DESIGN OF RURAL TRANSPORT INFRASTRUCTURE

J. Lebo and D. Schelling, World Bank (2001)

Objectives of the paper

Abstract

The majority of Rural Transport Infrastructure (RTI) in developing countries carries traffic of less than 50 motorized four-wheeled vehicles per day (VPD), but often a substantial number of intermediate means of transport, such as bicycles and animal-drawn carts. In most cases, the appropriate standard for these are single-lane, spot-improved earth or gravel roads provided with low-cost drainage structures, such as fords and submersible single-lane bridges. The (trouble) spot improvement approach is the key to the least-cost design. Cost savings of 50 to 90% can be achieved compared with fully engineered roads of equal standard throughout.

Labor-based approaches are best-suited for the implementation of RTI interventions. By transferring financial resources and skills to the local level, labor-based strategies can have a substantial poverty- reducing impact. They also have the potential to improve the gender distribution of income, providing employment opportunities for women where wage-employment is scarce.

Key issues

- An emphasis on reliable, cost-effective access to as many of the rural population as possible, rather than high access standards for a few;
- Appropriate design standards need to balance the transport requirements of core economic and social activities with the impact of geography (geology, topography and climate) on construction and maintenance costs;
- Cost-effective and innovative techniques such as spot improvement, labor-based approaches, and low-cost structures, and;
- RTI projects implementation using labor-based approaches, with strong local community involvement, contribute to poverty alleviation.

1. INTRODUCTION

Three billion people in developing countries, or about two-thirds of their population, live in rural areas. The majority of them survive on less than two dollars a day, and about 1.2 billion live on less than a dollar a day.[1] Their lives, are characterized by isolation, exclusion, and unreliable access to even the most basic economic opportunities and social services. For the majority of their transport needs, they rely on non-motorized means and on rugged paths, tracks and roads, which are typically in poor condition and often only passable in dry weather.

For purposes of this paper, rural roads, tracks, paths and footbridges are referred to as rural transport infrastructure (RTI). The RTI network in developing countries consists of an estimated 5-6 million kilometers of designated[2] rural roads and an additional expansive network of undesignated roads, tracks, and paths. While the length of the undesignated network is unknown, it is estimated to be several times the extent of the designated network (Malmberg Calvo, 1998). The vast majority of trips that take place over RTI (more than 80 percent) are short distances (less than five kilometers) and made by non-motorized means, including walking, animals, bicycle, and porterage.

This paper focuses on the appropriate design of rural transport infrastructure. The task is especially urgent considering evidence that developing countries have often adopted excessively high standards of access, particularly when donor financing was involved. Given scarce resources, such higher than necessary standards of access to limited populations lead to costly long-term maintenance and the denial of access to under-served populations. Therefore, a basic access approach, whereby priority is given to the provision of reliable, least-cost, all-season basic access to as many people as possible, is promoted.

2. CONCEPTS AND DEFINITIONS

2.1 Basic Access Approach to RTI Investments

The RTI network is the lowest level of the physical transport chain that connects the rural population, and therefore the majority of the poor, to their farms, local markets, and social services, such as schools and health centers, potentially increasing their real income and improving their quality of life. A minimum level of service of the RTI network, referred to as *basic access*, is therefore one of the necessary building blocks of poverty reduction. In this context, the provision of basic access should be considered a basic human right, similar to the provision of basic health and basic education.[3]

1 Poverty net: http://www.worldbank.org/poverty/data/trends/index.htm.

2 “Designated” means formal government responsibility or ownership has been established.

3 In some countries, such as France, access is stated as a fundamental human right in the constitution.

Basic access infrastructure must ensure that the prevailing type of rural transport vehicles (motorized or non-motorized) can expect reliable access. Reasonable levels of delays at river crossings or temporary road closings during the rainy season must be tolerated, which in turn can reduce investment costs considerably. The maximum time allowed for temporary closures is both a political decision and an affordability issue.[4]

A basic access intervention is defined as the least-cost intervention (in terms of total life-cycle cost) for providing reliable, all-season passability by the prevailing means of transport. If affordable, this may mean all-season passability for a pick-up truck, a small bus, or a truck, even if these present only a small fraction of total traffic. However, it should be recognized that appropriate RTI is also required for the efficient and economical use of non-motorized (or intermediate) transport.[5]

2.2 What is Rural Transport Infrastructure (RTI)?

RTI is the rural road, track, and path network on which the rural population performs its transport activities, which includes walking, transport by non-motorized and motorized vehicles, and haulage and transport of people by animals. RTI includes the intra- and near-village transport network, as well as the infrastructure that provides access to higher levels of the road network. Following are the key features of RTI:

2.2.1 Physical Features

Community RTI consists mainly of tracks, paths and footbridges, and sometimes (partly) engineered roads. They should normally not exceed five kilometers in length to ensure that the community has the capacity to maintain it.[6]

2.2.2 Traffic Characteristics

Transport activities on RTI are performed to a large extent on foot, sometimes by intermediate means of transport (IMT), such as bicycles and animal drawn carts, and sometimes by using the services of motorized transport. Average daily motorized four-wheeled traffic on the majority of the RTI network is below 50 vehicles per day (VPD), while non-motorized traffic (NMT) can be a multiple of this number.

4 In India, the policy is that rural road closures should not exceed 12 hours per event and not more than 15 days per year in total. In most francophone African countries, the road agencies operate rain barriers on rural roads. Normally, the rule is that these barriers must be closed during heavy rains and at least four hours thereafter. In Nepal, due to the severity of the monsoon season and the high cost of permanent river crossings, most roads other than the national highways and urban roads are seasonal access roads that are closed for about three months during the monsoon season

5 As in the case of Bangladesh where non-motorized rickshaw-vans (for goods) and passenger rickshaws dominate traffic.

6 This will require a one-hour walk from the village to the most remote part of the community road and one hour back, which reduces the available effective work time for maintenance to six hours. However, in countries with a low population density, community RTI is often much longer than five km (which often means that roads are not affordable).

2.2.3 Ownership

By definition, RTI is the local access infrastructure that is normally owned by local governments and communities. Community RTI is usually undesignated, or not part of the formally recognized transport network. In the absence of a respective legal framework, community RTI belongs to communities. However, the capacity of communities to own and take care of RTI is limited usually to the intra- and near-village network and to short links to the main road network.[7]

2.2.4 Managing and Financing

Many different arrangements exist for managing and financing RTI (Malmberg Calvo, 1998). Financial resources available for RTI include transf ers from central government (from the Treasury, dedicated road funds, or through donor financing), which should be leveraged to generate local resources in cash or in kind. In most cases, financial resources are extremely scarce, particularly for maintenance.

3. DESIGNING RTI FOR BASIC ACCESS

The majority of RTI in developing countries carries traffic of less than 50 motorized four-wheeled vehicles per day (VPD), but often a substantial number of intermediate means of transport, such as bicycles and animal-drawn carts. In most cases, the appropriate standard for these are single-lane, spot-improved earth or gravel roads[8] provided with low-cost drainage structures, such as fords and submersible single-lane bridges.

The removal of surface water is crucial for the success of basic access RTI, since at this traffic level, the weather causes more damage than does the traffic (Robinson, R., et. al. 1998). This means that a good camber of 5 to 8%, adequate side drains, and carefully designed cross drainage structures are required. Stone or concrete drifts, or splashes, are acceptable as a substitute for culverts. Major river crossings can be designed to allow traffic passage at low flows, and be closed at high flows. In many situations, peak flows may only last for a short duration (less than three hours). However, where rivers can not to be crossed for long periods, high-level and relatively expensive crossings should be provided to achieve basic access standards. If these are not affordable, providing an all-season footbridge should be considered, to allow pedestrian and IMT crossings during the rainy season.

Although roughness and speed are not important design parameters for basic access RTI, there are certain limits of roughness that should not be exceeded to avoid damage to vehicles. Speeds should normally not exceed 30 km/h, taking into account the varied use of basic access roads, by people, non-motorized, and motorized traffic on

[7] Often projects "assign" responsibilities to communities (in the absence of local government capacity) which exceed their capacity in the long-run, or which are too complicated to manage (for example, links that provide access to several villages). This is often done instead of the necessary, but difficult, task of promoting capacity building at local government and community levels.

[8] In some cases, at steep hills or where suitable gravel material cannot be found (as in Bangladesh), paving may be the most economical solution.

the carriage way. The most important criterion for the infrastructure is to be able to withstand the elements and traffic without extensive damage.

3.1 The (Trouble) Spot Improvement Approach

The situation faced by the rural transport planner is a deteriorating network of roads, tracks, and paths, passable only in the dry season, with difficulty, and not at all in the rainy season. In these situations, the spot improvement approach, focusing interventions only on difficult sections, is an appropriate method to provide basic access at a lower cost.

Road failure is most likely to occur on steep hills, at water crossings, and in low-lying areas. Solutions include realignment, paving of steep sections, provision of simple but permanent water crossings, and raising low-lying areas on embankments. All interventions must be properly designed and engineered, but will only apply to a specific spot. In many situations, upgrading an existing track or earth road to basic access standard will only require interventions on 10% of the road length—greatly lowering the costs of providing all-season passability. The construction cost savings can be in the order of 50 to 90% when compared to full improvement.

On the other hand, Spot improvement interventions require considerable judgment on the part of the design engineer. The types of interventions will vary according to the terrain, weather, and vehicle types. It is essential to ensure that untreated sections have sufficient capacity for the prevailing conditions and transport types. If the in-situ soils are incapable of bearing traffic loads when soaked, then it may be necessary to provide camber and drainage throughout. If the soils are not of sufficient strength, even in this condition, then a gravel surface should be provided throughout. During the design process, each section must be carefully analyzed in order to find the least-cost solution. The spot improvement approach also applies to periodic maintenance, where in many situations spot re-groveling, instead of full groveling, is the right approach.

However, there is generally a great deal of resistance to spot improvement as a technical solution, especially in donor-financed interventions. A variety of constraints, such as political pressure and road agency and donor preference for high-standard, high-cost roads[9] need to be overcome. More recently, some donor-financed interventions, in close collaboration with the responsible road agencies, have successfully implemented projects based on the spot improvement approach.

In addition to the above-mentioned problems, spot improvement approaches will not work in areas that have very poor soils or are prone to flooding. Despite these problems, there is a strong case for the spot improvement approach. Without it, most developing countries simply cannot afford to provide basic access to the majority of their rural populations. An example of a successful spot improvement program is

[9] Often justified based on anticipated lack of maintenance and a lack of willingness to tackle this problem.

given in Box 1. Further good examples of successful spot improvement programs exist.[10]

Box 1: The Roads 2000 Program in Kenya: A Spot Improvement and Labor-Based Approach to Network Rehabilitation and Maintenance

The Roads 2000 Program is a maintenance implementation strategy that supports a number of policy objectives of the Kenya Road Maintenance Initiative. It was developed as a solution to the deteriorating unpaved road network of 53,000 km. Road condition surveys identified a limited number of trouble spots, rather than general conditions, as the main cause of non-trafficable roads. Furthermore, the surveys found that the traditional equipment-based maintenance approach could not provide the required services with the current funding levels.

Building on the successful experience of the labor-based Rural Access and Minor Roads Programs, Roads 2000 adopted a new approach to rapidly bring the network up to a maintainable standard and place it under effective maintenance with the optimum use of local resources.

The three principal components of the Roads 2000 approach were:

- Rehabilitation Phase: Bring roads back to minimum maintainable standard
- Routine Maintenance: Establish labor-based maintenance system
- Spot Improvement: Plan and carry out a follow-up program of selected spot improvements

During initial preparation work, the road was brought to a passable and maintainable standard by labor units. The role of these work-units was to clear the vegetation and drainage system and re-establish the road camber.

This preparation phase was followed by the establishment of small-scale contractors (group or single person contracts) to carry out routine maintenance on a permanent basis. On the more heavily-trafficked roads (> 50vpd), they were supported by tractor-towed graders.

During the rehabilitation phase, required spot improvements were identified and implemented as funds and resources allowed. Typical works included:

- installation of new culverts (on average one new line per km);
- replacement or rehabilitation of existing culverts;
- spot regravelling (to a maximum of 4% of the road network length);
- provision of alternative surfacing over limited distance (for example, steep sections, approaches to structures);
- full road reconstruction over a limited distance; and
- bridge and drift rehabilitation;

The following costs have been established for unpaved roads (adjusted to year 2000 prices):

- partial rehabilitation and spot improvement US$2,000 / KM
- labor-only routine maintenance US$240 / KM / Year
- routine towed grading US$280 / KM

Great potential for furthering the spot improvement approach is also seen in the implementation of performance-based road management and maintenance contracts. Until recently, these contracts have only been applied on major highways, and not on low-volume unpaved roads. A recent World Bank-financed project in Chad is

[10] For example, the SRR (Structures on Rural Roads) component of the first and second Rural Roads & Market Improvement Projects of the World Bank in Bangladesh, and the Morogoro Road Support Project assisted by the Swiss Development Cooperation in Tanzania.

proposing to introduce such types of contracts on approximately 450 kilometers of the unpaved main road network.[11] Performance criteria are: (a) passability at all times; and the assurance of (b) a specified average speed; (c) minimal riding comfort; and (d) road durability and preservation. This type of contract should guarantee an approach whereby the contractor, in his own self-interest, will focus on the critical spots of the network, while assuring a minimal comfort for the road user.

3.2 Staged Construction—not recommended for RTI[12]

Staged construction is understood here as investment into structural elements of RTI to accommodate upgrading needs which might be required in the future due to traffic growth. While it might be possible to demonstrate long-term savings through staged construction in the case of trunk or provincial roads, where substantial traffic growth can be expected, the same is normally not possible for RTI, especially when initial traffic levels are very low. Where road agencies insist on such “advance” investments, economic analysis should be carried out to determine their justification. Such analysis must take into account the additional short-term maintenance because of higher-than-necessary investments.

3.3 ENGINEERING DESIGN OF BASIC ACCESS RTI

Basic access RTI has to be properly designed if it is to resist the weather and traffic, and produce a maintainable and sustainable asset. The engineering design, traffic, safety, environment and social impact considerations, needs to take into account a few key design considerations. These are related to the type of traffic use expected on the RTI, road safety considerations, the expected impact on the environment, and the social impact of RTI interventions. These requirements are briefly explained in the paragraphs below.

3.3.1 Traffic

A wide variety of motorized and non-motorized traffic should be expected on RTI. However, roads and structures need to be designed to allow the largest and heaviest users to pass safely without damaging the structures. Often these largest users are seven-ton trucks, and, in other cases, pick-up trucks or motorcycles, and power tillers. In some cases, a design for non-motorized means of transport might suffice. Design to a low standard suitable only for 4WD-drive vehicles should normally be avoided, since these vehicles are rarely used by local transporters or the local population. One potential problem is the possibility of large trucks using the road to evacuate heavy natural products and resources, such as crops, timber, minerals, etc. The likelihood of such traffic must be confirmed at project appraisal.

3.3.2 Road Safety

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[11] The National Transport Program Support Project, 2000. Also see, Asif Faiz et. al. TRB Record.

[12] However, a “phased” approach can be recommended, as practiced in the “Green Road Approach” in Nepal, where first a trail is constructed and then gradually expanded to a road, particularly in a mountainous environment.

Road safety is of primary importance for all road users. However, the safety concerns of basic access RTI are different than those for higher-level infrastructure. Typical problems are single-vehicle accidents and accidents between motorized and non-motorized vehicles, pedestrians and animals. The challenge for the rural transport planner is, therefore, to ensure that the speed of motorized traffic is low, say, not more than 30 km/h, particularly within villages. It is often argued that since single-lane roads with passing places are inherently dangerous, wider roads should be built for safety reasons even when the traffic levels are low. However, the risk of vehicle-to-vehicle collision only increases slightly (Ellis and Hine 1994),[13] even if the volumes increase from 10 vehicles per day to 50 vehicles per day, and this level of traffic can be accommodated by passing places. However, where the road is expected to carry large volumes of pedestrian, or NMT, consideration needs to be given to their safety and a wider road shoulder or separate pedestrian and NMT-ways should be constructed (particularly within villages).

3.3.3 Environmental and Social Impact Mitigation

Basic access RTI interventions have both direct and indirect environmental and social impacts. Improved access might require the acquisition of productive agricultural land and housing, which might necessitate resettlement. Such resettlement will likely be minimal in the case of improvements to existing roads.[14] Other major direct environmental impacts are dust from vehicles and erosion of RTI surfaces, drainage structures, and outlets. Indirect impacts are the opening up of previously inaccessible, or marginally accessible, territory to immigration and resource harvesting. The processes that help to identify and mitigate the potentially adverse impacts of RTI projects, while enhancing their positive effects, are the environmental assessment (EA) and social assessment (SA). Both EA and SA processes must be initiated at the beginning of the project cycle and continued throughout.

3.4 Implementation Methods

3.4.1 Labor-Based Technology

The application of labor-based approaches to basic access RTI interventions contributes to their poverty-alleviating impact. Constructing RTI with labor-based methods requires between 2,000 and 12,000 person-days per kilometer for construction and 200 to 400 person-days per kilometer for maintenance. Utilizing local labor allows the local community to earn wages, as does procuring materials and tools from local sources. Furthermore, labor-based methods contribute to local empowerment through skills-transfer and creation of ownership. Also, if correctly designed, labor-based methods can have a substantial gender-specific impact.[15]

[13] As demonstrated by Ellis and Hine, “a road with traffic of 10 vehicles per day has 0.05 conflicts per day at a speed of 40 km/h. This will increase to 1.3 conflicts per day at a volume of 50 vehicles per day.”

[14] Although encroachment into existing alignment is a situation encountered frequently.

[15] For example, the “Destitute Women Program” implemented in Bangladesh.

Box 2: Relevance of Labor-Based Execution

Road construction and maintenance works are often described as equipment-based or labor-based, depending on the relative intensity of productive factor use. The term “labor-based” is used to describe projects where labor is substituted for equipment when it is cost-effective. This covers most road-related activities apart from compaction and heavy earthworks. The term also includes the use of appropriate light equipment (mostly tractor-trailer) which supports the utilization of labor in specific essential activities such as compaction and gravel haulage for surfacing.

In most developing countries, especially in rural areas, unemployment is high, jobs are scarce, and the average daily wage rate for workers in the agricultural sector is somewhere between less than US$1 and US$5 per day. Equipment is usually owned by a few large-scale contractors or government departments. Maintenance and back-up services can be problematic and expensive, and real equipment costs are prohibitively high. The lower unit-cost of labor relative to capital therefore makes labor-based road works both economical and socially desirable.

In their recent publication *Employment-Intensive Infrastructure Programs: Labor Policies and Practices, 1998,* the International Labor Organization concludes that* labor-based construction and maintenance: (a) was about 10% to 30% less costly, in financial terms, than more equipment-intensive works; (b) reduced foreign exchange requirements by 50% to 60%; and (c) created, for the same amount of investment, two to five times more employment.

Several important factors contribute to the viability of labor-based construction techniques, such as government attitude, economic conditions (especially labor and capital markets), the location of the project, road agency administrative and financial procedures, capacity for management and human resource development, and the provision of adequate training.

* Based on comparative studies carried out in a number of countries, such as Ghana, Lesotho, Madagascar, Rwanda, Zimbabwe, Cambodia, Lao People’s Democratic Republic (Lao PDR) and Thailand.

The type of work associated with basic access is ideal for labor-based methods. Spot improvement interventions are small-scale and varied, requiring attention to detail, and often do not require heavy construction equipment. In the case of community RTI, the full involvement of the community gives them the opportunity to acquire the skills for the eventual infrastructure maintenance by labor-based methods. It is important to note that equipment (for example, graders) are seldom available for subsequent maintenance activity for RTI, a fact that should be planned for at design.

There are certain prerequisites for effective labor-based contract execution, including labor availability in sufficient numbers, supervision experience, and the availability of qualified contractors. These contractors must be small-scale and have experience in labor-based project execution. They should possess, or have access to the appropriate equipment. If they have no direct experience in labor-based execution of works, they must at least be willing to undergo respective training.[16] Box 2 elaborates on the relevance of labor-based approaches.

Despite these advantages, it has been difficult to mainstream labor-based approaches. The difficulties encountered include inflexible labor laws, the availability of cheap second-hand heavy equipment, unsuitable procurement laws, and a lack of capacity to rapidly pay labor-based contractors (Stock, A. and J. de Veen. 1996). To mainstream labor-based approaches, these obstacles need to be overcome at the policy level.

16 Good guidelines for the training of small scale contractors can be found in a ILO publication: *Capacity Building for Contracting in the Construction Sector*.

3.4.2 Small-Scale Contractor Development

By their very nature, basic access interventions are small-scale, varied, and scattered. The work is ideal for execution by small-scale labor-based contractors and by community contracts. Such types of contracting require (a) an appropriate policy environment; (b) capacity building programs for designing, managing, and execution of contracts; and (c) appropriate procurement procedures.

Considerable experience is available for the development of small-scale labor-based contractors (Bentall, Beusch, de Veen, 1999). An enabling environment must be created. If the contractors are to survive, they require a regular workload, rapid payment of bills, and access to credit facilities and equipment rental opportunities. The key is the management capacity of the contracting agency. To overcome capacity constraints at the local government level, it is often recommended that government entities join together to form joint-services committees or hire consultants to assist in contract management (Malmberg Calvo, 1998). Contractors' associations have an important role to play in the capacity building process as well (Larcher, 1999).

The limited capacity of single small-scale contractors may require the employment of numerous contractors if major earthworks are involved (average capacity will be about 1km of earthworks per month and 0.5km of gravelling per month). Part of the capacity building process is assistance to the contractors with appropriate equipment, which in most cases is tractor-towed equipment, such as trailers, water bowsers, rollers and towed graders.[17]

3.4.3 Community Contracting

Community contracting has become a major means of channeling grant funding to the rural poor. Community contracting means procurement by, on behalf of, or from communities. Implementing agencies are the communities themselves who take direct responsibility for their own development, and the role of government here is to provide facilitating support (usually through the assistance of NGOs). Participation from the community has to be an overriding consideration in designing the various procedures, including procurement and disbursement. Simplified procurement procedures for community contracting are required (World Bank, 1994). Experience from such community-based investment operations has shown that participation greatly assists accountability. A key feature for successful community contracting is the existence of a legal framework that gives communities legal status, without which they are unable to receive or manage funds.

3.5 Maintenance of Basic Access RTI

A common feature of RTI is insufficient or non-existent maintenance. Financial allocations to RTI maintenance are almost always inadequate, both relative to the main road network and compared to general expenditures for construction.[18]

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17 See MART Working Papers no. 1 to 14.

18 As a rule of thumb, expenditures for maintenance should be 50-80% of total expenditures for roads in a growing network and 90-95% in a mature network.

Moreover, capacity to execute maintenance is lacking. A good indicator for the lack of maintenance capacity is the need for rehabilitation, which by definition is caused by a lack of maintenance. Earth and gravel roads and paths are very vulnerable to the elements and will often not survive a single season without proper maintenance. A road or path is no better than its weakest link, and one failed drainage structure or section can be sufficient to disrupt access. The principle roots of maintenance neglect are institutional and financial. These must be addressed prior to any consideration of investments in RTI (Malmberg Calvo, 1998).

It is often argued that in light of insufficient maintenance capacity, initial higher standards are required. However, this is a short-term view. While higher standards, such as bituminous surfacing, might extend the useful life of the RTI by a few years, a lack of maintenance on such a surface eventually causes even higher costs for the users and the agencies, as total-cost analysis would demonstrate. Furthermore, routine maintenance is required in all circumstances. In its absence, the useful life of an “over-designed” surface will be reduced substantially.

Maintaining an earth or gravel road is relatively costly. As a rule of thumb, un-discounted maintenance costs over the typical life of RTI will equal the initial construction costs. For example, a typical US$5,000/km basic access road may cost an average of US$250 a year per km to maintain over its assumed twenty-year life.

From an engineering point of view, there are important tradeoffs between routine, recurrent, and periodic maintenance, and further investments. Often, enhanced routine maintenance is able to provide the required “passability,” which reduces the need for periodic maintenance or further investments in the form of spot improvements. This is of particular importance with respect to periodic maintenance.[19] In many developing countries, reserves of naturally occurring gravel used for periodic renewal of gravel layers are simply no longer available. The maintenance of a proper camber and the protection of drainage structures will reduce the need for periodic maintenance and rehabilitation. If comparing the costs of increasing the grading frequency on earth roads against gravelling at low traffic levels, the former is usually much more economical (Hine and Cundill, 1994).

4. CONCLUSION

In order to complement poverty reduction strategies, rural transport interventions must be an integral part of rural development interventions focusing on the mobility and access needs of rural communities. Substantial gains in accessibility—for more communities, in more regions of a country—are possible if rural transport infrastructure interventions are designed in a least-cost, network-based manner focusing on eliminating trouble spots.

The (trouble) spot improvement approach is the key to the least-cost design. Cost savings of 50 to 90% can be achieved compared with fully engineered roads of equal

[19] In Burkina Faso, for example, the systematic execution of grading operations in combination with spot recharging of gravel has greatly reduced the need for periodic regravelling.

standard throughout. However, to put this approach into practice, a variety of constraints, such as political pressure and road agency and donor preference for high-standard, high-cost roads[20] need to be overcome.

Labor-based approaches are best-suited for the implementation of RTI interventions. By transferring financial resources and skills to the local level, labor-based strategies can have a substantial poverty-reducing impact. They also have the potential to improve the gender distribution of income, providing employment opportunities for women where wage-employment is scarce.

[20] Often justified based on anticipated lack of maintenance and a lack of willingness to tackle this problem.

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