

# COMMUNITY PARTICIPATION AND ENVIRONMENTAL PROTECTION IN THE CONSTRUCTION OF MOUNTAIN ROADS: PROMOTION OF THE “GREEN ROAD” APPROACH IN NEPAL

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## ABSTRACT

*Considering the serious shortcomings of the conventional techniques, a new approach for the construction of rural roads has been developed in Nepal. This new “green road” approach is environment friendly, participatory in nature, and uses labour based technologies. The approach is based on the recognition that there are many stakeholders in the promotion of rural roads. Each of them is in a position to contribute to road construction in a unique way. While government and parastatals as well as people’s organizations may contribute in terms of planning, designing, financing, and management of the road, people at large would contribute through the sharing of indigenous knowledge in terms of local geology as well as by participation in the actual construction activities. Road construction is not seen as a one-time wage earning opportunity but also as a starting ground for self-help activities. The actual construction technique follows the philosophy of minimum disruption to existing vegetative cover and re-utilization of the excavated materials as construction material. Decentralized implementation, employment of local people, local ownership of the road and maintenance obligations, all contribute to the promotion of local capacity-building and self-help efforts. The economics of green road construction is highly favourable in terms of employment generation and utilization of local resources.*

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## INTRODUCTION

Nepal is a mountainous country with an estimated population of 22 million people in 1999, and a total area of 147,000 square kilometres. The mountains are generally rugged and the land feature rises as it goes towards the north to the main Himalayan range. Physiographically the country can be classified into three broad belts. Ranging between 4,880 to 8,848 metres above sea level, are mountains with 35 per cent of the land area and about 7 per cent of the population. Hills between the altitude of 610 to 4,880 metres above sea level have 42 per cent of the land area and 46 per cent of the population. The “Tarai” Gangetic plains with 23 per cent of the land area accommodate 46 per cent of the total population of the country. There is a great diversity in climate, vegetation, farming practices, culture and religion, and the living habits of its people. Up to about 35 years ago forests covered almost 46 per cent of the country but this has declined to about 30 per cent in recent times. The ever-increasing population and the resulting demand for agricultural land is one of the major reasons for forest clearing. The decline of forest cover has serious environmental implications in the mountains and the hills. The rising incidence of land slides in the hills and mountains and floods in the low lying areas are generally associated with the decline in the forest cover.

The population is growing at a rapid rate of about 2.3 per cent a year at present. The dominant trend during the last few decades is that of rapid urbanization as well as migration towards the southern plains. The general level of development measured by gross domestic product (GDP) per capita is less than US\$ 250, which is one of the lowest in the world. The real GDP grew at a rate of less than 3.5 per cent a year during the past 10 years (CBS 1999). The incidence of poverty is extensive. Depending upon different methods used in estimation, the number of people below the poverty line ranges from about 42 per cent to more than 70 per cent of the total population (Kievelitz and others 1998). The incidence of poverty is higher in the rural areas.

Nepal has 13,400 kilometres of roads. Of these 4,186 are black topped, 3,528 are gravelled and 5,686 are fair weather roads. The road network still does not connect the headquarters of 18 out of 75 districts of the country. The country has a road density of roughly 9 kilometres per 100 square kilometres. Poor accessibility not only restricts the movement of people and goods but also of ideas and technologies. This is realized at the policy level as well and there is now emphasis on the

construction of agricultural roads, particularly in the hills and the mountains. The Agriculture Perspective Plan, 1995, estimated that about 6,200 kilometres of rural road need to be constructed within the next 20 years to provide impetus for agriculture led growth (APPROSC and JMA 1995). Of these 1,950 kilometres is to be in the hills and 850 kilometres in the mountains. The Plan estimated that an investment to the tune of US\$ 251 million is required to construct these roads. Given the current level of investment in rural roads, this figure represents a quantum jump.

## **I. CONSTRUCTING ROADS IN THE MOUNTAINS**

The construction of roads in the mountains is a difficult and costly task. The cost is not only financial but also environmental. Building roads in a conventional manner with the use of heavy equipment leads to severe environmental degradation that takes decades for re-stabilization. The Himalayan environment is extremely hostile to road building (Ramsay 1986). This is because of intensive fractures of rock masses, thrust, faults and a number of major discontinuities. The common resulting effects are landslides and slope failures across the whole Himalayan range (Kanungo and others 1993). Additional human activities in the fragile mountain region further degrades the whole ecosystem.

The mass movement and debris flow is another important consideration. An enormous amount of debris flow was observed in the Indian Himalayan highways. This was caused by unsatisfactory road alignment and poor design (Ives and Messerli 1990). It was estimated that in the Indian Himalayas each kilometre of road required the removal of 40,000 to 80,000 cubic metres of debris (Validya 1985, 1987). Similarly, the instability of the road slope after construction produced 550 cubic metres per kilometre of debris a year. Slope instability should be widely recognized as an ever-present danger. Interference on the unstable slope could create problems such as landslides, slips, slumps, mudflows and rockfalls.

Because of the reasons mentioned above, road construction and other development activities can easily create serious environmental hazards. The design of mountain roads is thus a costly and complex task. Geotechnical and hydrological investigations are required before road alignment is decided. These are expensive activities that require skilled manpower. There are instances of massive expenses incurred in

road rehabilitation due to a poor understanding of geomorphology prior to the construction of roads (Deoja 1991). Mountain road failures in Nepal from 1979 to 1993 are estimated to have resulted in a loss of more than 2.5 billion Nepalese rupees (Deoja 1993).

The time taken to complete mountain roads is also fairly long. It is estimated that in Nepal construction of 50 to 60 kilometres of hill/mountain road takes six to eight years. The cost of road construction by the Department of Roads (1998) is estimated to be between 5 million to 8 million rupees per kilometre. If such costly roads have to be rehabilitated again because of slope failures or mass movements then for poor countries such as Nepal having a network of roads in the mountains and the hills becomes only a distant dream. While there is indeed a need to take all precautionary measures from the very inception of a plan, there is also a need to take an alternative approach to road construction in such an environment. The alternative approach should be based on the principle of minimum damage to the environment, should utilize labour based technology and be affordable. The Swiss Agency for Development and Cooperation (SDC) and the German Technical Cooperation (GTZ) have supported rural road construction in Nepal during the last decade and a half that embodies these principles. Many useful lessons have been learned in this process. These lessons, which will be discussed in the following sections, need to be incorporated in assessing an appropriate approach to road construction in Nepal.

## **II. SEARCH FOR AN ALTERNATIVE APPROACH**

The search for an alternative approach to road construction in Nepal began with the realization that the traditional approach was too skill and cost intensive. The traditional technology relied heavily on machines doing most of the work. This required heavy investment in machinery while most of the people to be served by the road remained idle for want of work. The extensiveness of rural poverty further implied that the technology which was not based on the heavy use of labour was unlikely to provide any income and employment opportunities to those who were in most need of it. Further, given the level of economic activity and volume of transaction in the rural areas, costly structural works were not justified. Therefore, the challenge was to identify a road construction approach that was less costly, labour based, and did not contribute to environmental degradation. A first step toward a new

approach was made in 1985, in Palpa district, under the support of SDC and GTZ, when a local road improvement programme was included as a part of a rural development programme. An important and far-reaching decision was made to look at road construction activities as a part of rural development activity with a set of goals to achieve. Prior to this shift, road construction was always seen in isolation even though the purported objective of road construction was to promote development. The new approach recognized the following:

- The road construction should contribute to poverty alleviation
- The road should provide income and employment opportunities to the rural people
- The road should not cause any damage to the environment

Over a period of time more experience was gained regarding local road building in Dhading, Gorkha and Lamjung under GTZ support. These experiences were in the areas of community participation, financing, technical support, management and provision for the operation and maintenance of the completed road. All of these taken together formed a new road construction and management approach that was termed the “Green Road Concept”. A green road is one which is environmentally sound, built using participatory labour based methods, affordable (i.e., low-cost), and technically appropriate. Its goal is to conserve the delicate mountain ecology and in particular protect and further strengthen vegetation as means to prevent excessive soil erosion. As green road construction is labour-based, the local rural population draws direct short-term benefits from the approach through off-farm employment generation. In the mid-term, the improved motorable access to remote areas provides better public and private services as well as reduces the transport costs, which stimulates the rural economy significantly and creates new income-generating opportunities (GTZ and SDC 1999). Thus, while the road/trails are the physical output, the capacity-building of local organizations, promotion of community organizations, promotion of the self-help potential of rural people and enhancement of the skills of the local population are other very important outputs. The green road concept, therefore, goes beyond the creation of infrastructure and encompasses the very fundamentals of the GTZ strategy of support to rural development in Nepal which promotes the organization of the poor, the capacity-building of local

organizations and the promotion of alternative income-generating opportunities.

### **III. DECENTRALIZED PLANNING, IMPLEMENTATION AND COMMUNITY PARTICIPATION IN THE GREEN ROAD**

The construction of rural roads using the green road concept requires some sequential activities and planning steps. The first and foremost is the preparation of a district transport master plan. This is an important activity that needs to be taken up in order to prioritize the demand for rural roads. In fixing the priority two main aspects are to be considered. First, the rural road has to be in the overall context of national and district development plans. This would ensure that the infrastructure development does not go in an independent direction and investment made on it will not be wasted for want of complementary investments. Roads alone will not bring in all the expected benefits if complementary investments that exploit the comparative advantage of the area opened by the road do not take place. Second, the master plan has to be endorsed by the District Development Committee which means of the district development authorities must be willing to share responsibilities for the road construction. Since a district development committee plan is required to be endorsed by its District Assembly, it implies acceptance of the road as a district priority by the representatives of the Village Development Committees although the road alignment may not pass through all of their villages. Since, in the Nepalese context, having a road in a village is almost a universal need, the agreement on a district transport master plan not only removes potential friction within the district polity but also ensures continuity of funding for a number of years in the future. Four key actors are involved in the process of preparing a master plan. First, the District Road Coordination Committee, the legislative body of the District Development Committee composed of district development committee executives and representatives of political parties, has the final decision making power with regard to the master plan. Second, an executive body of the District Development Committee composed of representatives of different line agency officials of the central government and the civil servants within the District Development Committee is assigned the responsibility of planning different alternatives to be provided to the District Road Coordination Committee. This executive body has an advisory role. Third, a judicial body of the District Development Committee is charged

with the responsibility of lawful planning and implementation and resolution of conflicts when the situation demands. They could ask support from the district administration if it is so required. Conflict resolution is done out of the judicial process in a court of law. Fourth, the District Road Transport Unit is the implementation unit composed of district development committee engineer, overseers, and sub-overseers. They carry out the preparation of plans. Thus, the preparation of the district transport master plan is a participatory process that leads to consensus in the end.

The participation of the community at each stage is fundamental to the green road approach. The community participates in different forms. At a macro level the community participation is ensured through consultative meetings during the preparation of road/trail alignment. The discussion at the District Assembly is another form of community participation as this body is composed of representatives at the district and village levels. The preparation of a master plan follows a participatory process. Once the master plan is formalized then the next level of participatory consultation begins at the micro level or at village development committee levels. The role of different actors and interest groups are formalized at this level. Since the green road concept does not (at least in theory) provide for the use of contractors, the first step is to socially mobilize people to do the construction of the road. This is usually done through a non-governmental organization (NGO). The NGO follows an approach of self-help promotion in mobilizing people. This means creating a formalized community-based organization that promotes self-help activities such as group based savings and credit operations, promotion of non-traditional farming practices, promotion of off-farm income opportunities, awareness creation about ostentatious consumption practices and encouragement to curtail them, and promotion of healthy community living practices.

Road management committees of different hierarchical level (main committee, subcommittees) comprising representative members of Village Development Committees, coordination committees when necessary, and road user committees composed of user representatives are formed. These committees formulate management policy and assign responsibilities to the different groups. The formation of these committees and the assignment of responsibilities to different grass-roots organizations are done in recognition of the fact that different stakeholders have different vested interests in seeing that the road is

constructed as planned and desired. Therefore, these committees not only facilitate construction but also perform a check and balance function. The Village Development Committees also share some of the financial costs of road construction. The users also share part of the cost either through foregoing a percentage of their wage (for those engaged as labour, it is a direct contribution) or through the paying of road users charges (indirect contribution). The land for the road is usually provided free of cost. But if there are problems it is taken care of by local committees themselves. As the increased access leads to an appreciation in the land prices usually people are not reluctant to provide land for road construction.

Once the planning and management steps are agreed upon then a broader community involvement and participation are sought for the actual construction of the road. The people willing to work as labourers are organized into groups through the partner NGO involved in social mobilization. These groups could be male or female or mixed. But children are not allowed as road workers. These labour groups are given flexible working hours. This is done in order to ensure that the labour time for road construction does not compete with that for agriculture. Payment is according to the volume of work done by each labour group. Another important point to note here is that this approach to a large extent automatically targets the poor. Community participation is also crucial in the maintenance of the green road. To begin with, the green roads are constructed in a manner that minimizes maintenance needs. However, minimum maintenance is always necessary. The responsibility of maintenance in most cases falls with the user committees. Since these committees are composed of local people they mobilize communities for maintenance work. Basically two approaches are used in mobilization. The routine maintenance is done through paid labour groups led by a local supervisor. When a road reopens after the monsoon, paid groups as well as voluntary labour is used to maintain the road. Voluntary labour is sought from the local populace.

The construction of green road requires support in two major areas: technical and social mobilization. Box 1 lists the type of activities required under each support. Not all of this support needs to be provided externally. The district technical team or the NGO partner in social mobilization would be doing most of the activities listed on their own.

**Box 1. Type of technical and social mobilization support required**

<i>Technical support</i>	<i>Social mobilization support</i>
<ul style="list-style-type: none"> <li><input type="checkbox"/> Preparation of a district transport master plan</li> <li><input type="checkbox"/> Road alignment selection</li> <li><input type="checkbox"/> Surveying, design and report preparation</li> <li><input type="checkbox"/> Training materials</li> <li><input type="checkbox"/> Input to district decision-making</li> <li><input type="checkbox"/> Training to <i>Naikes</i> (foreman), labour groups, masons, supervisors, user committee members etc.</li> <li><input type="checkbox"/> Arranging local supply and services</li> <li><input type="checkbox"/> Construction supervision</li> <li><input type="checkbox"/> Site office and store management</li> <li><input type="checkbox"/> Work measurement, valuation and certification for labour payment</li> <li><input type="checkbox"/> Quality certification</li> <li><input type="checkbox"/> Progress monitoring and reporting</li> <li><input type="checkbox"/> Preventive maintenance</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Initiating dialogues and meetings</li> <li><input type="checkbox"/> Playing a catalytic role in maintaining political balance and bringing consensus in decision-making</li> <li><input type="checkbox"/> Communicating with politicians, the user committee and the general population</li> <li><input type="checkbox"/> Training</li> <li><input type="checkbox"/> Assistance to the User Committee to mobilize local people</li> <li><input type="checkbox"/> Assistance to the User Committee to ensure the social welfare of the labours</li> <li><input type="checkbox"/> Helping to make decisions and other aspects of programme management</li> <li><input type="checkbox"/> Witnessing labour payment work</li> <li><input type="checkbox"/> Helping labour groups generate group savings and undertake revolving income-generating activities</li> <li><input type="checkbox"/> Providing secretarial assistance to UC</li> </ul>

*Source:* German Technical Cooperation (GTZ) and Swiss Agency for Development and Cooperation (SDC), 1999, *Green Roads in Nepal* (Kathmandu, Nepal).

**IV. ENVIRONMENT FRIENDLY CONSTRUCTION TECHNOLOGY AND METHODS**

A “green road” is a fair weather rural road constructed for low volume traffic. The basic consideration in the green road technology is that of the preservation of nature while the road is constructed and operated. As described earlier this can happen only when the technology of construction does not go against the natural forces operating in the

Himalayan mountains. Thus avoiding faulty geological formations, maintaining of mass balance within a small cross-section and moving along the natural slope are three basic principles behind the road design. The concept utilizes local knowledge and experience to understand geomorphological features. This helps in avoiding costly surveys but at the same time ensures the avoidance of landslide prone areas in the road alignment.

The selection of the optimum alignment is the first important step designed to minimize the damage to the natural environment as well as to reduce future maintenance costs. After the deciding on road alignment, a detailed survey, design, cost estimation and preparation of the report are done. The report includes the identification of training required, the preparation of all necessary training materials, forms, formats etc.

A typical design should include:

- Longitudinal profile
- Horizontal plan using topographical maps
- Cross sections at a fairly small interval
- Detailed cross-section at critical areas particularly at switchbacks
- Structural work such as retaining walls, water management structures
- Estimate of volume of works and costs, labour requirement – skilled, unskilled
- Quantity of material to be procured from outside and cost estimate
- Quantity of tools and equipment to be procured from outside (wheelbarrows, shovels, crowbars).

The road standards incorporate following features:

- Avoid unnecessary road width to reduce volume of excavation
- Allow natural road surface run-off by allowing 5 per cent outward slope

- ❑ Drainage only when necessary along the mountain side
- ❑ Avoid steep longitudinal gradient, maintain average gradient of 7 per cent
- ❑ Provide water management structure whenever necessary.

Environmental considerations are of prime importance. Thus the construction practice does not allow for cut and throw, nor does it allow for massive cutting at one stretch. Rock blasting is not allowed. The equipment used is wheelbarrow, chisel and hammer. In general, this technology encompasses the following aspects:

*Minimal slope cutting and preservation of the vegetative cover.* This is attained by restricting on uncontrolled disposal of excavated materials down the hill. Whatever material is extracted is reused for filling (cut and fill). Toe walls are created to withhold the excess materials. Bush clearing is done up to the formation and not beyond it. If trees are on the alignment they are not cut till the road is operational. Planting materials that are suitable for vegetative cover are collected for bioengineering.

*Mass balancing.* It is the most important consideration and is done through the controlled cut and fill method. Mass balance within a fairly small cross-section is to be done. This will ensure that the cut materials are used for fill on the valley side and not thrown down the slope. Thus the excavated materials are reused as construction material.

*Bioengineering.* Bioengineering is done to stabilize the slope and reduce soil erosion. It is an important part of green road construction and is a preventive measure. The environment is thus preserved even while the road is being constructed.

*Proper water management.* Where possible the natural slope is used to disperse water towards the valley in a controlled manner. Generally a 5 per cent outward slope is provided. In cases where water needs to be collected by the mountain side, drains are provided to remove water as soon as possible.

*Construction in a phased manner.* In the beginning a track of 1 to 1.5 metre width is opened. Then gradually the track is opened to the requisite level by cutting on the hillside and filling on the valley side. Actual road construction is started after the natural compaction of

the track over one monsoon. After the road is constructed bioengineering is done to maintain vegetative cover along the road.

*Training.* Proper training at different levels is provided. Different types of training are required for different stakeholders. Management related, supervision related, accounting related and construction related training is provided prior to the construction of a green road.

*Labour based construction method.* The construction is done during the slack agricultural season, usually during October to May. Local people work on the green road. Thus it brings employment opportunities to those who would otherwise migrate to the southern plains or to India in search of work.

*Ordinary tools and equipment.* Mostly hammer and chisel are used to break rock. Heating or drilling is also done if necessary in breaking rocks. Blasting is not allowed as it causes unnecessary damage to the surrounding environment.

No heavy equipment is used to construct a green road. Material is usually transported by wheelbarrow. When necessary tractors with trailers are, however, used to transport stones or sand over longer distances. As local materials are used as far as possible the transportation of construction materials over a long distance is not required.

**Box 2. The green road: its salient features**

- It is a fair weather road open to traffic for nine months of the year
- The road is closed during the monsoon and repair work is done during this time
- It is a single lane road with a bypass every 200 metres
- Labour costs account for about 65 per cent of the total construction cost
- The participation of politicians, users, the community at large and technicians is essential
- Heavy equipment is not used, rock blasting is not permitted
- The cut and fill method is used to construct road. In the beginning a track of 1 to 1.5 metres is opened. It is then gradually expanded to the requisite width

## V. INSTITUTIONAL ARRANGEMENTS

Innovative institutional arrangements are required in constructing green roads. Regular government machinery, particularly the Roads Department, does not seem to be the appropriate institution to implement green roads. There are two major reason for this. First, the Roads Department works under a different norm than that required for green roads. If the usual departmental norms are applied then the cost (of the green road) will increase significantly. Second, a decentralized approach with the involvement of different stakeholders is required to implement the green road. The Roads Department does not follow this approach. It rather follows a system with a chain of command within the Department. Therefore, it will find the coordination needs rather taxing. The Nepalese Government has decided to create a separate department, namely, the Department of Local Infrastructure Development and Agricultural Roads to implement district level roads (HMIS News 1999). This does not necessarily mean that the district level roads will follow the green roads principle. There is already confusion as to where this department will be housed, with the Ministry of Local Development or the Ministry of Works and Transport.

The institutional structure and involvement of different institutions have changed over time as more experience was gained during the building of green roads. To begin with, in Palpa district the green road was basically implemented through technical consultants. When the green road was implemented in Dhading district the implementation modalities underwent a radical change. The District Development Committee (then District Panchayat) was the responsible institution to mobilize people to work on the road, supervise them, keep the muster roll, make payments to the labourers, manage equipment, and supervise work quality. In other words, apart from technical support which was provided by the GTZ Project Support Unit and later on by private consultants, the district and village level political bodies took all the responsibility of managing the construction work. This was an indication that if given responsibility, the local level institutions were able to meet the challenges. When the green road was implemented in Gorkha district a NGO was responsible for social mobilization and GTZ provided financial resources as well as technical support. In order to speed up, the work was initiated at multiple places along the alignment.

An emerging innovative approach in the road construction programme is the provision of financial assistance through different

sources into a single basket being carried out on a cost-sharing basis. This approach has been introduced in the three green roads being constructed in Lamjung district. The Village Development Committees, District Development Committee and the users are pulling their resources together. They are bearing the responsibility of the construction and maintenance of the roads. The Rural Development Through Self-help Promotion Project (RDSPL/GTZ) provides technical support through local private consultants and social mobilization support through a local NGO.

The resources for the road construction in Lamjung district are collected in a single basket. The different sources contributing to the basket are as follows:

- The Village Development Committees provide funds out of their development grant
- The District Development Committee provides some financial assistance
- The government provides financial assistance through the Ministry of Local Development
- Five days equivalent voluntary labour per household is provided from each and every household located in the influence area of the road
- The RDSPL/GTZ is providing technical support

The Village Development Committees and the District Development Committees have further pledged certain fixed annual amounts of money for maintenance and the beneficiary households will provide one day's voluntary labour per household.

## **VI. THE ECONOMICS OF GREEN ROADS**

One of the major considerations in the green road concept is cost. The construction of roads in the mountains following conventional technology is very costly. The cost of roads constructed by the Department of Roads ranges between 5 million to 8 million rupees per kilometre (ICIMOD 1997). While these are better standard roads, the district level roads constructed by the Department are thought to be in the vicinity of 3 million rupees per kilometre (ICIMOD 1997). However, no officially accepted data are available up to now.

Obviously there are many factors that influence costs. The geological features along the alignment and the number of bridges and structures affect cost estimations very much. Similarly, the choice of construction technology and methods also influence costs. The cost of construction of a single-lane fair weather green road is provided in Box 3.

<b>Box 3. Cost of construction of green road</b>			
<i>Particulars</i>	<i>Construction cost (percentage)</i>	<i>Construction cost</i>	
		<i>Rs. per km</i>	<i>US\$ per km</i>
Labour costs	65	780 000	12 000
Construction material	15	180 000	2 770
Tools and equipment and transport costs	10	120 000	1 850
Construction supervision, social mobilization and overhead	10	120 000	1 850
Construction cost	100	1 200 000	18 470

It is estimated that a labour input of 12,000 person day per kilometre is required to construct a green road. Payment to labour accounts for about 65 per cent of the total cost per kilometre. What is even more important to emphasize here is the fact that the labourers are locals who would have temporarily migrated elsewhere in search of jobs had the green road programme not provided an employment opportunity at their doorstep. The significance of having a job at a place close by goes beyond the mere earning of a wage. They would not incur extra food and lodging costs and would be able to save more. About 60 per cent of the households from which at least one member worked on the road reported a cash income in excess of 10,000 rupees for that year (IMU 1998). In a rural setting this is a significant figure. Additionally, these earnings were used by the households to meet the basic need expenses. Most of the labourers spent their earnings from the road programme in meeting the households' food and other basic needs. The impact on consumption patterns was primarily reflected in four major areas of cereal consumption, increase in protein intake, increase in health related expenditure, and increase in educational expenditure for the children (IMU 1998). This contrasts with the

expenditure pattern of wages earned by road labourers who follow a traditional contractor based construction method. A sizable portion of the wage in these cases is generally used for gambling and alcohol consumption. About 30 per cent of the households reported savings due to an opportunity to work as labourers on the road. In all 35 per cent of the households that participated in the construction programme reported paying an outstanding loan partially or fully either by savings out of the wage earned or by borrowing from their group saving fund (IMU 1998). Thus, employment in road construction and income derived from it had a far-reaching poverty alleviation effect.

The construction cost of 1.2 million rupees excludes training costs at the local level. But they are usually not very high. It is estimated that 5 per cent of the total cost per kilometre will be sufficient to provide different types of training and observation visits.

Regular maintenance of green roads is of crucial importance. As these are fair weather roads the maintenance needs are felt after being used for almost nine months at a stretch. Based on data from Palpa district roads, it is estimated that 187 person-days per kilometre per year is required to maintain the green road. Consequently, the annual maintenance costs required to keep the road in good condition was found to be between 1-2 per cent of the total cost, which matches with international standards (GTZ and SDC 1999).

The economic benefits of green roads have not yet been empirically calculated. However, there are proxy measures that indicate benefits. An estimate that uses methodology from the Department of Roads in their estimation of the Priority Investment Plan comes out with a figure of Rs. 1,297,000/km/yr. as the economic benefit of a green road (GTZ and SDC 1999). The road is assumed to have a lifetime of 20 years. The benefit is estimated in terms of savings in transport cost and producer surplus defined as net value of increased production as a result of increased accessibility.

## **VII. CONCLUSION**

The green road is a fair weather road open to traffic for nine months of a year. The road is closed during the monsoon and repair works are done during this time. These are single-lane roads with a bypass every 200 metres. Labour costs account for about 65 per cent of the total construction cost. The participation of politicians, users, the

community at large and technicians is essential. Heavy equipment is not used and rock blasting is not permitted. The cut and fill method is used to construct the road. In the beginning a track of 1 to 1.5 metres is opened. It is then gradually expanded to the requisite width.

Constructing rural roads following the green road approach offers several benefits over the traditional road construction approach. First and foremost, it is affordable as the construction technique uses local material and people to construct the road. It is participatory as different stakeholders are actively engaged from planning to operation and maintenance of the road. Since it uses local labour it has a immense potential for poverty alleviation. Environmental protection is a key aspect of the green road. It is thus an approach which is suitable for the construction of rural roads in a participatory manner and at low cost.

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