, and community members, the construction of the diversion canal and the pump house, and, finally, the installation of the turbine pump took nearly eight months. The project was completed at the end of 1986 and the total cost was Rs 1.2 million. The pump currently generates 16 kW of power. Approximately 45 litres of water per second are lifted up to 21 metres, from Daraudi River, and 15 hectares of agricultural land belonging to 41 small farm families are irrigated. Agro-processing units are also attached to the turbine for rice hulling, grain grinding, and oil expelling.

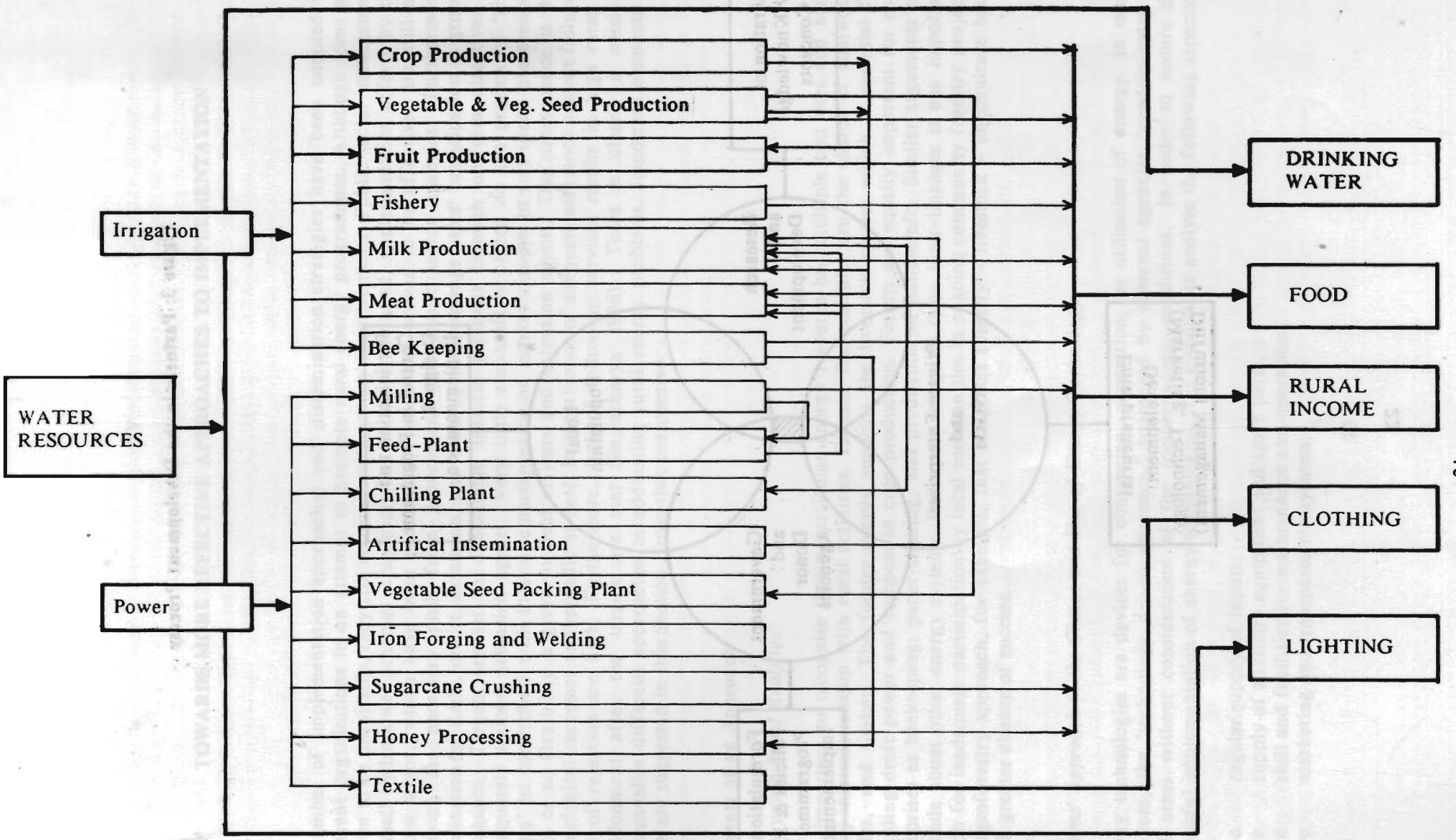
Before the installation of the pump, only one crop of rainfed paddy could be grown on the *Tar* land. Currently the farmers are cultivating multiple crops including early paddy, late paddy, wheat, potato, and seasonal vegetables. The irrigation system and the processing activities are being managed by a committee chaired by Iswar Prasad Pant. With the increased income from crop production and mill operation, other activities, as shown in Figure 2 are gradually being undertaken. The basic idea is to maximise the sustained use of local resources for meeting the basic needs of the community such as drinking water, food, clothing, lighting, and income generation. Emphasis is also placed on minimising external dependence. With the encouragement from benefits received due to the project, the community has recently established a fishery pond and integrated it with fruit and fodder plantations. By-products from the agro-processing units are fed to the fish. According to a report from Badri Sharma, SFDP Group Organiser working with the community, the farmers have now harvested their first fish crop.

The village has undergone a visible change within a year. Twenty-one new houses and a primary school have been built. A number of fodder trees were planted on areas that are not suitable for crop farming. The farmers are now planning to increase their livestock numbers so that more milk and meat can be produced for the market. Confidence in their own ability to plan and implement has also increased. The farmers' committee is now thinking of investing a part of its income in the installation of a generator to produce electricity. According to Ram Prasad Kaini, who has been very active since the programme was initiated, *"The hard days have passed and a better future is ensured."*

The key to success here is the participatory approach. It advocates experiential learning through active participation of all the concerned partners in situation analysis, decision-making, and evaluation. Partners include two or more of the following parties: (a) village residents, (b) government officials or donor agency representatives, (c) researchers, and (d) private entrepreneurs or non-government organisers (Figure 3). All those involved become engaged in change by changing, through a constant process of action and reflection. Dialogues and negotiations among the partners make them sensitive to one another's perspectives. Their mutual interests are reflected in problem identification, planning, implementation, monitoring, and evaluation. Action is perceived as the consequence of shared goals and shared responsibilities (Bajracharya et al. 1987).

Another important aspect of the approach is that energy planning and the application of energy technologies become, not the end by themselves, but the means to address critical problems faced by villagers. This lends itself to greater relevance in the eyes of community residents. Consequently, they are more willing to participate in programme activities because of the confidence that their own needs and priorities are being looked into.

Figure 2: Irrigation and Rural Energy Development Model
(Potential Project Activities Envisaged for Small Farmers' Model Village Development)

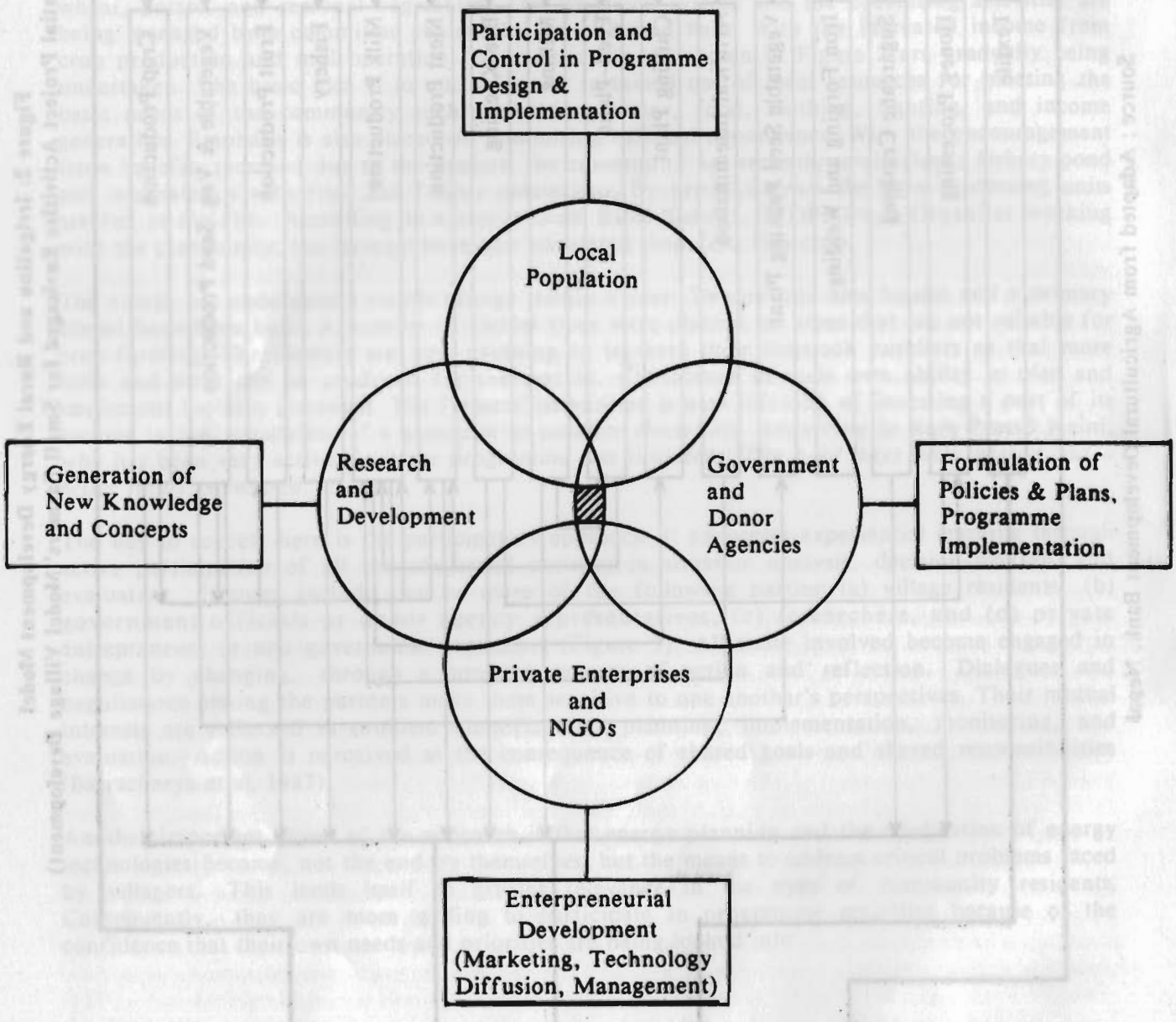


Note: -

Direct linkages
Indirect linkages

Source : Adapted from Agricultural Development Bank, Nepal

Figure 3: Partners in the Development Process



IV

TOWARDS MORE EFFECTIVE APPROACHES TO IMPLEMENTATION

A number of implementation approaches and dissemination strategies have been adopted by different organisations in an attempt to promote rural energy programmes. Although some are proven to be unsuitable, they still continue without any improvements. Public sector management of small hydropower schemes is an example. On the other hand, implementation efforts by the private sector, which have been successfully tested and proven to be effective, are still not receiving the necessary push from government and public sector agencies. Furthermore, coordination of R&D, credit, extension, and training to encourage users' participation is grossly inadequate. Targets are set to disseminate specific products through uniform directives to inadequately trained extension agents. Very little emphasis is placed on the process of "fine tuning" to correspond with local circumstances or on market surveys to suit users' preferences. Little or no flexibility is given to field officers and extension agents. The consequence is that technological successes are sporadic at best. In the absence of adequate assurance against failures, rates of rejection are high. Furthermore, lack of follow-up services results in high rates of abandonment after the targets are met (Bajracharya 1986). There is clearly a need to conceptualise different approaches to addressing rural energy problems. Important elements of these are suggested in this Section from that perspective.

Elements of an Approach

Energy and Rural Realities

It is important to recognise that a particular energy resource has multiple end uses and has a strong interrelationship with rural activities. Forests, for example, are the source of fuelwood, fodder, and timber. The fodder supply supports the livestock system which is essential for providing draft power and compost in crop production. Forests are equally important for such enterprises as beekeeping, paper-making, and production of handicrafts. Similar arguments can be made about other energy systems. Failure to recognise these inter-linkages is one important reason for inadequate participation by local communities in ongoing community forestry projects. An agroforestry approach, for example, that integrates forestry - livestock - horticulture has a much greater chance of success.

Systems' Approach in the Choice and Use of Energy Technology

Energy technologies are devices for conversion, generation, or utilisation of energy. In many instances, the "technology driven approach," sponsored by external agencies, predominates in rural areas without consideration of the socioeconomic conditions. In order to ensure the successful implementation of energy technologies, it is essential to analyse the following aspects:

- regular supply of inputs,
- supply of auxiliary equipment and spare parts,
- skill and facilities for maintenance and operation,
- marketing and transportation systems,

- o organisation for resource mobilisation and management, and
- o credit, extension, and local manufacturing support.

All these aspects together constitute the energy technology system. A particular technology may need readjustment or modification in design to fit into the socioeconomic environment. Economic viability, institutional and management capability, and sustainability need to be carefully assessed before technological feasibility can be ensured.

Supply of Commercial Energy

We have already referred to the sparing use of kerosene (45,200t), diesel (13,000t), and electricity (171 GWH) in rural areas. Although small in actual quantity, they do contribute to lighting and the operation of farm-related equipment and the demand will foreseeably increase as long as the supply can be assured. From this aspect, it is important to give adequate attention to the distribution system so that the rural population can rely at least on a sustained and regular supply of what little they get. In seriously deforested areas where the priority for protection is very high, it would be worth considering, in the short run, whether the substitution of fuelwood by heavily subsidised kerosene is a viable proposition from an economic and supply point of view. In the long run, however, given Nepal's comparative advantage with hydropower and the high import cost of petroleum products, the solution would very much rest on the substitution of kerosene and diesel by (a) electricity from decentralised small hydro-schemes and central grid extension and (b) biogas generation in significant amounts. This would require a substantial allocation of financial resources, administrative capability, institutional coordination, credit availability, and political determination. An appropriate energy pricing policy would also play a key role in this venture.

Research for Development

Research on rural energy technologies is of recent origin in Nepal. Over the last ten years, the Research Centre for Applied Science and Technology (RECAST) of Tribhuvan University has been engaged in technological research related to the development of improved cooking-stoves, biogas, micro-hydro technologies, and solar dryers and cookers. In addition, a variety of research activities on micro-hydro and biogas technologies has been conducted by private turbine manufacturers and the Biogas Company. What needs encouragement is 'Participatory Action Research' aimed at developing suitable energy systems that correspond to rural needs and priorities. This approach emphasises collaborative efforts among researchers, manufacturers, users, and promoters. Research priorities have to be set within the above framework (Bajracharya 1984 and 1986).

Demonstration and Dissemination

Attempts have been made to popularise technologies by demonstrating their applicability in rural areas. The Appropriate Technology Unit has been established by ADB/N in four different regions of the country for the specific purpose of demonstration and dissemination. New products and designs that are developed, either in Nepal or outside, are brought to the service area for field testing. Samples are given to the small farmers' groups and tried under local conditions. The usefulness, reliability, and farmer's acceptance are determined on the basis of close monitoring by ATU staff. A part of the cost is borne by ATU. If the technology proves to be unsuccessful, ATU compensates for the entire cost. When the technology is willingly adopted and accepted by

the former, ATU works towards its supply and distribution through private manufacturers and entrepreneurs with credits made available by ADB/N field offices and SFDPs. After the establishment of ATU in Rapti Zone in 1982, for example, a total of 127 biogas plants, 56 water turbines, one 4kW rural electrification scheme, 538 improved cooking-stoves, and 406 storage basins were installed within three years. These technologies were rarely found in the area prior to the establishment of the ATU. Furthermore, ATU in Rapti Zone imparted training to 1,728 farmers on the operation of biogas plants, water turbines, improved cooking-stoves, and beekeeping (Upadhyaya 1985).

Support Services for Repair and Maintenance

This is often a neglected but important aspect in the dissemination of new energy technologies. Repair and maintenance facilities are normally available in urban areas and some accessible market centres (especially in the *Terai*). Satisfactory services are available, for example, from the sales' depots of the Agricultural Tools' Factory and the Biogas Company, as well as some small mechanical workshops. The principal difficulties lie, however, in the hills of Nepal where the energy problems need the most attention. If anything goes wrong from a technical standpoint, either the technician has to be brought to the village from urban or market centres or the machinery has to be carried, literally on backs, to the repair shop in the nearest urban centre. The inconvenience and the heavy costs naturally discourage users from trying out new technologies. As a part of the technology dissemination package, therefore, emphasis has to be placed on (a) the training of some selected people in the village in repair and maintenance services and (b) the promotion of rudimentary mechanical workshops in conveniently located village centres. Regarding the second point, it might be noted that there are village blacksmiths and some local entrepreneurs who could be encouraged through proper incentives. Until these services are locally possible, technology suppliers should be compelled to go on regular monitoring visits with the purpose of providing repair and maintenance facilities where required. Financing agencies, such as ADB/N and other commercial banks who provide loans for new technologies, could be asked to take the necessary initiative in this direction.

Development of Energy Villages

Rural residents of Nepal are aware that the shortage of energy has been a major constraint in realising the objectives of economic development. Lack of access to alternative technologies and the absence of systematic adaptation of potential technologies have, for example, hindered the development of irrigation to increase agricultural production, and the harnessing of energy for agro-processing, lighting, and cottage industries. There is, in addition, the absence of a systematic understanding of the 'process' that enables village residents to absorb the technology suited to their needs and embark upon economic development efforts.

To counteract these obstacles, the concept of the "Energy Village" is proposed to intensify deliberately the use of rural energy technologies and to integrate them with the various energy requirements of the community as a whole. The Irrigation and Rural Energy Development Model (Figure 2), implemented by the community of small farmers in Karma Singh *Phant* of Gorkha District, provides a case in point. The community, with the assistance and support of ADB/N, has successfully demonstrated the use of water resources to generate the energy required for application in irrigation and agro-processing. This is then integrated with diversified systems of crop production, horticulture, fisheries, fodder production, and livestock-raising activities. Emphasis was placed on the maximum use of local resources (such as water) and also on the reinforcement of the organisational capabilities of small farmers' groups. The principal elements

of this approach include (a) intensifying energy use, (b) providing the necessary support to use technologies suited to local conditions, and (c) institutional mechanism through SFDP to increase small farmers' capabilities to operate such systems. The development efforts at Karma Singh *Phant* are in the preliminary stages but the results are indeed encouraging. It is conceivable that this model may be disseminated to other villages. The emphasis on specific resources might be different but the principles could be the same.

Private Sector Involvement

Experiences show that the private sector approach could be the most feasible and lowest cost option for implementing rural energy projects. Proper incentives and necessary support systems are, at present, minimal for the engagement of the private sector in the development and management of rural energy programmes. Several alternatives are possible.

Farm Forestry Approach

While the "Community Forestry Approach" needs to be continued, alternatives such as agroforestry and private farm forestry need to be encouraged. Various activities might be included.

- Promotion of a network of nurseries for the distribution of saplings, including those of fruit and fodder trees.
- Establishment of effective extension and training services to enable village people to become extension agents.
- Provision of long-term credit with concessional rates of interest for integrating crop farming with pineapples, bananas, pulses, groundnuts, and others that yield quick economic returns.
- Development and distribution of proven technical packages for tree farming with compensatory measures in the case of failure.

ICS Dissemination

Government subsidy may be provided for (a) training of potters and technicians for stove installation and (b) publication and distribution of posters and manuals for ICS production and maintenance. Credit agencies should, at the same time be encouraged to finance ICS production through pottery enterprises in rural areas. Stove installation activities can also be promoted as a part of the ongoing credit programmes of financing agencies. The important point is to promote direct linkages between stove producers and users. A subsidy of 50 per cent may be provided directly to stove producers so that users can get them at relatively lower prices.

Small Hydro Schemes

The performance of government-owned small hydro schemes can be much improved if the management and operation are entrusted to private agencies. Arrangements for training may be provided by the Small Hydropower Development Department to encourage such involvement.

Installation of Biogas Plants

To increase the dissemination of biogas plants, private contractors may be encouraged to install them according to design specifications provided by the Biogas Company. There is evidence to show that the cost of installation is lowered under these circumstances. A former staff member of the company had, for instance, gone ahead with the establishment of his own private firm and succeeded in installing biogas plants at much lower cost than the Biogas Company could manage.

Strengthening Local Participation

The afforestation efforts in Belkot Village *Panchayat* of Nuwakot (as described in Section III above) show that the village communities have the capability to plan and implement their own programmes, to mobilise their own resources, and to manage the project on a continuing basis. The experience from SFDP indicates that small farmers are motivated to participate when credit is accessible to them. The experience in REPS-PAR shows that villagers participate willingly in implementation when they are involved in the choice of the project and they are engaged in planning and decision-making (Bajracharya et al. 1987). Both the REPS-PAR and SFDP approaches highlight the role of the catalytic agent in motivating village residents to participate actively in the programme. Another key aspect that needs to be considered is the participation of women in programme activities. The success of the community forestry programme in Darchula was largely due to the active participation of women in the forestry users' committee. A similar involvement of women would help a great deal in the promotion and dissemination of ICS. In many cases, the introduction of a new technology or device fails either because women are not trained or because the new device does not meet their needs. ICS acceptance increased in Sangramtar, for instance, when the design modification was done as per the local requirements. Such requirements were identified through the interaction of the household women, the researcher, and the ICS producer.

The local community clearly needs to be encouraged and allowed to formulate their own plans and programmes of action based upon their values, goals, needs, and priorities. Their indigenous knowledge, skills, and organisations require much strengthening for effective implementation of programmes. Many local informal organisations have been successful in managing community projects such as village forestry, irrigation systems, and drinking water systems. The rules, regulations, and control mechanisms were established without any external help or assistance. When government agencies attempt to form new organisations, the tendency is to ignore the existing ones. As a result both the government-sponsored organisations and the pre-existing ones become ineffective as demonstrated in the experiences of community forestry in Dolkha District.

There are many examples of informal mechanisms that people were using to organise their social life, pool their labour and other resources, express their common interests and concerns, and mediate or resolve conflicts. The *guthi* in Kathmandu Valley is an institution in which members partake in religious and social responsibilities. In some cases, they might own a common piece of land. Revenue obtained from *guthi* land is known to have been used to support religious or communal activities such as afforestation, installation of taps or ponds, and sponsorship of cultural and social events. The *Thakalis* of Western Nepal operate rotating credit associations (known as *dhikur*). A common fund, established through contributions from members, may be used on a rotating basis for establishing new business or for meeting unexpected expenses during times of financial crisis. The *Gurung* women organise labour groups for agricultural activities on the basis of traditional female associations called *Rodi* (UNICEF 1987). The *Tharu* community in Dang-Deokhuri and Kailali districts have set rules and regulations for timely operation and management of local irrigation systems. The scale of operation involves as much as 5,000ha.

These local organisations, which contribute to reinforcing ethnic and kinship solidarity, provide effective networks for community participation. It is worthwhile to explore fully the potentials inherent in these systems.

The key factors for the successful participation of local groups rest on (a) flexibility in rules and regulation, (b) assistance of the experienced catalytic agent in guiding the people to form their own group as per their requirements, and (c) provision of credit and extension support as 'entry points for mobilising external resources while strengthening local organizations.

Improving Institutional Coordination

The absence of coordination among institutions and organisations in the planning and implementation of rural energy programmes is a major constraint. This is apparent not only at the national level but also at the district or project level. There exists a gap between micro-level implementation and macro-level planning. As a consequence, it is difficult to see whose responsibility it is to look into rural energy. Seen from the conventional perspective some of the responsibilities lay with sectors dealing with agriculture, irrigation, forestry, power, and cottage industries. The irony is that when rural energy is fragmented, its significance and priority are lost in the midst of other activities within each of the sectors. The elements of an appropriate institutional framework are discussed in greater detail in the following section.

V

INSTITUTIONAL IMPLICATIONS

Rural energy development is not an end in itself but an important input for achieving the objectives of agricultural and rural development. Energy-related decisions, therefore, cannot be made in isolation without giving due consideration to direct or indirect impacts on the rest of the economy. Rural energy planning and implementation, therefore, involve several organisations and institutions. Currently, the Water and Energy Commission and the National Planning Commission are responsible for planning for energy supplies on a sectoral basis. Various government agencies (such as the Ministry of Water Resources, Ministry of Agriculture, Ministry of Forests, and the Ministry of and Local Development) provide policy and programme guidelines for implementation. The Ministry of Finance allocates financial resources to the line ministries. Rural energy programmes are then implemented through (a) relevant government departments under different ministries, (b) semi-government institutions, such as the Agricultural Development Bank and the Small Hydroelectric Development Department of the Nepal Electricity Authority, and (c) private sector organisations, such as the Biogas Company and turbine manufacturing firms. At the village level, those involved actively in the implementation of rural energy activities include individual entrepreneurs such as mill owners and biogas plant operators, small farmer credit groups, self-help organisations, and other formal/informal associations.

Current Institutional Arrangements

Government Institutions

Since the Sixth Five Year Plan (1980-1985), increasing importance has been given to the development of new and renewable energy sources. A number of decentralised rural energy projects have been undertaken in the rural areas but with limited impact on the rural population. The Water and Energy Commission Secretariat (WECS) was created by His Majesty's Government in 1980 under the Ministry of Water Resources to provide planning guidelines for the development of the water and energy sector. In the initial years, the efforts of WECS were mainly concentrated on the planning and monitoring of operational problems in big hydropower projects and very little on renewable energy activities. This is not surprising because WECS is an institution under the Ministry of Water Resources where priority is given to the development of hydropower. In addition, WECS does not have a formal functional responsibility vis-a-vis the National Planning Commission (NPC) which is responsible for the overall planning of the energy sector. Its role is, therefore, limited as an advisory body. In spite of these institutional limitations, WECS has recently taken some initiatives in renewable energy development, for example:

- preparation of an annual plan for rural energy projects with the help of an "Energy Task Force" consisting of representatives from relevant government and semi-government agencies, and

- development of a plan to promote alternative energy resources.

The fact remains, however, that the representatives are not obliged to implement the proposed plans. They do, nevertheless, serve the function of helping the concerned members to initiate possible action programmes in their respective agencies.

Financial Institutions

As already explained in the previous chapters, the Agricultural Development Bank of Nepal (ADB/N) has been actively involved since the mid-1970s in the promotion and dissemination of a number of renewable rural energy technologies, for example, micro-hydro for agro-processing and rural lighting and biogas for cooking, lighting, agro-processing, and water lifting. ADB/N has been effective in mobilising its resources for financing these energy systems through its nationwide network. The efforts of the bank alone are not, however, adequate. The ADB/N experience shows that many of these activities, centred around rural energy, are technically and economically feasible and socially adaptable. Rural entrepreneurs, village residents, technology manufacturers, and the ADB/N have all benefitted from such undertakings. The irony is that government institutions and other commercial banks have not seriously joined in the efforts towards wider dissemination. The Government, for example, announced a policy in 1985 to provide a 50 per cent subsidy to promote private initiatives in undertaking rural electrification schemes. However, the bank faced difficulties in getting the funds released from the Ministry of Finance.

Private Sector Organisations

Commercialisation of some energy technologies has been fairly successful when private manufacturers have been involved in the dissemination effort. Installation of micro-hydro turbines and biogas digesters are examples of successful programmes implemented by such companies as Balaju Yantrashala, Nepal Yantrashala, Kathmandu Metal Works, Butwal Engineering Works, Development Consulting Services, and the Biogas Company. Credit and extension support from ADB/N have helped them in continuing with these activities. They have shown their interest and capability in developing suitable renewable energy systems and extending the services to private entrepreneurs in rural areas. Their organisational network and services would be greatly strengthened if government policies and support mechanisms became favourable and consistent.

Research Institutions and Technology Centres

For about a decade, the Research Centre for Applied Science and Technology (RECAST) has been involved in the design and testing of water turbines, improved cooking-stoves, water-lifting devices, and biomass gasification. Several private sector institutes are engaged in product improvement work. The sharing of research findings and opportunities for prototype field testing are, however, limited. In the past, RECAST was active in testing rural energy technologies with users' participation at Village Out-Reach Centres (Shrestha and Singh 1986). These activities were instrumental in creating awareness among village communities in the use of rural technologies. Unfortunately, the project has been discontinued mainly because of funds and other support. The ATU of ADB/N is at present the only institution that is continuing with the field testing and demonstration of rural technologies in the villages and promoting them with credit support. Such activities deserve further intensification.

Local Organisations, Entrepreneurs, and Artisans

Local organisations including informal water user groups, forestry groups, and village residents, including artisans and entrepreneurs, have knowledge and skills to contribute to the development and diffusion of energy technologies. In areas where SFDP and PCRW programmes are launched,

institutional mechanisms exist to mobilise the participation of local beneficiaries in planning and implementing programmes including rural energy projects. In other areas, a number of informal local organisations have existed for centuries. Progress in rural development programmes and energy projects are, however, lagging behind expected targets because of the lack of institutional support, the inefficiency of active extension agents or catalytic agents, and the absence of adequate encouragement to enhance the involvement of local informal organisations. Formally sponsored organisations such as "forest users' committees", and "water users' committees", and set up as a part of government programmes, have yet to demonstrate effective operational and management capabilities. Appropriate organisational mechanisms need to be developed to assist farmers, artisans, and entrepreneurs in strengthening their capabilities in mobilising their own resources, seeking the assistance of government programmes, as appropriate, and obtaining financial and technical assistance, if necessary, in order to increase the input of energy and thereby increase rural productivity.

Donor Agencies

Donor agencies, until recently, have been more interested in centralised multi-megawatt hydropower projects with high environmental risks than in decentralised multipurpose micro-hydro development programmes. Huge investments and grant assistance, poured into large projects, have usually resulted in substantial cost overruns and delays in project completion. While large energy projects cannot be neglected, it is important to recognise that renewable energy technologies have been valuable in improving the rural economy. At the same time, the recipient agencies must emphasise institutional capabilities and favourable policy conditions for the effective planning and implementation of renewable energy programmes. In this context, it is encouraging that an "Alternative Energy Task Force" has already been established to monitor project implementation and coordinate annual project planning. However, because of the ad hoc nature of the Task Force and the absence of a government agency with the mandate to plan, implement, and monitor renewable energy activities, coordination among institutions and organisations is very weak.

Towards an Appropriate Institutional Framework

Need for a Government Agency

Realisation has existed for some time that the absence of a government agency responsible for planing, programming, and oversee energy activities in Nepal is a problem. In view of the absolute dependence on traditional energy sources such as fuelwood for domestic and rural consumption, there is a growing need to search for alternative options. The development and widespread dissemination of new and renewable energy sources and their efficient use will provide major solutions. On the other hand, consumption of commercial energy will continue to grow in the future and significant substitutions of petroleum products seem unlikely. The role played by commercial energy sources such as petroleum products, coal, and electricity in the Nepalese economy is vital although the consumption is only about 4 per cent of the total energy. Irregular and inadequate supplies of such energy sources have led to economic stagnation. Furthermore, Nepal's vulnerability is evident from the most recent incident when India refused the entry of petroleum products and coal to Nepal after the expiry of the trade and transit treaties in March 1989. This experience has brought about a greater realisation of the need to reduce the dependency on imported energy sources such as kerosene, petrol, diesel, and coal, and the need to substitute imported commercial fuels with locally available sources. The emphasis,

therefore, is on increased supply and effective use of electricity from both big hydropower projects as well as decentralised micro-hydro schemes.

Effective implementation of such a strategy calls for the reorganisation of the existing government institutions towards the creation of a "Ministry of Energy (MOE)." This institutional set-up is based on the growing realisation that there is no single agency to coordinate energy planning and programme implementation. At least two departments within the ministry should be considered. The " Department of Renewable Energy (DORE)" can be responsible for assisting institutions and organisations for the appropriate supply management of traditional and non-conventional energy sources, such as fuelwood and biomass/agricultural residues, and for promoting greater energy generation and the efficient utilisation of alternative sources such as bio-gas, hydropower from micro-turbines, solar and wind energy, and energy from biomass gasification.

Secondly, the "Department of Commercial Energy (DOCE)" can deal with the supply of electricity, petroleum products, and coal, and can explore options for inter-fuel substitution. The major function of such a ministry will be to coordinate energy planning and implementation with the National Planning Commission (NPC), related line ministries, and bilateral or multilateral donor and financing agencies. To strengthen energy planning and implementation, each ministry and semi-government corporation would benefit from the establishment of an internal "energy cell", so that it could provide a coordinating link with the Ministry of Energy for a more meaningful inter-agency relationship. Another important function of MOE will be to integrate the energy component in all sectoral plans and monitor operational problems. Concurrently, an important activity would be to build a systematic database to enhance the formulation of feasibility studies and impact assessment of energy programmes.

The Ministry would benefit from the formation of a "Renewable Energy Coordination Committee" with representatives from institutions such as the Agricultural Development Bank, the Department of Agriculture, Department of Forestry, Department of Industry, National Planning Commission, Nepal Electricity Authority, Nepal Oil Corporation, Nepal Fuel Corporation, Research Centre for Applied Science and Technology, Royal Nepal Academy of Science and Technology, Biogas Company, and turbine manufacturers. There is also a need to establish an "Energy Planning Division" at the National Planning Commission to formulate renewable energy policies and plans. Within the institutional framework as suggested above, the implementation of energy programmes can continue to be the primary responsibility of various agencies that already exist. The major functions of the two departments are outlined below.

Department of Renewable Energy (DORE)

- To coordinate the preparation of plans and assist various energy-related organisations in the implementation of programmes on renewable energy.
- To establish necessary linkages between macro-level planning and micro-level implementation through the cooperation of energy-related organisations.
- To monitor progress and provide policy guidelines and support mechanisms for research, development, training, demonstration, and dissemination of energy technology systems for rural areas.

- To develop and assess the productive application of renewable energy technologies in agriculture and rural industries and to recommend site-specific options that are cost-effective, environmentally sound, and sensitive to the local resource base.

- To assist and provide incentives for private sector organisations involved in R & D, manufacturing, marketing, operation, and maintenance of renewable energy systems.

- To arrange financing through internal and external sources for research, development, extension, and training on renewable energy systems and for encouraging entrepreneurial ventures.

Department of Commercial Energy (DOCE)

- To coordinate the preparation of plans for the import of commercial energy and to assist in the arrangement of its timely supply and distribution.

- To formulate relevant policies concerning the conservation and effective use of commercial fuels and to monitor the progress of their adoption.

- To provide energy pricing guidelines and to assist agencies in formulating strategies for the substitution of imported fuels by hydroelectricity and other renewable energy sources.

- To develop a realistic schedule for hydro-electric schemes, both big and small, to take advantage of the huge water resources available in the country.

- To arrange the systematic exploration of hydro-carbon deposits such as petroleum products, coal, and gases.

- To assist and provide incentives for R & D on commercial energy.

- To arrange financing through internal and external sources for R & D, extension, manpower training, project design, and implementation.

Emphasis on Private Sector Development

Experiences with renewable energy programmes suggest that the promotion of the private sector in production, marketing, sales, and services can be very effective. Programmes undertaken by government agencies and public sector organisations are usually constrained by the relative inefficiency of the outreach capability and management system. The cost of running small hydro projects at the district or village level, for example, is considerably high for the Small Hydroelectric Development Department. Private companies are likely to provide better alternatives for the same type of work. Evidence shows that mini- and micro-hydro projects are profitable when organised by the private sector. This is equally true for other rural energy systems such as agroforestry, biogas, and stove production. Economic gains through cost-effective technologies can be assured if the organisational and management capabilities of producers and users are enhanced.

A shift in government policy is necessary if private sector involvement is to materialise. This means, for example, (a) a more positive attitude towards small energy systems, (b) willingness and

commitment to use the private sector in the planning, implementation, and management of projects, (c) protection against the import of energy technologies that can be produced locally, (d) assistance in the financing and marketing of energy technologies, and (a) development of an appropriate pricing policy and other incentives to encourage the adoption of renewable energy technologies in place of fuelwood and petroleum products. The important point is to increase the interaction, among government agencies, private sector organisations, rural entrepreneurs, and local communities.

Participatory action research as described by Bajracharya et al. (1987) provides a sound methodology for promoting the interaction. The current administrative structure within government agencies is unlikely to implement the required measures in the immediate future. In the context of Nepal, it is more conceivable that a private agency be created to mobilise the interaction of various parties as mentioned above. The major function of the agency would be to provide the services of well-experienced "catalytic agents" to public agencies for implementing government programmes. Training may be provided to staff to organise users and ensure their participation in rural energy activities. "Catalytic agents" of this agency should have the following qualifications:

- experience in motivating rural farmers to form cohesive groups for the planning and implementation of rural energy systems;
- skill in understanding local energy problems and the ability to suggest practical options;
- ability to train programme staff from various government organisations on the use of participatory approaches for problem solving in rural areas;
- capability to coordinate the contributions of technologists, researchers, manufacturers, financiers, and government officers in order to meet the requirement of village residents;
- skill in analysing field results and compiling progress reports; and
- the capability to undertake feasibility studies and organise training programmes for rural entrepreneurs and village residents on rural energy systems and on the technical aspects of operation and maintenance.

Strengthening Regional Organisations

Government ministries and semi-government institutions have regional set-ups that are relevant for the development of renewable energy sources. The purposes of these offices are to execute national policies and to supervise and monitor programme execution in the concerned districts. For example, agricultural and related energy technologies are tested and demonstrated in regional or district farm research stations by the National Agricultural Research and Service Centre, Ministry of Agriculture. If the concerned technology shows promise, it is certified for promotion and extension to the farm level through the Agricultural Development Office in the districts. Courses on the operation and maintenance of the technology are provided regularly to farmers by many training centres under the jusisdiction of the District Agricultural Development Office. A case in point is the demonstration of solar dryers at the Jumla Apple Farm in order to encourage farmers to process dried apples. At Malepatan Livestock Farm, Pokhara, hydraulic rams supply the water requirements. Lots of improvements are, however, possible and desirable. A much

stronger link with these research farms can be developed to promote more energy technologies, along with their current involvement with farm mechanisation and irrigation technologies. The present emphasis on the use of diesel in farm technologies can, for instance, be shifted to the use of locally available renewable energy sources. This would in the long run benefit the farmers in view of the high diesel cost and its unreliable supply. Similar innovations can be instituted through the network of regional training centres and Appropriate Technology Units of the Agricultural Development Bank, the regional training centres for the development of cottage industries run by the Department of Cottage and Village Industries, and the Forestry Training Institutes in Pokhara and Hetauda. These efforts can also be effectively linked to the Integrated Rural Development Projects administered, with bilateral and multilateral assistance, by the Ministry of Local Development. Many of these projects have already realised the need to look into the question of rural energy supplies in order to supplement their development activities.

There are many possibilities for strengthening these institutions to support and provide better services to rural entrepreneurs, farmers, and local communities. Some specific suggestions are worth exploring.

- "Rural Energy Development Cells" may be created to plan and implement the energy component as a part of integrated development programmes. They would benefit from the assistance that the private extension agency can provide (as described above).

- Appropriate Technology Units of the ADB/N will be expanding their network of technology testing and demonstration. Emphasis should be given towards strengthening these ATUs to adopt the integrated approach as in Karma Singh *Phant* where SFDP groups and private entrepreneurs cooperated together in establishing the "Irrigation and Rural Energy Development Model" (see Fig. 2).

- Schools and colleges have been effective in demonstrating the importance of increased energy input for enhancing rural development. Regional training centres could be playing a valuable role in assisting them by providing training and relevant information. Concurrently, emphasis should be placed on designing special curricula and conducting regular training courses for farmers and village entrepreneurs on the operation and maintenance of energy technologies.

- Forestry training institutes in particular can be instrumental in developing agroforestry schemes and encouraging private farm forestry. Training and other technical support could be easily provided by them. Financing support from credit agencies could be linked to these activities. Integration of horticultural crops could also be integrated into the scheme to generate sustained income for rural residents.

Strengthening District and Grassroot Organisations

The Decentralisation Act of 1982 is an encouraging step towards strengthening district and grassroot organisations. Village and district development plans can now be formulated through the participation of rural residents. Under the Decentralisation Act, sectoral plans are prepared by concerned agencies on the basis of projects identified by Ward Assemblies and recommended by Village Assemblies. These plans are subsequently discussed and approved by the Sectoral Plan Formulation Committee as a part of the process for drafting the District Plan under the aegis of the District Secretariat. The Draft Plan is then reviewed by the District Assembly and eventually submitted to line ministries and the National Planning Commission for inclusion in the National Plan. Currently, there are five Sectoral Plan Formulation Committees, none of which deals

directly with energy. Not surprisingly, rural energy development is usually not incorporated as a priority item. Considering the importance of energy for rural development, it is worthwhile considering the energy component. The following institutional mechanism is suggested with the objective of enhancing local capabilities to plan and implement rural energy programmes.

- Strengthening the organisation of farmers, artisans, and entrepreneurs is vital for carrying out rural energy programmes. Mechanisms for developing local cooperation need to be encouraged. To this effect, the efforts of the Small Farmers' Development Programme (SFDP), the programme on Production Credit for Rural Women (PCRW), and other non-formal organisations might be consolidated to deliver services and provide support mechanisms for initiating rural energy programmes. Ongoing government programmes might consider the provision of catalytic agents for training local development agents from among the rural communities. A deliberate effort should be made to identify informal organisations that are actively engaged in cooperative activities in the community. Many organisations of this kind have been functioning effectively with self-made rules for proper management and control. They have demonstrated the capability to mobilise their own local resources and skills without external assistance. With the emergence of government-sponsored organisations, the traditional ones are gradually disappearing. Recognition of their existence might facilitate the identification of effective ways to mobilise the local participation of the villagers.

- Rural energy programmes will not get any prominence unless they are integrated with the District Development Plan. A separate Sectoral Plan Formulation Committee on energy is not necessarily an important consideration. What would be important is to establish a District Coordination Committee for Energy Planning and Management. The responsibility of this committee would be to study the five sectoral plans and assess how the energy components could be integrated into each sector. From this perspective, it would be essential to provide proper orientation and training to district officers on the technical, economic, and management aspects of rural energy systems and on how the identification and selection of technology systems could contribute to achieving district development goals. For example, a joint institutional arrangement can be initiated with the District Forest Controller's office and the Agricultural Development Bank to provide technical and credit support for developing private farm forestry or agroforestry schemes on a commercial basis. Similarly, financial and training support may be provided to rural entrepreneurs to set up a demonstration centre with a special focus on decentralised energy production, maintenance, and repair.

VI

CONCLUSIONS

The implementation aspects of rural energy planning described in this paper are based on observations from one of the least developed countries in the world. Some of the conclusions that can be drawn from the Nepalese experience would be applicable to other developing countries. Others are specific to the country and are of varying importance to other countries. A case in point is the emphasis on decentralised renewable energy technologies. This is necessitated partly by the opportunities and constraints presented by the mountain terrain and partly by the predominance of the subsistence agricultural economy. We have already noted that fuelwood, agricultural residue, and animal dung cake constitute 96 per cent of the total energy consumed. Substitution by imported petroleum products in the context of poverty is unfeasible. The mountain terrain, however, provides ample opportunities for hydropower development, although the current capacity is very low indeed. Many of the communities are scattered and not easily accessible. These peculiarities require special considerations in programme implementation. We do not expect all the points to be directly applicable to other countries. In some countries, we foresee that commercial energy planning could play a more important role than that described in this paper. The important lesson, however, is that each country needs to understand its own peculiar characteristics to which the criteria of implementation have to respond. Although some of the basic principles might be similar, the emphasis will invariably differ. The following conclusions will therefore have to be seen in that light.

- A widespread recognition exists that energy programmes have a great deal to contribute to the development of rural areas. What is lacking is the concerted effort to put the recognition into actual practice. The investment of resources and manpower is very low and that too is dispersed in many sectors among different line agencies. Consequently, the impact of rural energy programmes is not of much significance. This characteristic would be common to most developing countries. In order to overcome this particular problem, we have advocated the establishment of a "Ministry of Energy" for the planning and implementation of energy-specific activities, traditional as well as commercial, in coordination with other line agencies. Attempts along this line have recently been initiated in some countries, e.g., India, Indonesia, Thailand, and others. The effort deserves very serious attention if rural energy activities are to be coordinated and consolidated and thereby make the desired contribution.

- There are many examples of success in the implementation of rural energy programmes. Success is evident when the energy programme is compatible with the development objectives aspired to by the users in the specific context of their socioeconomic conditions. Furthermore, decision-making and control have to rest ultimately on the users if the success is to be sustainable. We have shown that external sponsorship has really not been effective. Participatory village development approaches and private sector initiatives have, on the other hand, performed admirably. External resources are indeed brought in and used. The difference is that the users become active participants in the dialogue with technologists, bankers, and other external resource people when decisions are made. This has to be accepted as a fundamental principle in the implementation of rural energy programmes, not only in Nepal but also in other developing countries.

- Rural energy programmes have different components of varying scale. Cooking-stoves have to be distributed to households; micro-hydro turbines for milling may be operated by individual entrepreneurs or a group of partners; lift irrigation schemes using small hydropower plants involve the whole community of affected farmers; petroleum products can be distributed only through selected depots in market centres. Technological dissemination, therefore, needs to take into account the varying organisational and managerial requirements. The implication is that the implementing agency has to adopt a flexible and negotiative stance. This has general validity in all the countries.

- Rural energy programmes that are oriented specifically to supplying cooking or lighting requirements are only of secondary relevance. This is true in spite of the supposed fuel crisis in Nepal caused by deforestation. This is equally true in the case of mini-hydropower schemes that are installed with the primary purpose of lighting district headquarters in the country. A greater relevance is apparent, as in the case of Karma Singh *Phant*, where the water pump provides lighting but, more importantly, the milling services and water for irrigation for agricultural production. Given the subsistence nature of the economy in rural areas, opportunities for income enhancement or greater productivity through energy use are of greater importance.

- Following from the above point, it is important to note that energy programmes have to be seen only as one input in the development effort and, therefore, has to be integrated with other inputs. Examples include: the requirement of effective credit and extension schemes; compatibility with development priorities in the eyes of local people as well as concerned agencies; the enhancement of local people's ability to adopt and pay for new ventures; reliability in the supply of materials and technologies; and the capability of manufacturers to deliver appropriate technologies and required services. Unless there is a convergence of efforts by all related actors (local people as well as those from outside the rural area), the success of the programme cannot be sustained.

- Because of the cross-cutting nature of energy with respect to sectoral activities, a different managerial style is required. One model that has been described is that of the Small Farmers' Development Programme of the Agricultural Development Bank of Nepal. The principal idea here is that the Group Organiser acts as the catalyst in initiating rural energy activities and organising people in the process of adoption. External resources are channelled in through the credit scheme. Encouragements to involve the private sector (such as turbine manufacturers or the Biogas Company) are prominent in the scheme. Attempts are made to train local people in the operation and maintenance of technologies. Where possible, the capability of local artisans is upgraded to provide repair and maintenance services. When major problems are encountered, local people are aware of where to go and whom to contact. This model with appropriate variations holds a great deal of promise and deserves further strengthening, especially for implementation at the village level. Coordination is, however, needed at the policy level so that the private sector gets adequate incentives. A national agency such as a Ministry of Energy can then focus more on quality control and the monitoring of activities by the private sector. At the same time, the Ministry might direct research institutions to develop relevant technologies, design training programmes, and work closely with manufacturers and the ultimate end users.

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