WORLD EMPLOYMENT PROGRAMME

ROAD CONSTRUCTION AND MAINTENANCE

Choice of technology in developing countries

INTERNATIONAL LABOUR OFFICE GENEVA

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International Labour Office Geneva

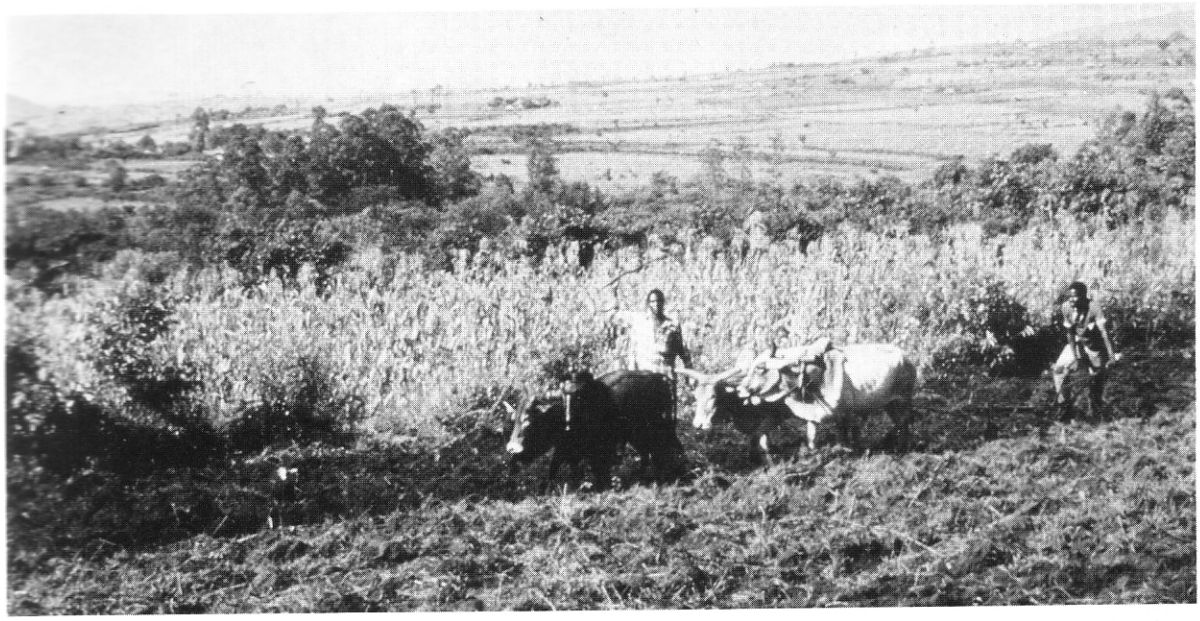
As part of its Construction Technology Programme, the ILO is carrying out a series of advisory services in Africa on labour-based road construction and maintenance techniques. These advisory services are financed from a grant from the Swedish Government. This booklet explains the rationale behind this work and gives a brief description of the use of labour-based techniques.

This booklet is available free of charge from:

The Technology and Employment Branch
International Labour Office
CH-1211 GENEVA 22
Switzerland.

Roads and development

One of the major obstacles to rural development in developing countries is the lack of access. Acceptance of this relationship has been implicit in the enormous efforts made in the past few decades to develop the rural road systems of most developing countries.



The agricultural potential of areas such as the one shown above can be realised only if transport of both the necessary inputs and the agricultural outputs is feasible and economical.

Similarly, local markets can develop only in areas where a regular supply of agricultural produce is ensured.

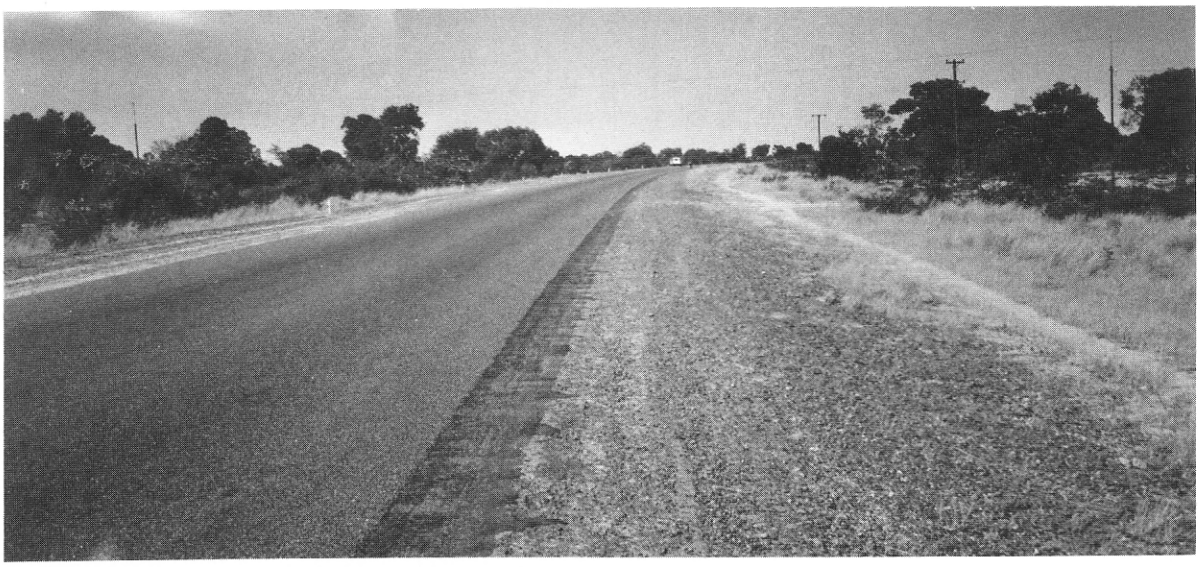
The development of agriculture, the distribution of food, the provision of health services, and the access to information through educational services and other forms of communication in rural regions of developing countries all depend heavily on access to transport facilities and, in particular, roads.

In recent years the emphasis has been on low-volume rural roads that carry a limited number of vehicles per day.

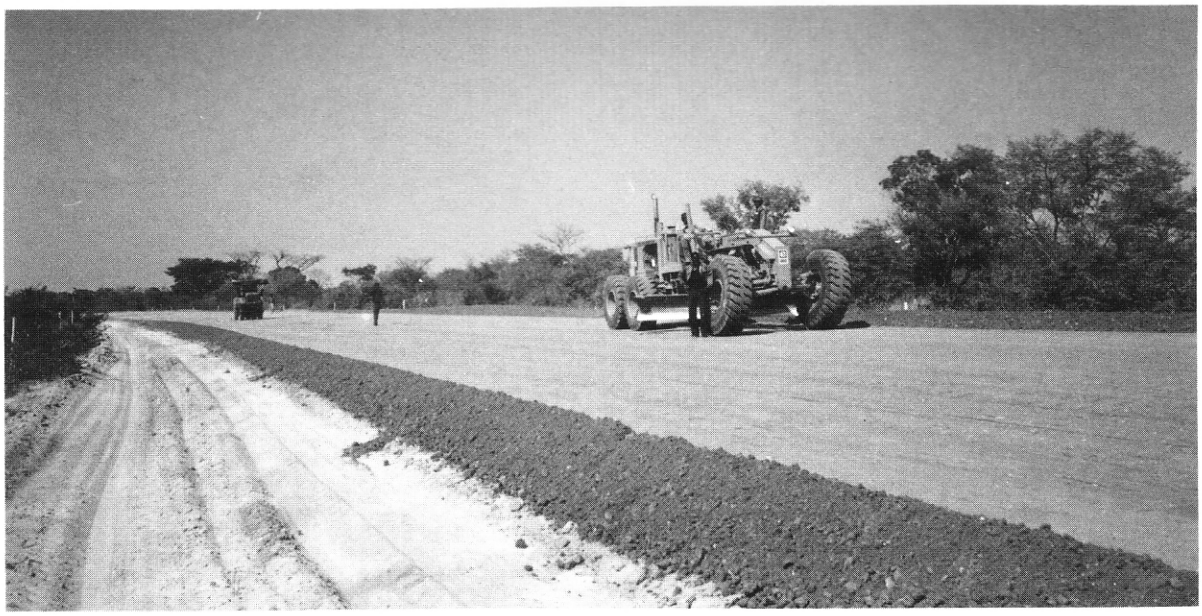
Nevertheless, a large part of the rural transportation network in developing countries still consists of footpaths or tracks suitable only for four-wheel driven vehicles or animal-drawn carts.

The choice of technology

It would be unrealistic to expect all roads to be as well constructed and maintained as the one shown below. Equally, it is not necessary to aim for such a standard for the major part of the roads in question.



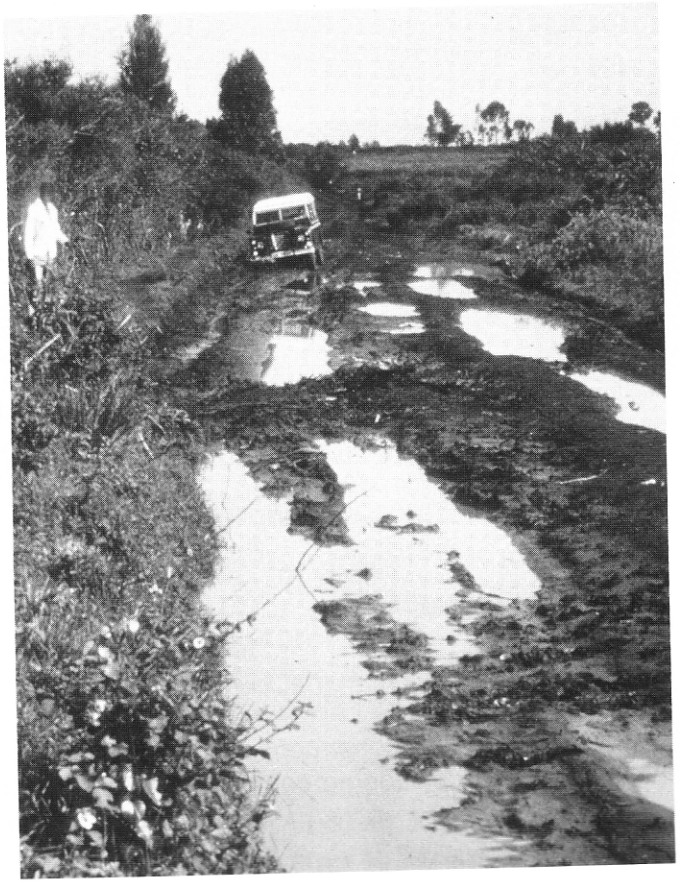
The heavy investment in the construction of rural roads over the past two decades has been used mainly for the acquisition and operation of equipment. Most rural roads projects in developing countries have been, and continue to be, carried out with equipment-intensive techniques.



However, the lack of spare parts, the shortage of skilled operators and mechanics and the reliance on petrol and diesel are major limitations.

The result is that equipment-based construction methods are a major burden on the limited foreign exchange reserves of developing countries, as the major part of the resources used—management, machines, fuel and spare parts—has to be imported and paid for in foreign exchange.

An additional problem is that, in spite of the heavy investments in the construction of the road network, lack of adequate maintenance has resulted in a rapid deterioration of the rural road networks.



The ILO's Construction Technology Programme

In the early seventies the ILO embarked on a programme of appropriate construction technology. This Programme had the objective of assessing how labour-based technologies could be made technically and economically competitive with equipment.

Initially it focused on road construction. Since 1980 it has broadened its scope to cover road maintenance, small-scale irrigation and rural transportation. In addition, it deals with several aspects of the development of the domestic construction industry. Its main objective is to ensure the continued and large-scale use of the most appropriate technologies—labour, equipment or a combination of the two—by both the technical ministries and the private sector involved in the construction industry. Not surprisingly, in the socio-economic environment of most developing countries the potential for *efficient* labour-based methods is enormous. The emphasis of the programme's work has therefore been on increasing the efficiency of traditional labour-intensive work methods by the introduction of adapted organisational and management techniques and on modifying the institutional framework in which these work methods have to be applied. The target group for the programme has been the technical ministries/organisations responsible for civil construction, maintenance and transportation.

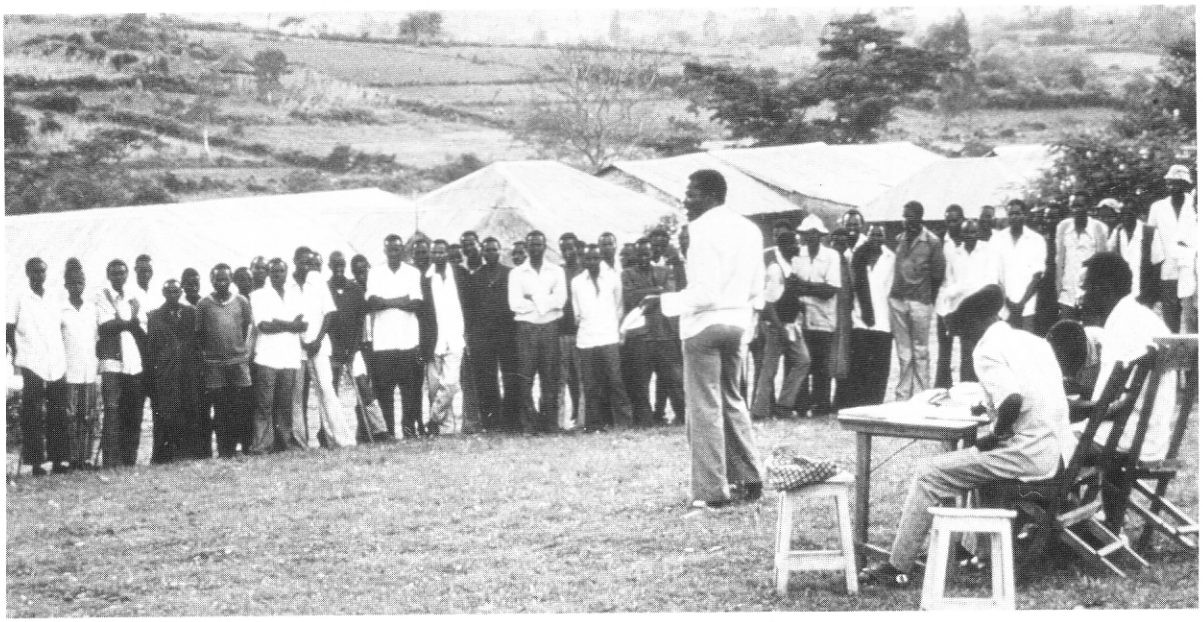
The experience gained from labour-based pilot projects and full-scale projects in several developing countries—Benin, Botswana, Chad, Ethiopia, Honduras, Kenya, Lesotho, Malawi, Mozambique, Philippines—during the past ten years has shown that labour-based road construction and maintenance *is* a viable alternative to equipment-based methods. However, it has also shown that a great deal of effort and continuous inputs are required to realise the potential of labour. The following pages illustrate some of the issues to be dealt with when implementing labour-based programmes.

Labour-based road construction

The gravel road shown below was constructed and is maintained by labour-based techniques at costs lower than would have been possible using equipment. Both the quality of the work and the speed of construction compare favourably to similar roads constructed by machines.

The use of efficient and cost-effective labour-based methods is not just a question of employing labour and starting work, however. The level of sophistication in planning and managing these techniques should be similar to the conventional approach if labour-based methods are to be successful.

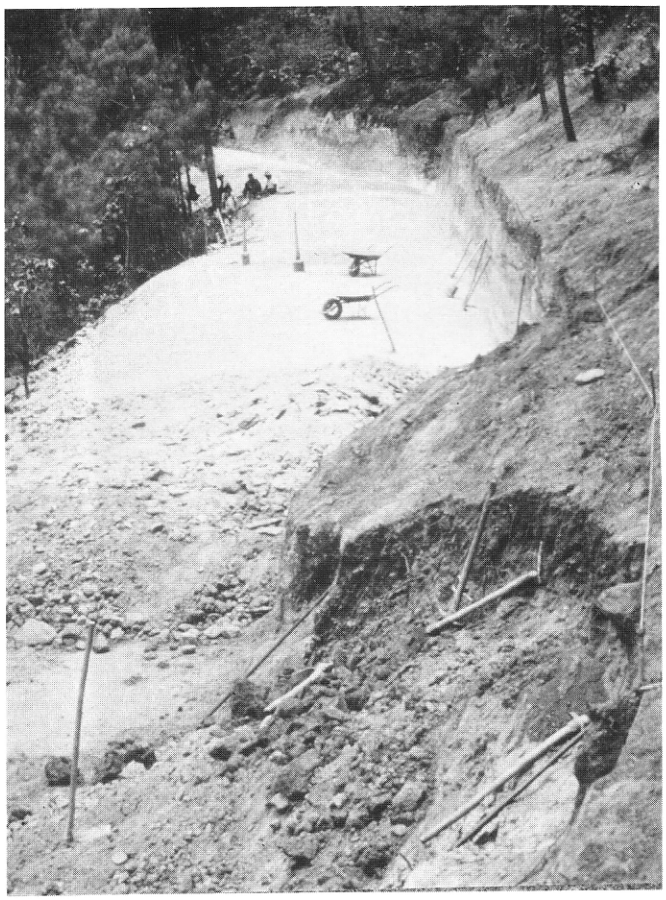
First of all, there is a phase of planning, financial approval, the establishment of an organisational structure, the appointment of professional project staff, the procurement of necessary tools and equipment and other preparatory activities.



The next stage is the recruitment, preferably with the assistance of the local administration, of unskilled, usually casual, labour. Labourers are recruited for the execution of the construction work, and they are selected on a random basis to avoid nepotism and corruption. Conditions of work and administrative procedures are explained carefully during meetings held prior to the actual recruitment.

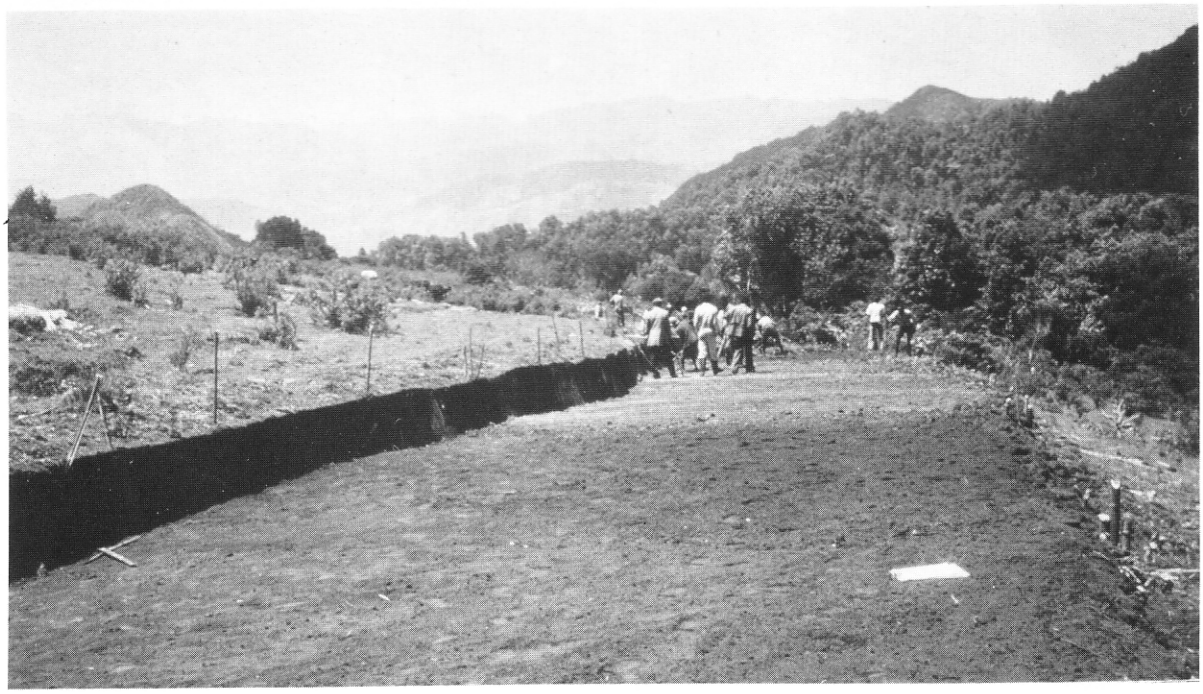
The actual road construction phase can be broken into a series of activities.

The first stage includes activities for site clearance such as bush-clearing, tree and stump removal, grubbing, boulder removal and rock excavation.

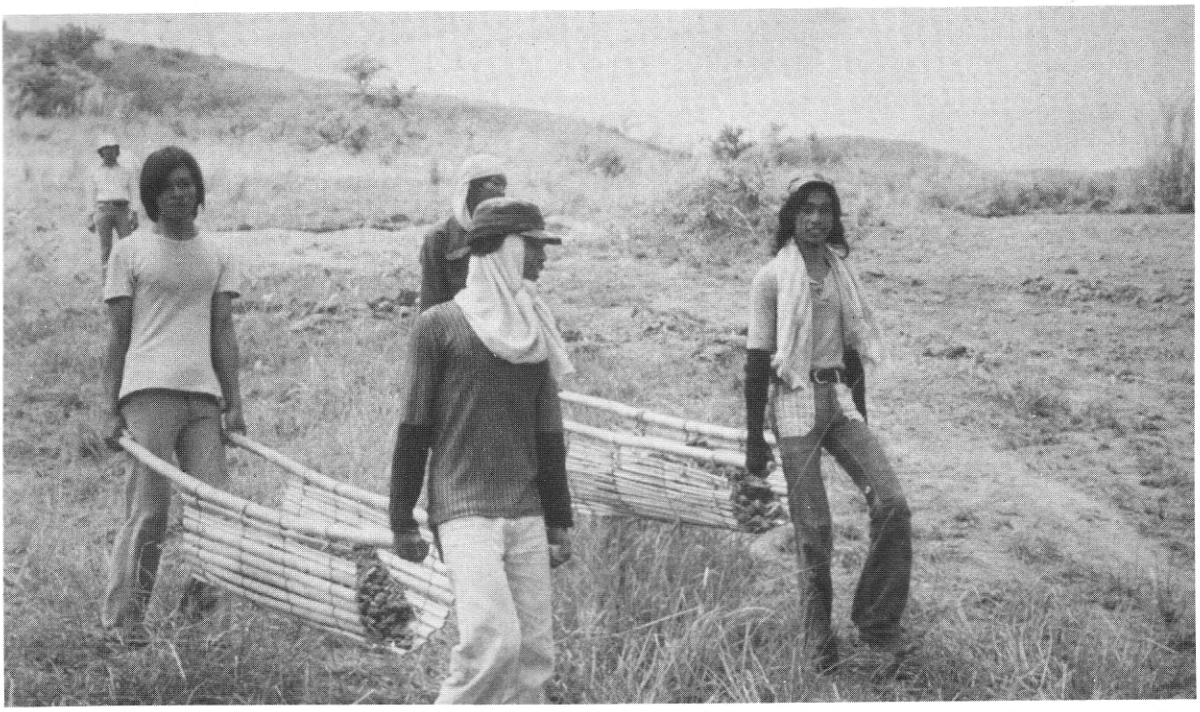


The next stage consists of excavation of the soil. Even heavy excavation can be done manually.

As excavation usually represents the bulk of the construction work, this activity in particular needs to be well organised and managed. The use of incentive schemes, good-quality tools and clear demarcation of tasks to be carried out are crucial means to boost productivity.



The loading and hauling of material are also important activities. However, with labour-based construction, an attempt is made to minimise the hauling distances.



There is a large range of hauling modes ranging from head baskets to scrapers. The productive output and optimum means of hauling vary with the hauling distance, condition of the route and site organisation.

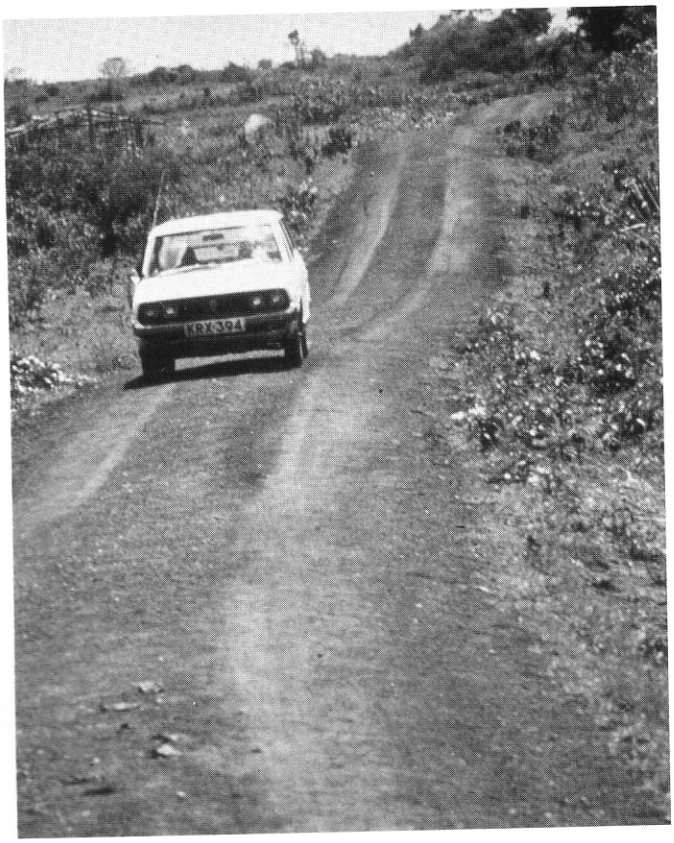
When the road section is cleared and established, the next activities are ditching and sloping, followed by spreading and camber formation. The task consists of the spreading of the soil excavated from the ditches and the slopes and which has been heaped in the middle of the road. The use of simple aids to check the quality of the work is essential.

Inadequate drainage is probably the most important single factor contributing to the deterioration of rural roads. A sufficient number of culverts of adequate capacity should be provided.

Also, simple scour checks and lead-away drains are constructed at this stage.

Compaction is the final stage of the earth road construction process. It is possible to achieve compaction by using heavy or light equipment (vibrating or deadweight), by hand tools, or using the hauling equipment judiciously for compaction.

Compaction can also be done indirectly by traffic or climate.



Gravelling is the most equipment-intensive part of labour-based road construction. The process includes excavation, loading and spreading, which can all be done manually.

Hauling by tractor/trailer combination has proved economical for hauling distances up to 10 km. Other modes such as donkey carts have been used effectively on shorter distances.

All roads need a minimum amount of regular maintenance, but the amount required depends on weather conditions, terrain type and traffic volume. The funds available for road maintenance are generally very limited. Rather than using expensive equipment only, it is preferable to identify, develop and apply cheaper, alternative approaches of road reconstruction and maintenance. Such approaches may include the use of private contractors, the application of labour-based methods partly sponsored by village resources, the use of self-help efforts in carrying out reconstruction works, concentrating maintenance efforts on selected sections of road, etc.

Well-organised "length-man" systems have proved to be cheap and effective in various countries in Africa and Asia.

The current programmes of the ILO in this area include the provision of advice and assistance to governments in Asia and Africa on the most effective means to maintain the rural road network.

Bibliography

M. Allal and G.A. Edmonds in collaboration with A. S. Bhalla: *Manual on the planning of labour-intensive road construction* (Geneva, ILO, 1977). Sw.fr. 40.

This manual is published mainly for the use of people who are engaged in the planning, evaluation and design of road construction projects. Nevertheless, both policy-makers and site engineers will also find valuable information in it.

The various stages in the planning and implementation of road projects at which procedures can be changed to incorporate the assessment of alternative technologies are isolated. The book covers items such as road planning and design, productivity, the range of labour-intensive techniques, road construction and maintenance costs, road users' costs and indirect benefits, evaluation of alternative technologies at market prices and at shadow prices, fiscal and financial policy, organisation and management, and conditions of tender and contract terms.

G.A. Edmonds and J.D.G.F. Howe (eds.): *Roads and resources: Appropriate technology in road construction in developing countries* (London, Intermediate Technology Publications, 1980). £4.95.

This book describes how the use of more labour-intensive techniques can be technically and economically efficient. It also shows that the level of planning and organisation required for efficient labour-based programmes is not less demanding than that for equipment-based programmes. The book is in two parts: the first deals with the institutional framework within which the application of appropriate technology is proposed and with the various aspects of the implementation of appropriate technology. The second discusses the major aspects of labour-based road construction, using as a basis the various ILO studies and programmes in India, the Islamic Republic of Iran, Kenya, Nepal, the Philippines and Thailand.

J.J. de Veen: *The Rural Access Roads Programme: Appropriate technology in Kenya* (Geneva, ILO, 1980). Sw.frs. 20.

This book describes the first attempt in Africa to implement labour-based road construction methods on a large scale. After several years of implementation, the RARP has become a massive endorsement of the view that it is technically and economically possible to construct low-cost, good-quality roads using labour-based techniques.

The book is divided into two parts: text and appendices. The text discusses in general terms the development of the administrative, organisational and training systems of the programme. It also describes the technical and financial involvement of the various aid agencies and the research carried out in the initial stages of the programme. The appendices describe in detail the procedures and systems used in the RARP and will be of particular interest to officials who will be involved in the actual execution of programmes of a similar nature.

Guide to tools and equipment for labour-based road construction (Geneva, ILO, 1980). Sw.frs. 60.

For labour-based techniques to be effective, the tools and equipment need to be of good quality.

This guide will help those responsible for planning and managing labour-based road construction projects to specify the appropriate tools and equipment for the job, by showing them how to establish test procedures, how to advise local manufacturers on the production of implements, how to contact sources of supply and how to ensure the correct use and maintenance of the tools and equipment selected.

G.A. Edmonds and J.J. de Veen: *The application of appropriate technology in road construction and maintenance: A learning methodology* (Geneva, ILO, 1981).

This document describes the methodology and content of seminars and workshops being held in Africa on labour-based techniques of road construction and maintenance. It includes case studies, individual and group tasks and lectures. The material presented can be usefully applied in similar workshops and training sessions in other developing countries. Moreover, the various case studies and exercises will provide useful background and reference material to those involved in road construction and maintenance in developing countries.

L.S. Karlsson and J.J. de Veen: *Guide to the training of supervisors for labour-based road construction and maintenance* (Geneva, ILO, 1981). Instructor's Manual (1 volume) Sw.frs. 120 and Trainees' Manual (2 volumes) Sw.frs. 120.

This guide consists of an instructor's and a trainees' manual, both in loose-leaf presentation. The former will help those responsible for the training of supervisory personnel to plan training programmes and to design and implement appropriate training courses in the field of labour-based road construction and maintenance. The latter contains the basic training material felt also to be of value to supervisors of other

types of construction or maintenance programmes. The guide is presented in self-contained modules and learning elements following a system developed by the ILO to enable individual vocational training programmes to be compiled. This allows its contents to be used selectively in supervisory training courses, either specifically for labour-based methods or for courses of a more general nature.

G.A. Edmonds and J.J. de Veen: *Road maintenance: Options for improvement* (Geneva, ILO, 1982).

This paper describes a methodology of assessing the costs and effectiveness of the various road maintenance systems used in developing countries, complemented by various tasks and exercises on road maintenance organisation and the choice of technology in road maintenance. The paper also contains summaries of the assessments of the maintenance situation in 11 African countries, made by senior engineers attending an ILO Regional Meeting in Gaborone, Botswana, in March 1982.

J. Howe and G. Hathway: *Earth roads—Their construction and maintenance* (London, Intermediate Technology Publications, 1980).

This book fills the need for a simplified description of road planning and construction, appropriate for non-engineers using, for the most part, naturally available material: earth. The book explains how earth roads could be constructed and maintained in a way that would prevent their progressive and often rapid destruction through the uncontrolled flow of water.

The text covers designs of earth roads carrying from a few up to 50 vehicles per day, describes the drainage principles and techniques, route planning and surveying, road construction and maintenance. Appendices describe the operation of some simple pieces of surveying equipment and provide a glossary of road construction terms.

Within the Construction Technology Programme of the ILO there is also a series of Construction Technology Papers (CTPs). They are generally detailed case studies of specific interest and are available in a very limited supply for specific purposes. Those that are more widely available are marked with an asterisk.

CTP 1 ILO: *Roads and resources: An evaluation of the factors affecting the application of appropriate technology,* Jan. 1978.

CTP 2* I. Barwell and J.Howe: *Appropriate transportation facilities for the rural sector of developing countries,* Jan. 1979.

CTP 3* Report of the ILO/DANIDA/Ethiopian Road Authority African Regional Seminar on the Application of Appropriate Technology in Road Construction, Addis Ababa, 10-20 March 1980.

CTP 4 J. Howe: *Botswana—District pilot project of labour-based road construction and maintenance—Tools and equipment study,* Sep. 1981.

CTP 5 K. Vaidya: *District pilot project of labour-based road construction and maintenance, Central District, Botswana—Labour economist's report,* Oct. 1981.

CTP 6 P. Mould: *Botswana—District pilot project on labour-based road construction and maintenance—Study by rural development consultant,* Nov. 1981.

CTP 7* G.A. Edmonds and J.J. de Veen: *The application of appropriate technology in road construction and maintenance: A learning methodology,* Mar. 1981.

CTP 8 L. Karlsson: *Papua New Guinea—Training of supervisors for labour-based public works,* Nov. 1981.

CTP 9* J.J. de Veen in collaboration with J. Boardman and J. Capt: *Productivity and durability of traditional and improved hand tools for civil construction,* Geneva, Dec. 1981.

CTP 10* *Report of the ILO/SIDA/Ministry of Works and Communications, Botswana, Regional Meeting of Senior Engineers on Road Maintenance,* Gaborone, 11-19 March 1982.

CTP 11 J. Howe: *Ethiopia: Training in labour-intensive techniques in rural road construction and maintenance and appropriate technology,* Mar. 1983.

CTP 12 ILO: *The maintenance of rural access roads in Kenya—A discussion paper,* July 1982.

CTP 13* G.A. Edmonds and J.J. de Veen: *Road maintenance: Options for improvement,* Aug. 1982.

CTP 14 I. Barwell: *Supply of tools and equipment for labour-based road betterment and maintenance in Mozambique,* Oct. 1982.

CTP 15 R.C. Petts and P. Roberts: *Report on an exploratory mission to the Gambia to assess the maintenance requirements and resources for feeder roads,* Nov. 1982.

CTP 16 J.J. de Veen: *Nucleus estates and smallholders (NES) projects in Indonesia: Feasibility study on the use of labour-based methods for the maintenance of NES roads and collection tracks,* June 1983.

CTP 17 R.C. McCutcheon: *District pilot project of labour-intensive road construction and maintenance, Botswana—Final report,* Sep. 1983.

CTP 18 B. Nilsson, J. Simpson and K. Vaidya: *A study of labour-based/equipment-supported road construction in the Philippines* (Volume One—Main report; Volume Two—Technical annexes; Volume Three—Socio-economic studies), Manila, Aug. 1983.

CTP 19* J. Howe: *Conceptual framework for defining and evaluating improvement to local level rural transport in developing communities,* Sep. 1983.

CTP 20 R.C. Petts: *Report on labour-based road maintenance in Maputo Province, Mozambique,* Aug. 1983.

CTP 21* K.C. Vaidya: *Guide to assessment of rural labour supply for labour-based construction projects,* Aug. 1983.

CTP 22 J. Simpson: *Minor road rehabilitation and maintenance programmes in Zambia,* Aug. 1983.

CTP 23* ILO: *Programme outline on rural transportation in developing countries,* Sep. 1983.

CTP 24 J. Simpson: *Minor road construction and maintenance in the Eastern Province of Zambia,* Sep. 1983.

CTP 25 J. Simpson: *Labour-based minor road construction and maintenance programmes in Lesotho,* Nov. 1983.

CTP 26 I.J. Barwell: *Southern Sudan: Tools and equipment for labour-based road construction and local manufacture and use of animal carts,* Nov. 1983.

CTP 27 J. Simpson: *Pre-construction planning for a pilot labour-based road project in Thailand,* Nov. 1983.

CTP 28 K.G. Vaidya and M.T.R. Sarma: *Assessment of labour availability in the Lao People's Democratic Republic,* Nov. 1983.

CTP 29 I. Barwell: *Pilot project on labour-based road construction and maintenance in the Lao People's Democratic Republic,* Dec. 1983.

CTP 30 P. Guthrie: *Labour-based road construction pilot project in southern Sudan (Technical details),* Dec. 1983.

CTP 31 J. Boardman: *MOZ/79/01—ILO/NORAD Pilot project of road improvement and maintenance in Mozambique (Final report),* Jan. 1984.

CTP 32 C. Relf and J. de Veen: *Appraisal of a pilot project for labour-based rural road rehabilitation and maintenance in Zambia,* Jan. 1984.