

Transport Research Laboratory

Library LOAN COPY (3)



## Key issues in rural transport in developing countries

by S D Ellis

The Transport Research Laboratory is the largest and most comprehensive centre for the study of road transport in the United Kingdom. For more than 60 years it has provided information that has helped frame transport policy, set standards and save lives.

TRL provides research-based technical help which enables its Government Customers to set standards for highway and vehicle design, formulate policies on road safety, transport and the environment, and encourage good traffic engineering practice.

As a national research laboratory TRL has developed close working links with many other international transport centres.

It also sells its services to other customers in the UK and overseas, providing fundamental and applied research, working as a contractor, consultant or providing facilities and staff. TRL's customers include local and regional authorities, major civil engineering contractors, transport consultants, industry, foreign governments and international aid agencies.

TRL employs around 300 technical specialists - among them mathematicians, physicists, psychologists, engineers, geologists, computer experts, statisticians - most of whom are based at Crowthorne, Berkshire. Facilities include a state of the art driving simulator, a new indoor impact test facility, a 3.8km test track, a separate self-contained road network, a structures hall, an indoor facility that can dynamically test roads and advanced computer programs which are used to develop sophisticated traffic control systems.

TRL also has a facility in Scotland, based in Edinburgh, that looks after the special needs of road transport in Scotland.

The laboratory's primary objective is to carry out commissioned research, investigations, studies and tests to the highest levels of quality, reliability and impartiality. TRL carries out its work in such a way as to ensure that customers receive results that not only meet the project specification or requirement but are also geared to rapid and effective implementation. In doing this, TRL recognises the need of the customer to be able to generate maximum value from the investment it has placed with the laboratory.

TRL covers all major aspects of road transport, and is able to offer a wide range of expertise ranging from detailed specialist analysis to complex multi-disciplinary programmes and from basic research to advanced consultancy.

TRL with its breadth of expertise and facilities can provide customers with a research and consultancy capability matched to the complex problems arising across the whole transport field. Areas such as safety, congestion, environment and the infrastructure require a multi-disciplinary approach and TRL is ideally structured to deliver effective solutions.

TRL prides itself on its record for delivering projects that meet customers' quality, delivery and cost targets. The laboratory has, however, instigated a programme of continuous improvement and continually reviews customers satisfaction to ensure that its performance stays in line with the increasing expectations of its customers.

TRL operates a quality management system which is certificated as complying with BS EN 9001.



**Transport Research Foundation Group of Companies**

Transport Research Foundation (a company limited by guarantee) trading as Transport Research Laboratory.  
Registered in England, Number 3011746. TRL Limited. Registered in England, Number 3142272.  
Registered Office: Old Wokingham Road, Crowthorne, Berkshire. RG45 6AU



Transport Research Laboratory  
Old Wokingham Road  
Crowthorne, Berkshire, RG45 6AU



Overseas Development Administration  
94 Victoria Street  
London, SW1E 5JL

## **TRL REPORT 260**

# **KEY ISSUES IN RURAL TRANSPORT IN DEVELOPING COUNTRIES**

**by S D Ellis**

Subsector: Transport

Theme: Reduce the costs of constructing, rehabilitating and maintaining road infrastructure and vehicle operations

Project title: Transport Planning

Project reference: R5591

**Copyright Transport Research Laboratory 1997. All rights reserved.**

This document is an output from a project funded by the UK Overseas Development Administration (ODA) for the benefit of developing countries. The views expressed are not necessarily those of the ODA.

**Transport Research Foundation Group of Companies**

Transport Research Foundation (a company limited by guarantee) trading as Transport Research Laboratory. Registered in England, Number 3011746.  
TRL Limited. Registered in England, Number 3142272. Registered Offices: Old Wokingham Road, Crowthorne, Berkshire, RG45 6AU.

First Published 1997  
ISSN 0968-4107

# CONTENTS

	Page		Page
Executive Summary	1	6.4 Constraints to the operation and introduction of vehicles	14
Abstract	3	6.4.1 Institutional factors	14
1. Introduction	3	6.4.2 Farming systems and markets	14
2. Transport as a basic need	3	6.4.3 Income levels	14
2.1 Setting basic needs targets in accessibility planning	4	6.4.4 The efficiency of the transport market	15
3. Accessibility and rural development	4	7. The role of the market in the provision of rural transport services	15
3.1 Accessibility and rural development: cause or effect?	5	7.1 Rural roads	15
3.2 Equity considerations	5	7.2 Rural transport services	15
4. Access to important social and economic facilities	6	7.3 Rural entrepreneurs	16
4.1 Transport costs	6	7.3.1 Rural transport operators	17
4.2 Access to health and education facilities	7	7.3.2 Service and repair artisans	17
4.3 The role of mobile services	7	7.3.3 Urban manufacturers and importers	17
5. Off-road transport as a burden in rural life and its differential effect on women	8	7.3.4 Credit institutions	17
5.1 The off-road transport burden	8	8. Conclusions and implications for further research	18
5.2 Water and firewood collection	8	9. Acknowledgements	18
5.3 The differential effect on women	9	10. References	18
5.4 Possible solutions	10	Appendix A	21
5.4.1 Appropriate modes of transport	10	Appendix B	22
5.4.2 Spatial planning and the use of non transport technology	11	Appendix C	23
5.4.3 Educating men to understand the transport burden on women	11	Appendix D	25
5.4.4 Access to credit facilities	11	Appendix E	27
6. The supply of transport services	11		
6.1 The role of animals and non-motorised transport aids	11		
6.2 The role of tractors and more modern technology	12		
6.3 The provision of conventional transport services	13		

## EXECUTIVE SUMMARY

Investment in rural roads has been a major concern of donor agencies and developing country governments. This process has been well documented, as have the problems associated with the subsequent neglect of this network. However, the importance of transport services in the provision of rural accessibility has largely been ignored until relatively recently.

This review attempts to draw together the key issues in rural transport in developing countries. It draws on the recent literature together with the author's own research in Thailand, Sri Lanka, Ghana, Zimbabwe and Pakistan. The purpose of the review is to redress the balance away from a "roads-only" approach to a more integrated view of rural accessibility which includes planning for the provision of vehicle services.

There are three major themes that run through this review. These are firstly, that the efficient supply of rural transport services is essential to accessibility and the promotion of economic growth. Secondly, that the current emphasis on roads fails to address the problem of rural mobility. An effective rural transport policy needs to take an integrated approach where roads are considered in conjunction with vehicle services and the location of essential facilities and services. Thirdly, that the market has an important role to play in the provision of rural transport services. Excessive regulation can lead to inefficiencies in transport operations.

Historically, conventional wisdom has assumed that good lines of communication (roads) and development go hand in hand. With the advent of road evaluations it was discovered that the relationship between access to roads and development was not always clear. Some author's have found clear evidence to link accessibility in terms of access to roads with economic development, while others have found little or no linkage stating that any correlations that may exist are as likely to come from existing political or natural resource advantages as from road building.

It is proposed in this review that accessibility should be thought of not just in terms of access to roads but also in terms of mobility or access to vehicles. Without mobility rural communities are isolated, which perpetuates the deprivation trap by denying them access to their most basic needs. Isolation will slow down the diffusion of new technologies and techniques, increase marketing and production costs and limit access to education and health facilities.

Recent studies have shown that there is a large off-road transport burden in short distance transport; this particularly concerns the collection of firewood and water and the differential impact on women. Studies have demonstrated

that the majority of village level transport, in terms of the number of trips, time taken, or tonne kilometres, are undertaken along an informal off-road infrastructure. For example, in Tanzania studies showed that the total off-road burden accounted for 80 per cent of total time and 81 per cent of total tonne kilometres in transport activities. Clearly the formal road network does not serve the majority of these rural household's transport needs.

It is also well documented that many Sub-Saharan African countries make very little use of low cost transport aids (eg animals, wheelbarrows, bicycles etc.) to ease this burden. In many rural areas there are no alternatives to headloading, an activity that is mainly conducted by women. In contrast Asian countries have higher levels of both motorised and non-motorised vehicle ownership and greater levels of vehicle diversity.

This report stresses that the poor supply of vehicle services (motorised and non-motorised) in Sub-Saharan Africa, adversely affects the efficiency, reliability and cost of rural transport services. As a result, a more integrated approach to rural transport planning is advocated which not only concentrates on road building, but also on the promotion of vehicle services, location of essential services and the provision of low cost paths and tracks. In addition, the provision of credit, operator and mechanic training, and a regulatory environment which does not restrict competition, are all essential elements to an effective transport system.

There is already a good understanding of the role that many vehicles play in transport systems, including trucks and, to a lesser extent, ox carts and bicycles. However, the importance of mid range vehicles in rural transport has not been considered in detail before. Agricultural vehicles such as tractors and power tillers play a vital role in both goods and passenger movements, as do pickups, motorcycles and indigenously manufactured simple motorised vehicles.

The review of the literature has shown that some of the issues relating to rural transport have been well covered but that there are still considerable gaps in many other areas of our understanding. The burden of off-road transport has been documented but there is little evidence of the implications for the productivity, health and general well being of the mainly women affected.

There is also a need for research on how a more integrated approach to rural accessibility planning can effectively be implemented. There needs to be a greater emphasis on the mechanisms by which vehicle services can be delivered more cheaply and efficiently. Particular attention should be paid to the elasticity of demand for passenger and goods movement, the existence of excessive regulation and the impact of government policy.

# KEY ISSUES IN RURAL TRANSPORT IN DEVELOPING COUNTRIES

## ABSTRACT

This review attempts to draw together the key issues in rural transport in developing countries. It draws on the recent literature together with the author's own research in Thailand, Sri Lanka, Ghana, Zimbabwe and Pakistan. The purpose of the review is to redress the balance away from a "roads-only" approach to a more integrated view of rural accessibility which includes planning for the provision of vehicle services.

The key issues covered include: a) the importance of transport in satisfying basic needs and the relationship between accessibility, mobility and rural development; b) the nature of rural transport and possible solutions to relieving the burden of village level travel, and the disproportionate effect that this burden has on women; c) the role of non-motorised, agricultural and conventional modes of transport are explored together with the constraints to their introduction and operation; and d) the importance of the market in enabling the efficient and low cost operation of transport services.

## 1. INTRODUCTION

Investment in rural roads has been a major concern of donor agencies and developing country governments. This process has been well documented, as have the problems associated with the subsequent neglect of this network. However, the importance of transport services in the provision of rural accessibility has largely been ignored until relatively recently.

The literature review to follow attempts to cover the main issues of relevance to the supply of rural transport services and to put their role in the wider context of rural accessibility. The subject has been divided into the following topic areas:

- 1) Transport as a basic need
- 2) Accessibility and rural development
- 3) Access to important social and economic facilities
- 4) Off-road transport as a burden in rural life and its differential effect on women
- 5) The supply of transport services
- 6) The role of the market in the provision of rural transport services
- 7) Conclusions and implications for further research

There are three major themes that run through this review. These are firstly, that the efficient supply of rural transport services is essential to accessibility and the promotion of economic growth. Secondly, that the current emphasis on roads fails to address the problem of rural mobility. An effective rural transport policy needs to take an integrated approach where roads are considered in conjunction with vehicle services and the location of essential facilities and services. Thirdly, that the market has an important role to play in the provision of rural transport services. Excessive regulation can lead to inefficiencies in transport operations.

Although the review is primarily based on a literature survey, this is supplemented by material collected from recent field surveys carried out by the author in Thailand, Ghana, Sri Lanka, Zimbabwe and Pakistan in relation to a study of rural transport vehicles. This research was carried out at Silsoe College, Cranfield University and undertaken on behalf of the Overseas Development Administration.

## 2. TRANSPORT AS A BASIC NEED

Poor accessibility in the rural areas of developing countries perpetuates the deprivation trap by denying communities access to their most basic needs. Chambers (1983) lists isolation as one of the five factors (isolation, powerlessness, vulnerability, poverty and physical weakness) which contribute to the deprivation trap. Isolation through poor accessibility will slow down the diffusion of new technologies and techniques, increase marketing and production costs and limit access to education and health facilities.

In the past the exact nature of rural people's transport needs were not fully understood and, as a result, transport interventions were mainly in the form of new road building. There is now considerable doubt as to whether new road building necessarily stimulates economic growth and, if it does, do the benefits "trickle down" to the poorest members of the community. As a result, some transport planners are now taking a basic needs approach to development and the provision of transport services. Priority is given to providing access to basic social and economic goods and services.

In order to plan accessibility to respond to people's needs it is important to define what actually constitutes basic needs. At the lowest level of basic needs there are three requirements - food, clothing and shelter. For the purposes of transport planning this definition has to be expanded in order to encompass all the transport elements required to satisfy needs. Howe (1983) lists core level local movement requirements as:

- (i) Health

- (ii) Education
- (iii) Markets
- (iv) Water
- (v) Firewood
- (vi) Other subsistence tasks  
(principally farming)

These six core level local movement requirements represent the first and most important level of accessibility in the rural context. The next level of level of accessibility is to wider needs through access to major centres of activity, and personal movement or travel for non-essential purposes.

Satisfying basic transport needs in rural areas, particularly in many Sub Saharan African countries, represent a significant time, energy and cost burden on households. The time spent on subsistence transport tasks alone can reach up to 40 hours per household per week. In addition, the formal roads network, and the conventional transport services that operate on them, fail to address the fundamental transport needs of rural people.

Most rural transport is conducted on an informal path and track network which links villages, farms, and sources of water and firewood. Women incur most of this burden, particularly with regard to the collection of water and firewood. Poor accessibility also limits access to other vital services such as markets, schools and health facilities, thereby limiting people's productive potential.

If transport planners are to improve access and the ability of rural people to satisfy their basic needs then a more integrated approach has to be adopted. Equal weight must be given to infrastructure (paths, tracks and roads), appropriate modes of transport and the improved location of facilities.

## 2.1 SETTING BASIC NEEDS TARGETS IN ACCESSIBILITY PLANNING

In order to establish whether accessibility planning has been successful it is necessary to set targets to measure the degree of success in providing basic needs. Howe (1981) states that basic needs targets should be based on outputs rather than inputs. For example, in the educational field the number of years of schooling might be used as an input target whereas a typical output target would be based on measured abilities developed by schooling (e.g. success in examinations). In the transport field an input target is the number of kilometres of road built whereas an output target might be a quantified measure of mobility. In some cases there are known relationships between inputs and outputs as is the case with vaccination programmes. However, the contribution that transport investments make to various basic needs output targets (such as trips to health centres, schools and markets) are very difficult to predict as is

demonstrated by the literature on rural road evaluations which will be covered in more detail in Section 3.

Despite the difficulties in setting output targets for rural accessibility there are a number that could be used. For example, all households should be within x km and y minutes from a water source, market or school; all markets connected by a route which is open at least 360 days a year; or all households within x km from a non-motorised transport service. The Pilot Integrated Transport Project in Malawi used these sort of targets to represent the ambitions of the project in providing access to various basic needs. For example, the targets included (a) to have access to water supplies within five minutes; (b) access to health facilities within 30 minutes; and (c) access to grindings mills within 60 minutes.

## 3. ACCESSIBILITY AND RURAL DEVELOPMENT

Creightney (1993) defines accessibility as "the ability or ease of reaching various destinations or places offering opportunities for a desired activity". The elements of accessibility therefore include the infrastructure and the means by which to use it. With respect to rural accessibility the infrastructure will be feeder roads, tracks and paths, and the vehicles (motorised or non-motorised) will provide the mobility. If increased access to roads is provided but there is no provision for vehicle services and hence mobility, then there has been no improvement in accessibility according to Creightney's definition.

Reducing the time and effort involved in reaching essential services is not only a case of providing infrastructure and transport services but also relocating services. By bringing services closer to people or making services mobile, the need for travel is reduced. Jones (1981) adds a further component to accessibility, that of time i.e. the time at which the individual is able to participate and the time at which the facility is available. Particular interventions are likely to suit access to certain facilities and services better than others. For example, access to water, firewood, health and educational facilities can be most improved through the more appropriate location of these services. Crop marketing can be improved through low cost means of transport, conventional transport services and/or the provision of roads. A combination of roads and conventional transport services is the most sensible approach to be taken for improving access to markets and employment activities.

### 3.1 ACCESSIBILITY AND RURAL DEVELOPMENT: CAUSE OR EFFECT?

Historically, conventional wisdom has assumed that good lines of communication (roads) and development go hand in hand. This supposition received such universal approval that road investments were not subject to evaluation on their contribution to economic or social development.



Many observers have found a good relationship between access to roads and economic development. For example, Airey et al (1993) collected data during the village level travel and transport surveys carried out under The World Bank's Rural Travel and Transport Programme (RTTP). He found that the average annual household income of the most accessible villages (in terms of access to an all-weather road and facilities) was always well above the survey area average. In Ahmed and Hossain's (1990) study of rural infrastructure development in Bangladesh they found that infrastructural endowment was associated with a rise in household incomes of 33 per cent, increases in agricultural income of 24 per cent, livestock and fisheries by 78 per cent, and a doubling of wages, while incomes from business and industry increased by only 17 per cent.

However, there is a problem with cause and effect in these examples, a better physical infrastructure does not necessarily imply that faster economic growth will follow. It may be that roads were first built to the villages endowed with the best natural resources and the most fertile soil. In addition, it could be that the most economically successful villages also had the most political influence and were able to ensure that they had the best access to infrastructure.

Creightney (1993), Hine (1982) and Howe (1981) have conducted literature reviews on the impact of roads on development and looked at the question of causality. They all link successful transport investment with good economic potential and stress that an overall dynamism is needed in order that economic opportunity can be sought and quickly exploited. Creightney argues that governments are more likely to invest in areas where opportunities or pressures are greatest, for example, in areas where farmers are experiencing greater agricultural profitability and therefore pushing for increased supportive infrastructure. Where infrastructure has been regarded as an instrument for leading development in the right direction it has often led to wasted investments. Infrastructure investments should be targeted to areas where growth is already occurring or to where there is strong potential.

Hine (1982) points to some of the limitations in the case studies which have attempted to link increases in agricultural production and economic growth with road investments. For example, where increases in agricultural production have been attributed to roads alone this, incorrectly, assumes that accessibility is the sole or most important factor in development. Other contributing factors such as irrigation, fertilisers and entrepreneurial ability are ignored.

The view that accessibility, particularly in the form of access to roads, is not necessarily a precursor to development would appear to be supported by subsequent research from Hine et al (1983a). He found that accessibility (in terms of the transport costs involved in moving produce from village to market) in the Ashanti region of Ghana had

no bearing on agricultural productivity. If anything, the least accessible villages farmed more intensively and sold a greater proportion of their produce. However, evidence was found that the more accessible villages had greater access to alternative sources of income such as from food marketing and the provision of rural services.

Allum (1995) suggests that the effectiveness of road building may be characterised by three distinct phases as a country moves from low to higher income status. In the first phase the contribution that road building makes to economic development is quite limited as potential for growth is limited by factors such as education, health and access to capital. As the country moves in to the second phase the road serves as an enabling force to allow the exploitation of under utilised natural and human resources. The third phase again sees a slow down in the effectiveness of road building as the country reaches saturation point and the contribution to development becomes more marginal.

This approach helps to explain some of the anomalies found in the literature on the contribution that road building makes to economic development and accessibility. Additionally, it serves as a basis for deciding on the most appropriate interventions in particular countries. For example, in the first phase less emphasis should be placed on "road building" and a greater emphasis on extending vehicle accessibility. For example, Hine et al (1983b) calculated that upgrading a path to a motorable track gave benefits some 100 times greater than upgrading the same length of motorable track to a standard gravel road. Similarly, there is also a need to introduce appropriate vehicle technology and relocate essential services. It is only in the second phase that measures of road based accessibility reflect more accurately the true degree of accessibility that rural communities enjoy.

### 3.2 EQUITY CONSIDERATIONS

Although the success of infrastructure investments in terms of increased economic activity and incomes is important, accessibility also needs to be assessed in terms of how it affects income distribution. Howe's (1981) review concluded that although rural roads projects usually increased total income, the differentials between rich and poor also increased. The rich were able to benefit from increased accessibility to a greater extent than the poor.

In a study of a Mexican village the building of a road, and the opportunities that it brought, increased income inequalities and social stratification, increased exploitation of the land, accelerated the loss of forest land and reduced soil fertility. The poor had fewer economic opportunities outside of subsistence agriculture, while the rich bought the best land and were able to mobilise capital more easily. However the road did improve access to other services; the people cited access to proper health care as "the most important change in their lives in the last five years" (Howe, 1981).

In a Nepalese case study the building of a road dramatically increased accessibility; travel times were reduced from about seven days, where porters carried standard loads, to a drive of two to three hours by vehicle. However, the road had little impact on agricultural production and led to a loss of employment in some areas. For example, there was a major loss of portering jobs and Indian made factory goods displaced the goods made by local craftsmen. Business opportunities in the road construction went to the already advantaged with money to invest and even the labouring jobs went to imported Indian labour. Despite the loss of work in some sectors the local economy did benefit from a creation of jobs in the vehicle services industry such as drivers, conductors and mechanics (Blaikie et al, 1976).

Although in the majority of cases improved infrastructure increases access to services, there are cases when the opposite happens. In countries where infrastructure has been improved there may be a tendency to centralise services. Advantage may be taken of the economies of scale that can be created by increasing the size of facilities as their target population effectively increases. However, this may have a negative impact on the poorest sectors of the population who will be put off using services because of the high cost of transport. Improved access to markets encourages the consolidation of land into larger plots, again benefiting the rich and increasing the numbers of landless peasants.

However, Ahmed and Hossain (1990) found that infrastructure investments do have a large positive effect on the incomes of the poor and that the main difference between income groups is where the increased incomes come from. For example, the poorer groups gain more from crops, wages, livestock and fisheries while the richer groups gain more from business and industries.

In the supply of transport services there are also issues of equity that should be considered. The people most likely to be able to afford vehicles, whether animal carts or motor vehicles, are the richer members of the community. Whilst the provision of transport services is likely to benefit everyone through the increased opportunities from improved access, the rich will do proportionately better and in some cases the poor may not benefit at all. Carapetis et al (1984) cites evidence from India that 40 per cent of rural households spend no money on transport at all, and that in Kenya only two per cent of trips were made by paratransit (matatus) and 0.5 per cent by bus. The majority of trips are made by walking.

There is even the question of equity within the household, because the introduction of improved means of production and transport (for example animal draught power) can increase the work load on women. Improved methods of cultivation increase the area of land that can be cultivated and, as a consequence, women have to spend more time weeding and in agriculturally related transport tasks. Im-

proved transport can result in men taking over tasks traditionally done by women. This can reduce their burden but it can also mean that they lose control over a part of household income. For example, women may have been involved in the sale of water and firewood which they have collected or the marketing of surplus crops.

Thus the impact of road building is diverse and case studies have highlighted a great variety of effects, both beneficial and otherwise. In the planning of rural accessibility, it is important that impact studies identify the likely gainers and losers from transport interventions. Where potential losers are identified specific measures should be taken to minimise or cancel out the negative effects. In addition, there are a variety of ways of incorporating equity within conventional economic planning. Either by first identifying likely beneficiaries and then differentially weighting the benefits according to income of the recipients or, more usually, by simply accepting a lower threshold discount rate for projects which benefit the poor.

#### **4. ACCESS TO IMPORTANT SOCIAL AND ECONOMIC FACILITIES**

Trips for social and economic needs such as to health facilities, education, religious centres, markets, government offices, employment and friends and relatives, are an important component of rural transport. In fact there is probably more suppressed demand in this sector than for the transport of goods. Evaluations of road investments often show a considerable surplus of passenger over goods movements. The demand for access to these services means that rural people value them highly and their weighting in accessibility planning should reflect this.

Improved access to major centres of activity such as markets, government offices and credit facilities allow welfare gains through increased agricultural productivity and marketing opportunities. Improved personal travel brings social benefits through a better quality of life, information flows, marketing efficiency and mobility of labour.

##### **4.1 TRANSPORT COSTS**

By their nature, the services described above are usually located in district or regional centres and therefore access is very often along all-weather roads and by hired transport. Even in countries where services such as health facilities or education are provided free, it is not just physical distance or mobility that limits access. In these cases transport charges can represent the greatest impediment in limiting the use of facilities.

In a study on the affects of road construction on health care in the Meru District of Kenya, it was found that the use of hospitals was almost entirely dependant upon vehicle transport. Therefore for hospitals offering a free service, trans-

port charges represented the most important component of treatment costs to the patients (Airey, 1991).

Another study on the same road project in Kenya evaluated the effects of the road improvements on all trip purposes. Surveys were carried out in 1983 (before road improvements), 1986 and 1989 (after road improvements) on journeys where at least one leg of the trip was undertaken by motor vehicle or bicycle. It was found that total incomes rose in this period as did the proportion of income from more accessible external sources. Between 1983 to 1986 average journey distances fell by 20 per cent and average costs by 34 per cent. However, travel expenditure fell from 8.5 per cent of household income in 1983 to 6.1 per cent in 1989. The shift towards a greater reliance on external sources of income is reflected in the trip purposes. The four most important journey purposes, namely work, shopping, social and health, accounted for 81 per cent of journeys in 1989. Table 1 gives a breakdown of the percentage of trips made for each category and by sex (Airey, 1990).

4.2 ACCESS TO HEALTH AND EDUCATION FACILITIES

There is a high economic price to be paid for insufficient access to economic and social facilities, particularly with respect to health and education. The principal asset of poor people is their labour, either for subsistence or wage employment. Poor people are ill more often and are less likely to have savings to support them during ill health. If poverty is to be reduced and productivity increased then labour must be promoted; this can be done principally by increasing access to health and educational facilities.

The 1993 World Development Report (The World Bank, 1993) states that "lack of physical infrastructure is the largest obstacle to the use of health services. Distance to health facilities limits people's willingness and ability to seek care, particularly when transport is limited". Poor access to education also adversely affects human well

being. Studies have found that levels of education are highly correlated with indicators such as life expectancy, female primary education being the most important variable (Stewart, 1988).

The education and health infrastructures in developing countries are often insufficient to meet the needs of dispersed rural populations. For example, the average travel time to reach family planning facilities in Uganda is one hour, whereas it is only 15 minutes in Thailand. In Guatemala, 86 per cent of women have no access to a family planning field worker, but this figure falls to 33 per cent in Egypt (The World Bank, 1993). In the Makete District of Tanzania the average travel time to a dispensary was just over 1.5 hours, and this increased to 5.5 hours for a hospital. In the Aurora province of the Philippines travel times were 25 minutes to a dispensary and nearly two hours to a hospital (Dawson and Barwell, 1993). The distance from medical facilities also has a great bearing on attendance. Howe (1983), cites evidence from Lusaka that for distances of less than five kms 50 per cent of patients attend hospital, this figure falls to two per cent for distances between 33 and 40 kms.

Dawson and Barwell's (1993) studies of rural household and community transport needs in four regions found that the household travel time associated with health issues accounted for only 3.5 per cent of the total household travel time. However, this gives no indication of the importance attached to access to these facilities. In household surveys carried out by the author, access to health facilities was invariably the most common concern.

4.3 THE ROLE OF MOBILE SERVICES

Rural inaccessibility is not exclusively a problem of the developing world. Research in the developed world suggests that many of the problems of inaccessibility can be solved by bringing the services to the people instead of taking the people to the services. Mobile centres can be used for a number of purposes including retailing (as is the case in developing countries today), social and health services, information and advice centres, banking and education. Two main advantages with mobile centres comprise:

- i) Mobile centres can serve small pockets of demand by effectively rolling them together to make a viable operation.
- ii) Mobile centres provide flexibility in that they can be located anywhere; they can arrive at times best suited to the needs of the clientele; they can be used for more than one activity either simultaneously or sequentially; and different types of clientele can be reached with the same vehicle (Moseley and Packman, 1983).

The high costs of reaching fixed public services and facilities may mean that mobile centres can provide a more effective delivery system. This is particularly the case for

TABLE 1

Percentage of trips made by journey purpose and sex in the Meru District of Kenya

Trip purpose	Percentage of journeys (%)	
	Males	Females
Work	39	22
Shopping	16	19
Social	18	17
Health	8	22
School	4	3
Trading	2	11
Personal Business	7	3
Bank	7	4
TOTAL	65	35

Source: A. Airey, 1990.

programmes to promote primary education, vocational training and health. For example, in Bangkok 60 per cent of students attending evening training courses at mobile units in slum areas successfully completed the courses. By contrast a competing scheme based at a fixed facility had a 90 per cent drop out rate (Creightney, 1993).

However, there have been difficulties implementing this type of scheme in rural areas. Overseas Development Administration evaluation reports on rural health vehicles in India and Peru cited a number of difficulties with their use. The largest obstacle seemed to be getting the support of recipient organisations, but there were also problems with the suitability of vehicles for rural roads and the ability to adequately repair and maintain them. Additionally, adequate finance and staff had to be found for effective operation (Thomson, 1983; Harland and Kadt, 1977). Poor management and/or the lack of prioritisation by host institutions for health vehicles in both projects weakened the effectiveness of the schemes.

Moseley and Packman (1983) identified two main disadvantages with mobile services. Firstly the costs associated with such services are high because of vehicle costs and also the "dead time" associated with the movement from one location to the next. Secondly, the quality of the service is unlikely to be the same as a fixed centre. There are certain limitations to the equipment that can be carried and the time spent in any one place.

## **5. OFF-ROAD TRANSPORT AS A BURDEN IN RURAL LIFE AND ITS DIFFERENTIAL EFFECT ON WOMEN**

Although in many rural areas there is basic access through earth, gravel or paved roads, much of the day-to-day transport for the household is undertaken off-road on paths and tracks that have been created by continuous use. The access road may not always reach the desired location or more often may not provide the shortest route for those having to walk or use non-motorised modes of transport. Water and firewood collection is the prime example of transport along off-road infrastructure. Although it varies from area to area, cultivable land, grinding mills, health facilities and schools are often only accessible along local off-road infrastructure.

### **5.1 THE OFF-ROAD TRANSPORT BURDEN**

Dawson and Barwell (1993) looked at studies measuring household transport tasks in the Tanga and Makete regions of Tanzania, villages in three regions of Ghana, and the Aurora Province of the Philippines. Data were collected on internal or village level travel such as water and firewood collection and crop production, and external travel outside the village to

facilities such as markets and health centres. The studies highlighted the burden associated with the transport of subsistence goods and particularly the collection of water and firewood. It was also evident that much of the transport burden fell to women. For example, in Makete internal travel made up 91 per cent of number of trips, 80 per cent of time taken for transport tasks, 96 per cent of weight carried and 81 per cent of tonne-km's.

Journeys for crop production in the African studies were considerably more time consuming than in the Philippines where access to agricultural land is easier and farming methods less labour intensive. For example, the transport burden in the African studies ranged from 11 to 29 per cent of the total time taken for transport tasks in comparison to 5 per cent in the Philippines. The existence of non-motorised vehicles for harvesting, and motorised vehicles for marketing in the Philippines dramatically reduced the amount of time spent on such activities to 1.5 and 1 per cent respectively. In comparison, in Ghana harvesting accounted for 25 per cent and marketing 17 per cent of the total time taken with journeys being characterised by heavy loads being carried on foot over long distances.

Box 1 opposite attempts to put transport movements into context for a household in Zimbabwe. The time spent and effort expended on different transport activities varies greatly depending on the level of vehicle ownership, the type of farming systems employed and the degree of accessibility enjoyed by the village. It is therefore very difficult to make generalisations on the composition of the transport burden in the rural areas of developing countries. However, it is fair to say that as villages become more developed, the transport burden shifts from internal to external travel.

### **5.2 WATER AND FIREWOOD COLLECTION**

In the studies looked at by Dawson and Barwell, water and firewood collection represented a major proportion of internal transport effort. Ranging from 58 per cent of the number of trips in Tanga to 82 per cent in Aurora, transport effort in terms of tonne-km varied from 27 per cent of the total in Aurora to 71 per cent in Makete.

The disproportionate amount of time spent on water and firewood collection is borne out by other studies. Curtis (1986) found in Kenya that round trip water collection times varied from under one hour in the wet season to six hours in the dry season. Similarly fuel collection times can vary from one hour per week in forested areas of Nigeria to 38 hours in Uttar Pradesh, India (Cecelski, 1985). Furthermore there is evidence that the task of water and firewood collection is getting more difficult. Evidence from Ghana suggests that women in the savannah areas have to walk further now than ten years ago. Over half of women in the forest areas are experiencing problems for the first time,

### **Box 1: The day to day transport pattern of a household in Zimbabwe**

The Mapendere family live in village 34 on the Sachuru resettlement scheme about 90 km from Sanyati, a thriving growth point. They are connected by a narrow but motorable gravel road which joins the main good quality gravel road to Sanyati after 20 kms. Despite good road access the family have no vehicle and rely on walking and hired vehicle services. The mother and daughter collect 20 litres of water twice a day which is a 40 minute round trip. Firewood is collected twice per week by mother and daughter; the mother carries 25kg and the daughter 10kg, and the round trip takes in the region of 1 to 1.5 hours. Once a month the mother hires a donkey which she loads with 60kg for the 12 hour trip to the village where the grinding mill is located.

The whole family helps with crop production; the mother and father walk 30 minutes each way twice daily and the children help out on Saturdays. The father goes twice a year to Sanyati to collect maize and cotton seeds. He sets off at midnight to reach the main road for 4am where he takes a bus into Sanyati. He normally arrives back at the village at midnight the following day. An animal cart is hired to transport the harvest from the fields to the village. A villager will then go into Sanyati to try and find a tractor or truck operator willing to come to the village to transport the harvest to market.

The family only goes to the market in Sanyati twice per year, and during the trip they also buy seed. If someone needs hospital treatment they have to travel 12 hours by foot because of the scarcity of vehicle services. The nearest school is one hour each way walking and is also where the mother and children go to church on a Sunday.

Source: Author's survey.

with 30 per cent having insufficient supplies. The number of cooked meals and nutrition levels may be falling as a result. Additionally, agricultural residues such as cow dung and cassava stalk are being used as cooking fuel and therefore denying the land valuable fertiliser (Momsen, 1992).

The introduction of more intensive farming techniques and the continued deforestation in many areas increase the distances involved in looking for firewood. Streams and rivers located at the bottom of ravines have paths that may be steep, narrow and slippery when wet. These conditions not only have implications for the time and effort required but also for the physical well being of those (mainly women) involved in the task.

## **5.3 THE DIFFERENTIAL EFFECT ON WOMEN**

What is clear from many studies is that women are often the ones who shoulder the bulk of the transport burden and in many cases this is made worse by male migration from rural to urban centres. Studies have reported women taking up to 85 per cent of total transport effort in terms of tonne kilometres (Dawson and Barwell, 1993). Appendix A summarises some of the main findings from this and other studies.

A number of theories have been put forward to explain this differential effect but they all stem from the traditional view of the woman's role in the household's productive and reproductive tasks. They are responsible for everything from child care and food preparation to crop production and marketing. This probably stems from the days when men were involved in hunting or communal activities such as territorial disputes which meant that the sexual division of labour was more even. Consequently women were required to stay within the vicinity of the homestead and take care of household tasks and particularly food preparation. Hence activities such as water and firewood collection were just regarded as another component in the final goal of food preparation.

Bryceson and Howe (1992) claim that although traditional roles go some way in explaining the differential in burdens, current social, economic, political and legal factors also play an important role. For example, many African men pay bride price, which imposes labour obligations on wives. This means that load carrying is just another service they are expected to perform. The suitability of a wife is often judged by her load carrying capacity. These divisions are often perpetuated by factors such as the "strong neck theory" which men use to justify women's role as load carriers. Although women do not naturally have "stronger necks" than men it does appear that in an African context they have developed a comparative advantage in load carrying. Moloiy et al (1986) looking at the efficiency of women load carriers in the Luo and Kikuyu tribes of Kenya reported that a load of 20 per cent of body weight could be carried without any increase in their rate of energy consumption. The authors suggest that an element of training and/or anatomical change since childhood allow these women to carry heavy loads (up to 70 per cent of body weight) economically. Training is undoubtedly a factor as the traditional division of labour is imposed early in life. A study in the Kirinyaya district of Kenya found that of all trips made, 59 per cent made by daughters were with a load compared to only 32 per cent for sons (Heidemann and Barth, 1985).

This heavy work load can take its toll on the health of women in rural areas. Where women face a shortfall in their food intake, this can lead to malnutrition and an increase in their susceptibility to disease. If the mother is frequently ill or tired this will affect her children's well being. Curtis (1986) gives evidence to suggest that high levels of anaemia amongst pregnant women combined with a heavy

workload can impair the growth of the foetus and reduce the quantity and quality of breast milk of expectant and nursing mothers.

The actual process of carrying heavy loads can cause headaches and backaches. More seriously the spine can be deformed and osteo-arthritis of the soft tissue of the knee can set in. Accidents can cause slipped disks, injury to carried children and broken backs and necks.

Studies have not yet managed to demonstrate the magnitude of women's burden in the form of the opportunity cost of energy or time. It is still unclear whether reducing women's current burdens would enable them to engage in economic or income generating activities, take more leisure time, or actually collect more of the same subsistence goods. Calvo (1994) suggests that the evidence points to women using time saved from water and firewood collection in free time or spending more time in other household chores, suggesting that their present burden adversely affects their welfare. What is more clear is the economic cost associated with young girls forced to forego their education in order to help in household transport tasks. A poor education will undoubtedly lead to lower productivity in the future.

## 5.4 POSSIBLE SOLUTIONS

The ideas that have been put forward for reducing the burden of off-road transport, and transport in general, are in line with the new holistic approach to accessibility planning. The solutions do not revolve around improved infrastructure as much as through improved transport services by the introduction of appropriate modes of transport, improved location of services, improved access to credit facilities, and the education of men to better understand the differential impact of transport tasks on women.

### 5.4.1 Appropriate modes of transport

Although the variations from village to village and country to country are enormous, it is clear from the research to date that the transport burden on women is lower where there is widespread use of appropriate transport modes. A range of transport solutions could be used but in most cases Non-Motorised Modes of Transport (NMT) will be the most appropriate. Where longer distance travel is required or loads can be amalgamated some tractor based technology or conventional vehicles can be used (see Sections 6.2 and 6.3).

Women may not benefit directly from access to NMT's but there is an indirect benefit as men take on tasks traditionally thought of as women's work once they become mechanised. This process is by no means immediate and universal, but it is clear from the data and field observations that the trend is in this direction. For example, in a Ugandan case study on the introduction of bicycles, Calvo (1994) observed that although women have limited access to bicycles there was a transfer of responsibility of certain tasks from

women to men. This was particularly the case for travel to grinding mills but less so for water and firewood. Similarly Doran (1994) found that animal cart ownership in Zimbabwe led to the delegation of duties within the household. Older women would often delegate water and firewood collection to boys or young men. Interestingly, this was particularly true if the household owned large water drums.

Although in many cases the introduction of NMT's can reduce women's burden, there are circumstances where NMT's make very little impact or actually adversely affect women's welfare. For example, poorer households who do not own NMT's are unlikely to hire them for subsistence transport such as the collection of water and firewood whereas they would do so for the income generating task of agricultural production and marketing. In cases where women supplement their income from the collection of subsistence goods or marketing tasks, the introduction of NMT's and subsequent transfer of responsibility of these tasks to men can mean that women are displaced from income earning opportunities. Poor access to NMT's by women is an important problem, and the main causes for this are listed below:

- i) Traditionally women's roles have been many and varied, from food preparation and child care to crop production and marketing. The result is that they have a multitude of tasks that must be completed, often at the same time, for example the collection of water and cleaning of clothes, crop production and firewood collection and, in all cases, the care of infants. This multi-tasking requires that women retain flexibility which may not be achieved with a single NMT.
- ii) By the nature of subsistence transport tasks there can be no direct financial return. As a result, the purchase of NMT's for subsistence transport has a very low priority in household expenditure, especially when finances are controlled by men. Additionally, the investment in even the simplest of NMT's can represent a large proportion of the household's annual income particularly for the poorest members of the community.
- iii) The nature of the off-road activities in which women are involved make many NMT's, particularly those with wheels, unsuitable. For example, water supplies may be accessible only from steep and rugged paths, and firewood collected in areas without cleared paths. The problems of the suitability of NMT's are particularly relevant in mountainous and forested areas.
- iv) Finally there is the problem of cultural taboos about women using certain NMT's and the faster take-up of new technology by men, probably more as status symbols than for practical use. For example, in many societies it is not acceptable for women to ride bicycles.

#### **5.4.2 Spatial planning and use of non transport technology**

There are certain non-transport measures that can be taken to reduce the time and burden in the transport of subsistence goods. These involve the location of services such as wells and wood lots in the immediate vicinity of the village and hence reducing the time and distance involved in transport.

The introduction of wells and hand pumps into villages not only reduces the time and effort involved in collecting water but also provides a cost effective alternative to many NMT's. For this technology to be viable there must be community involvement at all planning levels. They must recognise the need for the service and eventually pay for, manage and maintain it themselves.

Not only does the cost of such schemes compare very favourably with NMT's but it also gets to the root of the water supply problem. If wells are sited having consulted all sections of the community, the drudgery involved in water collection can be reduced. Evidence from countries in Sub-Saharan Africa suggest that large time-savings can be made by households in their collection of water. Time savings range from one minute in Malawi to almost two hours in Mozambique, Zaire, and Chad (Calvo, 1994). Additionally, ground water provides a safer source of water thereby reducing illness from water borne disease. Better health and less time spent in subsistence tasks should result in increased rural productivity.

There are also non-transport measures that can be taken to reduce the demand for fuel collection, for example, the introduction of fuel efficient stoves and planting wood lots close to villages. Studies in Mali, Kenya and parts of Asia have found that fuel efficient stoves can result in a 30 per cent reduction in the use of fuel (Calvo, 1992). Agro-forestry and the development of home gardens which combine tree and bush cultivation with agriculture can greatly increase productivity. In the process food, fodder and fuel can be harvested whilst helping to avert the problem of production seasonality. The time that women usually use to collect firewood can be diverted to the cultivation of these home gardens.

#### **5.4.3 Educating men to understand the transport burden on women**

By using participatory techniques which ask men to detail women's tasks and the time they take, it is possible to increase their awareness of the transport burden on women. The men in the community may not actually take over any of this burden but they may release household funds for the purchase of labour saving devices or allow the use of existing NMT for household tasks.

#### **5.4.4 Access to credit facilities**

Conventional institutional structures often preclude women from receiving credit, either because of their lack of collateral or because of their inability to demonstrate any financial return from the venture. However, evidence from the Grameen Bank in Bangladesh suggests that women have a far lower default rate than men. The number of rural women in Bangladesh with access to institutional credit has more than doubled since the mid eighties to over two million (Goetz, 1994). Additionally Mosley and Hulme (1994) argues that credit for consumption provides a vital developmental function in making it possible for the poor to reach a position where it is rational for them to invest in micro enterprises.

### **6. THE SUPPLY OF TRANSPORT SERVICES**

As has become apparent from the preceding discussion, the supply of transport services in the form of vehicles is often overlooked both in the planning of infrastructure and accessibility in general. Vehicle tracks and roads are of no use unless there are vehicles to operate on them. This Section describes some of the most commonly used vehicles in rural areas, their operating environments and characteristics. A summary of commonly used rural vehicles is given in appendices B to E. It also attempts to identify some of the constraints to the successful operation and introduction of vehicles and target areas deserving of further research. The section is split into four parts:

- (i) The role of animals and non-motorised transport aids
- (ii) The role of tractor technology
- (iii) The role of conventional transport
- (iv) Constraints to the successful operation and introduction of vehicles

#### **6.1 THE ROLE OF ANIMALS AND NON-MOTORISED TRANSPORT AIDS**

The role of animals and non-motorised transport aids (these can be combined as NMT's) have largely been underestimated in the planning of rural roads and rural transport services by conventional transport planners. For example, the existing road appraisal models such as the Transport Research Laboratory's "Road Investment Model" (RTIM) and the World Bank's "Highway Design and Maintenance Standards Model" (HDM) have not included components for operating cost, time and generated traffic benefits associated with NMT's and particularly animal carts.

The role of NMT's is particularly important in some Asian countries. In Bangladesh for example, a 1986 survey found that non-motorised vehicles accounted for 94 per cent of all



commercially operated vehicles and two thirds of total carrying capacity (the majority of these are probably accounted for by rickshaws). However, public investment in the non-motorised sector (excluding the provision of ordinary road space) accounted for only 0.004 per cent of total transport expenditure (Dawson and Barwell, 1993). Similarly, in India it is estimated that there are 15 million animal drawn carts carrying 1200 million tonnes of goods per year (Saxena and Varkeyachan, 1989). This is in the region of five to six times the quantity of goods being carried on India's railways. Bhalla et al (1994) further puts these results in context. His findings show that although there has been a fall in the importance of non-motorised transport in India it still represents a very significant part of total freight movements. In 1989 animal carts accounted for about half of all tonnes moved and in some areas this rose to 73 per cent when all non-motorised modes were considered.

Although in many parts of Asia there is an important role played by animals and other non-motorised modes of transport, this is by no means global. Starkey (1989) estimates that although the population of Africa is half that of India, Africa has only a twentieth of the number of animal carts. According to some estimates, for every ten African farmers who own animals for draft agricultural purposes only one owns a cart. This is also the case for other forms of non-motorised transport. The reasons behind the low take up of NMT's in Africa are discussed in Section 6.4.

NMT's can have an important role in many of the rural communities which suffer most from poor access to key subsistence, economic and social services. They can increase both load capacity and speed and expand the range over which people can seek economic opportunities. NMT's can reduce the drudgery of subsistence tasks, and are appropriate for operation on the existing network of paths and tracks without the need for expensive road building schemes.

However, in most of Sub-Saharan Africa there is little alternative to headloading or transport by trucks. It is often not viable to operate a frequent transport service in small rural communities and hence many villages are only served by motorised transport on markets days. There is an enormous gap between the productivity of trucks and headloading and, where there are no alternatives, the introduction of NMT's may allow the productivity gap to be plugged. They provide a vital step between the high load, high speed and high technology trucks and the drudgery involved with headloading.

## **6.2 THE ROLE OF TRACTORS AND MORE MODERN TECHNOLOGY**

Whilst NMT's have been struggling to gain credence with government policy makers in developing countries and donor agencies, tractors and other motorised technology have often been seen as a "quick fix". In trying to open up large new agricultural areas to production and increase the

intensity of cropping in others, the tractor has often seemed like an attractive proposal partly because of its range of uses. These include agricultural preparation, transport, threshing, pumping water and use as generators. The rugged nature of these vehicles has seemed particularly appropriate for areas with accessibility problems, where roads are heavily rutted or where there are difficulties of seasonal access. However, even with large subsidies, tractor programmes have often failed because the tractors are not sufficiently utilised or maintained (see Section 7.2).

The debate over the use of mechanisation in agriculture and transport revolves around the point at which traditional methods can or should be substituted for modern technology. If it is assumed that draught animal power (DAP) and tractor power are perfect substitutes then the move from DAP to tractors will only take place as factor inputs such as labour and feed costs reach such a level that DAP services become uneconomic (the substitution effect). However, if it is assumed that there are certain productivity advantages through increased yields in using tractor technology (the productivity effect) the argument becomes more complicated. For example, the power of the tractor enables it to use larger implements for deeper ploughing. The tractor also allows speedier and more continuous operations, and timely ploughing ensures that planting can take place at the optimum time. In reality there are both productivity and substitution effects, and to complicate the situation further, both animals and tractors are used intensively for transportation.

Binswanger (1978) reviewed various cost benefit analysis studies of tractor and DAP projects and found that the productivity effects associated with tractor use are relatively small. He argues that the substitution effect is far more important and, as such, tractor projects are unlikely to increase agricultural production. In other words, tractors should be substituted for DAP where land pressures lead to animal shortages and high feed costs, or where there are high or rapidly rising labour costs and labour shortages. This may be the case in parts of Asia, but in much of Sub-Saharan Africa at the moment, labour and animal costs are relatively low. In those parts of Africa where DAP is widely used there may be little economic advantage in switching to tractors. However, in many African countries little use is made of draught animals. The reason for this appears to be because of culture, heavy soils in forest zones and the incidence of tsetse fly.

Agricultural tractors and power tillers are primarily thought of in terms of their use in agricultural preparation and, indeed, this is the main reason why they are bought. In fact in many countries they are used almost exclusively for transport purposes, not only for the transport of harvest and inputs but also for marketing, building materials, passengers and any other freight that may be available. In Binswanger's study he finds that the transport use of tractors for agricultural and non-agricultural uses in South Asia exceeds 23 per cent of the total in all cases, and he finds



examples where this rises to 42 per cent. In recent studies in Pakistan, Zimbabwe and Ghana, the author has also found that for some tractor owners transport can account for up to 100 per cent of tractor usage and, additionally, that this work was often the most profitable.

As well as four wheel tractor technology there is also the two wheel tractor or power tiller. Power tillers have provided the next step to draught animal power in many parts of Asia, performing many of the same tasks as conventional tractors but at a fraction of the initial purchase cost. They have been primarily designed for ploughing operations in paddy fields but are truly multi-purpose with other uses which include threshing, transport (when attached to a trailer), pumping water and power generation. The key to their success has been the versatility of the single cylinder diesel engine which can easily be detached and used for other purposes. The Japanese version of the engine is light, reliable and easy to repair and maintain. Srisakda and Chivasant (1992) cites an example in Thailand where the engine is removed from the power tiller and attached to a purpose-built transport vehicle similar to a pickup truck.

The main objection to the use of power tillers in Africa is their poor performance in ploughing on hard ground due to lack of traction. The Institute of Agricultural Engineering in Harare found that their performance was equivalent to animal traction and therefore did not recommend promotion in Zimbabwe. However, their performance in transport is far greater than DAP and they would make an ideal alternative in areas with light soils or irrigated land. One of the problems in rural development is that agricultural policy has too often been divorced from transport policy. A more integrated approach has potential for developing large productivity gains.

Despite the widespread use of agricultural vehicles for transport there has been very little research on their contribution to the provision of transport services at the rural level. However, there have been a number of studies that have identified the transport potential of agricultural vehicles. Cheesman (1990), found that tractor operations can often be more cost effective than truck operations for maize transport in Malawi. Crossley (1986) has also looked into the cost effectiveness of various agricultural vehicles for transport operations. He has developed a model for the prediction of vehicle operating costs for the full range of agricultural vehicles as well as for the more conventional motorised vehicles. Both authors have found that agricultural vehicles provide good alternatives to conventional vehicles, particularly for relatively short distances (less than 50 km) and on poorer quality roads.

### 6.3 THE PROVISION OF CONVENTIONAL TRANSPORT SERVICES

The ownership of motor vehicles in much of rural Africa is extremely rare. In Makete in 1987 there was only one four wheeled vehicle and three motorcycles for 13,700 people, with the situation in rural areas of Ghana being similar. In Tanzania the conventional transport services that were available provided transport for local officials, the collection of crops from marketing boards and transport of building materials and fuel. They did not provide a means of transport for rural people. In Ghana where a limited motor vehicle service operates, transport is for external marketing, health, and social trips (Dawson and Barwell, 1993).

In an ideal scenario, conventional vehicles would provide the last link in the transport chain. NMT's, tractor based vehicles or smaller conventional vehicles would transport produce to the village and primary markets. From the primary markets, conventional vehicles in the form of trucks or pickups would distribute goods along inter-urban roads to urban centres.

However, what often happens is that a shortage of both conventional, tractor based vehicles and NMT's necessitates the transport of produce from farm to village by headloading. In addition, the vehicles that are available are often owned by urban based businessmen and traders who buy produce from the village and transport it to market. In so doing the farmers become isolated from the main urban markets and institutional credit facilities by monopoly providers of transport. A Ghanaian survey found that 57 per cent of small scale farmers sold the major part of their crop surplus at their home compared to only 24 per cent who sold their surplus at the local market (Hine et al, 1983b). In the situation where farmers have no access to alternative transport services, and become isolated from the main urban markets, the traders are in a position to exploit them.

Despite the low usage of conventional transport services by rural households, they provide an essential link between the villages and major activity centres. As discussed in Section 4 it is these services which provide the majority of the rural population with access to economic, social and welfare facilities and, although they represent a small proportion of their transport demands, they are highly valued.

In many of the more developed communities, trucks provide the cheapest method of transporting large quantities of agricultural produce and inputs over long distances because of their high load capacity and relatively high speed. They are particularly used on inter-urban routes or rural routes where there is high demand. Pickups by contrast gain their advantage from high speed and their manoeuvrability in congested urban areas. Their low payload is often ideal for small scale farmers either for agricultural or passenger transport. Motorcycle technology has many of the same

advantages as the pickup such as their use for goods and passenger movements, however they operate in a lower demand environment. For example, in Malaysia they are used for the collection of rubber from rubber plantations.

Section 4 demonstrated the reliance that rural people have on passenger vehicle services for access to major centres of activity and for social travel. The type of vehicles used and the way the service is provided varies greatly from country to country. For example, many countries rely almost entirely on paratransit type vehicles for mobility in rural areas. Other countries subsidise more conventional bus services to operate in rural areas; they run to a fixed time table and fares are relatively low. However, these services are often limited; for example, in the northern and southern regions of Malawi there is only one bus per 30,000 people, and this decreases in the central region where there is only one bus for every 45,000 people (Gaviria, 1991).

## **6.4 CONSTRAINTS TO THE OPERATION AND INTRODUCTION OF VEHICLES**

### **6.4.1 Institutional factors**

The most commonly stated reasons for the slow take-up of NMT's, particularly in Sub-Saharan Africa, are summed up by Kaira (1983) who thinks it is due to two factors - attitude, and custom or lifestyle. Kaira suggests that the attitudinal problems stem from centrally located institutional bodies who think that rural transport is "roads and motor vehicles", and that NMT's represent an outdated and backward technology. Carapetis et al (1984) also finds that officials do not fully understand the extent of rural transport problems. He quotes assurances given by officials such as "every village economically worthy of the name is connected by motorable road" (Sierra Leone); and "all farmers have at least either animal carts or pack animals" (Tunisia). However, the custom or lifestyle element also relates to traditions or taboos which may prevent sections of the community, particularly women, from the use of certain animals or of particular technology (e.g. bicycles).

### **6.4.2 Farming systems and markets**

Although institutional attitudes and culture are undoubtedly factors that must be addressed in promoting rural transport systems they do not represent the whole answer. Transport is a derived demand and, as such, transport services will develop as a response to demand. Where the intensity of agricultural production and population density are low, as is the case in much of Sub-Saharan Africa, the subsequent demand for transport will also be low.

The existence of this relationship between farming systems and population densities has significant implications for transport planning and demand for the transport of economic goods. It has already been noted that the bulk of rural

transport in many communities is for subsistence goods but the movement of these goods does not generate any direct financial return. As a result, there is very little effective demand for new vehicles because it is difficult to exploit the economies of scale of particularly motor vehicle transport. Hence, where population density and incomes are low there will be little demand for more efficient forms of transport. Where rural populations are dispersed it is more difficult to exploit the synergies between low cost transport services, a competitive marketing structure and agricultural innovation and development.

This scenario could go some way in explaining the lower vehicle densities in Sub-Saharan Africa compared to many parts of Asia. In general, Sub-Saharan Africa has low population densities and long distances between markets. It is clear that both demand and distance play an important role in determining a person's choice of vehicle. More research is needed on the most appropriate vehicles for areas where demand is dispersed and distant. For example, in the fertile and densely populated areas of Pakistan, animal transport is prevalent. In contrast the inaccessible hilly areas where population density is low and markets distant, pickups are used. It may be that in the latter areas the promotion of NMT's is inappropriate and that conventional vehicles would provide a more productive alternative. However, it is recognised that in difficult terrain pack animals may also have an advantage. For example donkeys are used in the inaccessible parts of Nepal.

### **6.4.3 Income levels**

A major factor influencing the level of vehicle ownership is the level of income from farming and, possibly more importantly, access to alternative sources of income. In Thailand for example, where there has been rapid growth in the construction and industrial sectors of the economy, there are increased opportunities for rural dwellers to find work in urban areas. This work is usually at far higher rates of pay than is the case for agricultural work. The money earned from these sources is then used to buy vehicles that can improve agricultural productivity, as well as income earning opportunities from transport services. Agricultural incomes and access to alternative income are often lower in much of Africa than is the case in Asia. Low rural incomes often preclude people from buying even the cheapest of NMT's, and makes them reliant on headloading and urban based traders.

### **6.4.4 The efficiency of the transport market**

The supply of transport services is particularly governed by the efficiency of the transport market and the degree of competition present in that market. In turn, this will affect how rural entrepreneurs provide essential backup services such as vehicle servicing, routine vehicle maintenance, vehicle manufacture and the provision of credit. The level of competition has a bearing on how efficiently these services are provided, the level of vehicle utilisation and

hence the price of transport services. These factors are discussed in more detail in the next Section on the role of the market in the provision of rural transport services.

## **7. THE ROLE OF THE MARKET IN THE PROVISION OF RURAL TRANSPORT SERVICES**

The theme of the 1994 World Development Report was "Infrastructure for Development". Emphasis was put not only on the quantity of infrastructure investments but also on the quality of infrastructure services (The World Bank 1994). The report attempted to identify some of the mechanisms by which the quality of services could be improved particularly through increased use of the market and competition. In this Section an attempt will be made to analyse the lessons that may be applied to the supply of rural roads and rural transport services.

### **7.1 RURAL ROADS**

Infrastructure services can be categorised according to the extent that they can be regarded as private or public goods. A private good is defined as both "rival" (consumption by one user reduces supply available to others) and "excludable" (a user can be prevented from consuming them). Private infrastructure services therefore include telecommunications, water supplies, railways and ports. To a lesser extent urban and interurban roads can be included in that congestion makes them "rival" in nature, and modern technology can enable users to be charged or excluded from use of the service, particularly in urban areas. In contrast, rural roads can be defined as pure public goods. They are typically non-excludable and non-rival, as the addition of an extra user will not reduce the supply to other users (i.e. no congestion), and there is no way to exclude users. As a result, it has traditionally fallen to government to build and maintain rural roads and the market has played no significant role.

Although the physical infrastructure in rural areas may not be suitable for private investment there are a number of measures that will make provision more responsive to the needs of rural people. If funds can be diverted to the regions, local institutions are more likely to be in tune with the demands of local people and therefore prioritise infrastructural investment more efficiently and with less wastage. Local level involvement at all levels of planning will also increase commitment to the day to day maintenance required, the lack of which is probably the most common source of failure in infrastructural projects. A World Bank (1994) review of 42 developing countries found that where maintenance was decentralised, backlogs were lower and the condition of the roads better. At the national level it is argued that more emphasis is placed on the technical criteria of road building rather than the social issues relating to quality and appropriateness of service.

However, total decentralisation is unlikely to be practical in many developing countries because of the lack of management and engineering skills at the regional level.

Whilst there must be decentralisation of the decision-making process to local institutions, participation from the local community is also essential. A review of 25 projects (mostly in agriculture and rural development) five to ten years after completion found that participation by beneficiaries and grass roots institutions was a key factor in those projects long term success. Again a lack of participation from the early stages often leads to poor maintenance (The World Bank, 1994).

In addition to increased community participation and the decentralisation of the decision making process, existing public sector road organisations can benefit from market discipline. By commercialising the management and maintenance of the existing road network, there is scope for efficiency gains and cost saving measures. An example of this is a shift from force account maintenance works to the use of private contractors.

Funding for road maintenance is also a particular problem because budget allocations from government represent only a small fraction of total requirements. A possible solution being tested by Africa's Road Maintenance Initiative is to develop "Road Funds" which are separate from the government's budget allocation process. These funds are earmarked solely for road maintenance with revenues coming from explicit road tariffs in the form of fuel levies and vehicle license fees (Heggie, 1994). A proportion of these funds find their way to rural roads but additional funds are required. Possibilities include local taxes, village funds, tolls and license fees for NMT's.

### **7.2 RURAL TRANSPORT SERVICES**

As with the provision of the physical infrastructure, the supply of rural transport services will also benefit from increased institutional efficiencies and market discipline. An effective rural transport system is not just reliant on the provision of roads but also on the vehicles that will provide the transport services. In case studies undertaken in Egypt, India, Botswana and Thailand it was found that the provision of the road was taken to be synonymous with the provision of transport services. No account was taken of the constraints that may be present to the supply of appropriate vehicles (Howe and Roberts, 1984).

The fact that planners have often overlooked the constraints associated with the supply of rural transport services, particularly in Africa, has meant that services can be unreliable and expensive. It has been calculated that African farmers receive only 30-50 per cent of the final price of products, compared to 70-85 per cent in Asia (Ahmed and Hossain, 1990). In a similar study of interurban freight movements in Pakistan and French-speaking Africa, freight

charges were found to be between four and six times more expensive in the African countries studied (Rizet and Hine, 1993). The main reasons for the higher transport charges in Africa were higher input prices, poorer utilisation and higher variable operating costs. The magnitude of the difference in charges provides clear evidence that the markets for African transport have some serious failings.

In addition to high transport charges, rural areas, particularly in Sub-Saharan Africa, suffer from a shortage in the supply of transport services. Evidence from Zimbabwe suggests that the number of motorised trips per person per week in rural areas is only between 0.2 to 0.5 compared with 3.5 in urban areas (SWECO, 1985). These low rural trip rates may be due to high transport charges, the limited research that has been undertaken gives price elasticities of demand in the range between -0.4 and -2.0. For example, an elasticity of demand for transport of -1.0 implies that a one per cent decline in charges will bring about a one per cent rise in traffic. Furthermore, vehicle ownership (motorised and non-motorised) in the rural areas of Sub Saharan Africa is far below the levels found in Asian countries with comparable incomes. For example, in recent surveys the author has found that vehicle ownership in rural areas of Sri Lanka are 14 times higher than in Ghana for non-motorised vehicles and 5 times higher than in Zimbabwe for motorised vehicles (Ellis and Hine, 1995).

There are a number of constraints to the operation of vehicles other than the quality of the road. These include the availability of credit, vehicle backup services for their repair and maintenance, availability of spare parts, operator and mechanic training, information on the types of vehicle available, and uncompetitive transport markets.

In many cases, transport services in African countries are highly regulated. There is often heavy union intervention as is the case in Ghana where all operators must register with the Ghana Private Road Transport Union (GPRTU) which controls prices, routes, membership and queuing for loads. In Zimbabwe, passenger transport is regulated both in terms of price and quality, which has a negative impact particularly in rural areas. Bus companies are required to operate on loss-making rural routes in order to receive permits to operate on the more profitable interurban routes. As a result buses leave the rural areas very early in the morning and return late at night. In Harare, where the bus service has been liberalised, there has been a large take-up in the use of small minibuses, as in many other African countries where this has happened (Maunder and Mbara, 1995). The result is that public transport can profitably go to low demand areas and provide a more regular service. If the existing regulations against the use of paratransits in rural areas of Zimbabwe were reduced, minibuses or pickups would undoubtedly provide a cost effective alternative to large buses and at the same time provide a better more frequent service.

In order to promote rural development many countries have supplied tractor services, and particularly ploughing services, at subsidised prices. Under government hire schemes, tractors are used primarily for ploughing and are restricted to one agro-climatic zone. The result is normally failure, with a high proportion of the tractors becoming inoperative after a few years. Seager and Fieldson (1984) found that of a sample of twenty-one government tractor hire schemes, all but one ended in failure. The reasons for failure included the fact that there are no economies of scale associated with operating large tractor fleets, problems with staff motivation resulting in low efficiency, the inability to reward staff financially for maximising the number of hectares tilled or keeping tractors in good working order, and low utilisation. Conversely, in the private sector operators benefit directly from increased efficiency and hence have the incentives to increase utilisation. They will move from one agro-climatic zone to the next and diversify their operations into transport as is the case in Sri Lanka and Pakistan. In the case of a successful farmer co-operative in Zimbabwe, the author found that of the 1500 hours operated in a year, 1000 hours were devoted to transport which represented 78 per cent of its income.

Pingali et al (1987) quote extreme examples such as Sierra Leone where there was a 96 per cent subsidy on public operations. The authors suggests that even in Swaziland with a 24 per cent subsidy, private contractors are unwilling to enter the market even though there is excess demand. Subsidy or any interference in price setting can lead to monopolistic, inefficient operations and low utilisation. This is the case under both union control, for example the GPRTU in Ghana, and government controlled or government subsidised tractor hire schemes.

### 7.3 RURAL ENTREPRENEURS

Biggs (1993) has found that the rapid spread of two wheel tractors in Sri Lanka was primarily due to the innovative capabilities of small scale rural entrepreneurs who had experience and access to a wide variety of skills. These entrepreneurs included vehicle operators, repair and maintenance artisans as well as the large scale urban machinery manufacturers and importers. It was the skill and forward planning of these entrepreneurs which meant that early fears about insufficient backup services and the poor availability of spares for the imported tractors were not realised. The problem of inadequate maintenance which has dogged so many developing countries in their attempts at mechanisation were not evident in Sri Lanka.

The evidence from Sri Lanka suggests that calls made by some observers for vehicle standardisation fail to get to the root of the problem which is usually the inadequate vehicle backup infrastructure. Very often the lack of communication between machinery manufacturers, importers, rural artisans and vehicle operators means that the latter are forced to operate in an information vacuum. This is particu-

larly the case for first time vehicle users. Consequently better education and training is needed for all those involved in the supply, service and operation of vehicles. Overall it appears that interventions to improve the efficiency of rural transport services may be more successful if targeted towards assisting rural entrepreneurs rather than the more conventional subsidised schemes such as the tractor hire companies described in Section 7.2.

### 7.3.1 Rural transport operators

The skills and entrepreneurship of rural transport operators can have a large impact on the costs of vehicle operation, both with regard to repair costs and vehicle utilisation. From the author's field experience in Ghana and Pakistan it was found that there were considerable differences in routine vehicle maintenance conducted by operators. For example, the routine changing of engine oil and filters occurred more frequently in Pakistan and as a result engine overhauls were only necessary after five years in comparison to as often as every two years in Ghana. In addition, vehicle operators in Pakistan actively sought new business opportunities even if it required them to travel hundreds of kilometres, whereas in Ghana vehicles can remain idle for long periods of time. The higher levels of vehicle utilisation in Pakistan also has a direct impact in reducing their vehicle operating costs.

Training programmes targeted at rural transport operators designed to improve routine maintenance practise, and increase awareness of the benefits from diversifying operations to increase vehicle utilisation, could bring large savings in vehicle operating costs. Additionally, operators should be kept informed of new vehicle technologies and of the most efficient operating practises.

### 7.3.2 Service and repair artisans

A good example of how vehicle service and repair training can be undertaken has been initiated in Kumasi, Ghana, where a large area has been developed for servicing vehicles. Over 60,000 artisans operate in this area, providing services from engine overhauls and manufacture of nuts and bolts to the strengthening of truck chassis' and elongating of cars to make bigger taxis. Workshops have been set up to disseminate skills around the artisans and to regional capitals and eventually to rural areas.

Once individuals have been trained they should be encouraged to set up on their own or work for local businessmen. They are then more likely to be able to respond to the needs of the local population. Experience from Zimbabwe at a tractorisation programme set up by the Institute of Agricultural Engineering and the French Technical Co-operation suggests that service facilities under the control of the Institute are unlikely to be sufficiently responsive to rural needs. Consequently vehicle operators in the area had to travel to Harare to buy even the most common components.

Businessmen in the area wanted to take on the facility at their own risk, as they were aware of the local problems and where the demand lay. For example one businessman said that he would diversify the business to include the manufacture of animal carts.

### 7.3.3 Urban manufacturers and importers

Good lines of communication between urban manufacturers and importers and rural operators are useful in enabling manufacturers to respond in innovative ways to rural demands. Domestic firms are more likely to respond to the requirements of rural operators in terms of price and quality. For example, Thailand has a very developed manufacturing base, producing machinery that exactly fits the requirements of farmers' needs. Urban and peri-urban factories produce power tillers and simple transport vehicles built to a cost and specification ideal to the skills and resources available in rural Thailand. In the provision of certain types of transport equipment, particularly non-conventional vehicles, there is a need for a domestic capability to manufacture and to adapt imported vehicles to suit local conditions.

### 7.3.4 Credit institutions

Mosley and Hulme (1994) states that "One of the most obstinate barriers to poverty relief, and to development as a whole, has historically been the inability of the poor to borrow for productive capital investment". This is particularly relevant for transport services where even the simplest of NMT's can represent a major portion of a poor person's annual income. Having analysed successful and unsuccessful credit institutions in a number of countries Mosley puts forward six conditions necessary for long term sustainability:

- (i) Institutions should be allowed to pass the full cost of borrowing on to the borrower;
- (ii) Loan instalments should be collected frequently i.e. weekly;
- (iii) Positive incentives should exist for repayment, for example rebates to borrowers for full repayment and performance related pay for bank staff;
- (iv) lenders should be insured against loan default, possibly through compulsory saving into a loan insurance fund;
- (v) systems should also require that borrowers save;
- (vi) Institutions should be able to redesign schemes rapidly as shortcomings become apparent.

Although a detailed analysis of the way credit institutions are set up is not relevant here it is clear that in the initial planning of rural transport services credit availability is essential for the supply of vehicles and their backup serv-

ices. However, heavily subsidised rural credit schemes have a very poor success rate and default rates are high. It is likely that rural credit schemes which "piggy back" already established credit institutions, both formal and informal, will be more successful. For example, existing money lenders already know the credit worthiness of local people and working with them can help to reduce risk and administrative costs. Furthermore, any interventions should be carefully targeted, not at the cost of credit (the availability of credit is far more important to the poor than the cost), but at the training of bank staff and borrowers in terms of record keeping and planning for the future. It is very common in developing countries for vehicles to be out of service not because of the lack of spares but because inadequate provision had been made on the part of operators for the eventuality of breakdown. This not only means that the operator loses income but that there is default on any bank loans. For the long term sustainability of any credit program sufficient resources have to be put into the root causes of loan default and in many cases this is due to inadequate training and education.

## 8. CONCLUSIONS AND IMPLICATIONS FOR FURTHER RESEARCH

The review of the literature has shown that some of the issues relating to rural transport have been well covered but that there are still considerable gaps in many other areas of our understanding.

There is now a good body of evidence to confirm that there is a large off-road transport burden in short distance transport; this particularly concerns the collection of firewood and water and the differential impact on women. It is also well documented that many Sub-Saharan African countries make very little use of low cost transport aids (eg animals, wheelbarrows, bicycles etc.) to ease this burden. What is less clear are the implications of this burden for the productivity, health and general well being of the mainly women affected. There is also very little research on the best methods for promoting transport aids that may reduce this burden, and on the benefits from the improved location of essential services and subsistence goods.

With regard to the physical infrastructure there are many studies that have attempted to measure the impact of rural roads on agricultural productivity and rural development in general. Indeed the main thrust of transport policy in developing countries has been to improve accessibility in rural areas through the provision of rural access roads. The results of this literature survey suggest that this approach may have been too narrow and therefore largely ignored issues relating to the provision of rural vehicle services.

Evidence from a number of countries suggests that there is poor availability of vehicle services in rural areas, particularly in many areas of Sub-Saharan Africa. In contrast urban areas

may have a surplus of vehicles waiting at bus and truck parks. Research is needed on how a more integrated approach can be taken to the planning of rural accessibility. There needs to be a greater emphasis on vehicle services and the mechanisms by which they can be delivered more cheaply and efficiently. Particular attention should be paid to the elasticity of demand of passenger and goods services as well as density of demand, the existence of excessive regulation and the impact of government policy.

Equity is another consideration which needs to be taken into account in the provision of infrastructure and transport services. Benefits from transport interventions will tend to go to those who make the greatest use of roads and transport services i.e. the richer sections of the community. Planners should be aware of the likely gainers and losers from these interventions and adopt procedures which specifically meet the needs of the poorest sections of the community.

There is already a good understanding of the role that many vehicles play in transport systems, these include trucks and to a lesser extent ox carts and bicycles. However, the importance of mid range vehicles in rural transport has not been adequately addressed. Agricultural vehicles such as tractors and power tillers play a vital role in both goods and passenger movements, as do pickups, motorcycles and indigenously manufactured simple motorised vehicles. Specific research is needed on each of these vehicle types in order to fully understand the contribution that they make to rural transport systems.

## 9. ACKNOWLEDGEMENTS

The work presented in this report forms part of the research programme of the Overseas Centre (Programme Director: Dr. J Rolt) of the Transport Research Laboratory. Part of the work relates to research carried out at Silsoe College, Cranfield University (Rural Transport Research Co-ordinator: Dr. P Crossley). The assistance of John Hine (Overseas Resource Centre) is also acknowledged.

## 10. REFERENCES

- AHMED, R and M HOSSAIN (1990). Development Impact of Rural Infrastructure in Bangladesh. International Food Policy Research Institute, Washington D.C.
- AIREY, T (1990). The Thuchi-Nkubu Road Study: Analysis of Travel between 1983 and 1989. *TRRL working paper OU/274*, Transport Research Laboratory, Crowthorne. (Unpublished report available on direct personal application only.)
- AIREY, T (1991). The Influence of Road Construction on the Health Care Behaviour of Rural Households in the Meru District of Kenya. *Transport Reviews*, Vol. 11, No. 3, 273-290.
- AIREY, T, I BARWELL and T STRANDBERG (1993). Local Level Transport in Sub-Saharan Africa. Final report

- on Rural Household Travel and Transport Patterns, IT Transport/ILO, Ardington and Geneva.
- ALLUM, P J (1995). Transport and Food Security in Developing Countries. MSc Thesis, Cranfield University, Silsoe.
- BARWELL, I, and I LEGGETT (1986). Study on Promotion of Rural Transport in Tanga Region. Tanzania, GTZ, Eschborn.
- BARWELL, I, and C MALMBERG-CALVO (1988). Makete Integrated Rural Transport Project: The Transport Demands of Rural Households: Findings from a Village Level Travel Survey. ILO, Geneva.
- BARWELL, I (1989). Household Travel Demand in Aurora Province, Philippines. ILO, Geneva.
- BHALLA, MK, S P SINGH and R PRASAD (1994). Rural Transportation Studies. April 1994, Indian Highways, pg 25-40.
- BIGGS, S, A KELLY and G BALASURIYA (1993). Rural Entrepreneurs, Two-Wheel Tractors and Markets for Services: A Case Study from Sri Lanka. *Occasional Paper No. 242*, School of Development Studies, University of East Anglia, Norwich.
- BINSWANGER, H P (1978). The Economics of Tractors in South Asia: An Analytical review. Agricultural Development Council, New York.
- BLAIKIE, P J, J CAMERON, D FELDMAN, A FOURNIER and D SEDDON. The Effects of Roads in West Central Nepal. Overseas Development Group, University of East Anglia, Norwich.
- BRYCSON, D F and J HOWE (1992). African Rural Households and Transport - Reducing the Burden on Women. IHE, Delft.
- CALVO, C (1992). Access of Women to Domestic Facilities. Sub-Saharan Africa Transport Programme, Rural Travel and Transport Project, *Working Paper No. 4*, Washington D.C.
- CALVO, C (1994). Case Study on Intermediate Means of Transport: Bicycles and Rural Women in Uganda. Sub-Saharan Africa Transport Policy Programme, *Working Paper No.12*, Washington D.C.
- CARAPETIS, S, H L BEENHAKKER and J D F HOWE (1984). The Supply and Quality of Rural Transport Services in Developing Countries: A Comparative Review. *World Bank Staff Working Papers No. 654*, Washington D.C.
- CARR, M and R SANDHU (1987). Women, Technology and Rural Productivity: An Analysis of the Impact of Time and Energy-Saving Technologies on Women. IT Consultants, Ardington.
- CECELSKI, E (1985). The Rural Energy Crisis, Women's Work and Basic Needs: Perspectives and Approaches to Action. Geneva, Rural Employment Policy Research Programme, International Labour Office, Geneva.
- CHAMBERS, R (1983). Rural Development: Putting the Last First. Longman, London.
- CHEESMAN, L P (1990). Rural Transport - Theory into Practice. International Journal of Physical Distribution and Logistics Management: *Strategic Issues in Transport Marketing*, Vol 20, No.5.
- CREIGHTNEY, C D (1993). Transport and Economic Performance: A Survey of Developing Countries. *World Bank Technical Paper No. 232*, Washington D.C.
- CROSSLEY, C P (1986). Analysis of Costs and Performance of Rural Transport Vehicles in Less Developed Countries. *International Journal for Development Technology*, Vol. 4, pages 121-138.
- CURTIS, V (1986). Women and the Transport of Water. IT Publications, London.
- DAWSON, J and I BARWELL (1993). Roads are not Enough. IT Publications, London.
- DORAN, J (1994). Transportation by Women, and their Access to Animal-Drawn Carts in Zimbabwe. in Starkey, P et al (ed.) "Improving Animal Traction Technology", pg 272-275, CTA publications, Wageningen, Netherlands.
- ELLIS, S D and J L HINE (1995). The Transition from Non-Motorised to Motorised Modes of Transport. *Proceedings of the 7th World Conference on Transportation Research, Sydney, Australia*.
- GAVARIA, J (1991). Rural Transport and Agricultural Performance in SSA: 6 Country Case Studies. Sub-Saharan Africa Transport Program, Washington D.C.
- GOETZ, A M (1994). Women's Control over Loans in Rural Credit Programmes in Bangladesh. July 1994, Development Research Insights for Policy makers, ODI-IDS Publication, Brighton.
- HARLAND, P and E DE KADT (1977). Rural Health Vehicles for Peru. Overseas Development Administration Report, EV 54, London.
- HEIDEMANN, C and U BARTH (1985). Rural Transport in Developing Countries: A Synopsis of Findings and a Framework for Development. Germany, Institut für Regionalwissenschaft der Universität Karlsruhe.

- HEGGIE, I (1994). Commercialising Africa's Roads: Transforming the Role of the the Public Sector. *SSATP Working Paper No. 10*. The World Bank, Washington DC.
- HINE, J (1982). Road Planning for Rural Development in Developing Countries: A Review of Current Practice. *TRRL Report 1046*, Transport Research Laboratory, Crowthorne.
- HINE, J, J D N RIVERSON and E A KWAKYE (1983a). Accessibility and Agricultural Development in the Ashanti Region of Ghana. *TRRL Supplementary Report 791*, Transport Research Laboratory, Crowthorne.
- HINE, J, J D N RIVERSON and E A KWAKYE (1983b). Accessibility, transport costs and food marketing in the Ashanti Region of Ghana. *TRRL Supplementary Report 809*, Transport Research Laboratory, Crowthorne.
- HOWE, J, and I BARWELL (1987). Study of the Potential for Intermediate Means of Transport in Ghana. Ministry of Transport and Communications, Accra, Ghana.
- HOWE, J and P ROBERTS (1984). Rural Roads and Poverty Alleviation. IT Publications, London.
- HOWE, J (1983). Conceptual Framework for Defining and Evaluating Improvements to Local Level Rural Transport in Developing Countries. International Labour Office, World Employment Programme, CTP 19, Geneva.
- HOWE, J (1981). The Impact of Rural Roads on Poverty Alleviation: A Review of the Literature. International Labour Office, Income Distribution and Employment Programme, *Working Paper No. 106*, Geneva.
- JONES, S R (1981). Accessibility Measures: A Literature Review. *TRRL Report No. 967*, Transport Research Laboratory, Crowthorne.
- KAIRA, C K (1983). Transportation Needs of the Rural Population in Developing Countries: An Approach to Improved Transportation Planning. Institut für Regionalwissenschaft der Universität Karlsruhe.
- MALOIY, G M O et al (1986). Energetic Cost of Carrying Loads: Have African Women Discovered an Economic Way? *Nature*, Vol.319, pg 668-669.
- MAUNDER, D A C and T C MBARA (1993). The Initial Effects of Introducing Commuter Omnibus Services in Harare, Zimbabwe. Transport Research Laboratory, *TRL Report 123*, Crowthorne.
- MOMSEN, J H (1992). Women and Development in the Third World. Routledge, London.
- MOSELEY, M J and J PACKMAN (1983). Mobile Services in Rural Areas. University of East Anglia, Norwich.
- MOSLEY, P and D HULME (1994). Effective Financial Institutions for Lending to the Poor. July 1994, Development Research Insights for Policy makers, ODI-IDS Publication, Brighton.
- PINGALI, P, Y BIGOT and H P BINSWANGER (1987). Agricultural Mechanisation and the Evolution of farming Systems in Sub-Saharan Africa. A World Bank Publication, Washington D.C.
- RIZET, C and J HINE (1993). A Comparison of the Costs and Productivity of Road Freight Transport in Africa and Pakistan. *Transport Reviews*, Vol.13, No.2, 151-165.
- SAXENA, R K and K C VARKEYACHAN (1989). Modernisation of Animal Drawn Transport Vehicles in India. International Seminar on Rural Transportation, Indian Roads Congress and International Labour Organisation.
- SEAGER, P J and R S FIELDSON (1984). Public Sector: Tractor Hire and Equipment Hire Schemes in Developing Countries. Prepared for the World Bank by NIAE (now SRI), Silsoe, Beds.
- SRISAKDA, L and S CHIVSANT (1992). Study of the "Itaen" Rural Transport Services in Northern Thailand. Rural Travel and Transport Project, Sub-Saharan Africa Transport Programme, Washington D.C.
- STARKEY, P (1989). Animal Drawn Transport in Africa. In Transport for the Poor, GATE, Eschborn, Germany.
- STEWART, F (1988). Basic Needs Strategies, Human Rights and the Right to Development. Centro Studi Luca D'Agliano, *Working Paper No.2*.
- SWECO (1985). Zimbabwe National Transport Study. SWECO, Main Volume, Harare.
- THOMSON, B P (1983). Mobile Health Clinics Project: India. Overseas Development Administration Evaluation Report, EV 254, London.
- WORLD BANK (1993). World Development Report 1993 - Investing in Health. World Bank, Washington D.C.
- WORLD BANK (1994). World Development Report 1994 - Infrastructure for Development. World Bank, Washington D.C.



## APPENDIX A

### A Review of the Literature on the Burden of Off-Road Transport

Author(s)	Study Area	Main Findings	Women's Burden
Barwell, I Leggett, I (1986)	Tanga Region, Tanzania	Households average 40 hours per week in internal travel alone i.e. excluding marketing, trips to market and health facilities. This represents 85 tonne-kilometres (t/km's) per year.	
Barwell, I Malmberg-Calvo, C (1988)	Makete District, Tanzania	Households (2.51 adults) average 50 hours per week in total travel - 87 t/km's per year. 91% of trips and 81% of total t/km's are internal.	Transport undertaken by women represents 75% of total time and 85% of total t/km's.
Howe, J Barwell, I (1987)	Ghana	Households (6.47 adults) average 93 hours per week in total travel - 216 tonne kilometres per year. 93% of trips and 76% of total t/km's are internal.	Transport burden for women is 3 times greater in terms of time and 4 times greater for t/km's than men's contribution.
Barwell, I (1989)	Aurora Province, Philippines	Households average 14 hours per week in total travel - 92 tonne-kilometres per year. 93% of trips and 35% of total t/km's are internal.	Men take an equal share in terms of time and 75% of total t/km's
Momsen, J (1992)	Dry Zone, Sri Lanka	Gender division of time use according to peak and slack seasons. Water and firewood collection represent 80 hours per month in the peak season and 90 hours in the slack season.	Women spend between 1.5 times more time in the peak season and 2 times more in the slack season in collecting water and firewood. Women spend between 25% in the peak and 35% in the slack season more time on all tasks than men
Carr, M Sandhu, R (1987)	Gurage, Ethiopia	Looked at the variation in water collection times in rainy and dry seasons.	Highlands - 95% of trips in both seasons take under 1 hour. Lowlands - in rainy season 74% of trips are under 1 hour. In the dry season 75% of trips take over 3 hours.

The studies mentioned in this appendix are referenced in the main text.

## APPENDIX B

## Characteristics of Human Powered Vehicles

Vehicle Type	Approx. cost (US\$)	Max load capacity (Kg)	Average speed (Km/h)	Range (Km)	Cost/t/km (\$) (10km trip distance)	Vehicle Characteristics
Headloading of body-weight		up to 70%	4	20		Ghana - mainly done by women carrying water, firewood, maize to the grinding mill as well as internal and external marketing. In many families all household and agricultural transport tasks are by headloading.
Back pack (Chee-geh)		70	4	10		Korea - used because of inadequate farm roads and difficult terrain. Frequently used for carrying rice, firewood, manure and grass.
Shoulder pole			40	4		Thailand - a bamboo pole is carried across the shoulders with a 20 litre water container attached to each end. Used for household water collection.
Wheelbarrow	50	100	4	1		Zimbabwe - used as a household means of transport to collect water, firewood and travel to the grinding mill. It is also used in small scale rural industry such as brick making.
Handcart	300 - 1000	4	10			<p>Sri Lanka - used in rural areas for the transport of wood and agricultural products sometimes in quite hilly areas where 2 or more people are used to push. The carts have 4 small wooden wheels.</p> <p>Ghana - Used in urban and rural areas, particularly in a market environment. They are used on a hire basis for the transport of wood and agricultural produce in a rural context and for market goods in urban areas. They have 4 wheels with pneumatic tyres but need good roads to operate on.</p> <p>Pakistan - similar to those in Sri Lanka they are used for household tasks and the transport of fodder and agricultural produce and inputs.</p>
Bicycle	60	70	10	50	0.88	<p>Sri Lanka - the most common form of transport for personal mobility and certain household tasks e.g. travel to the grinding mill and markets. It is also used for marketing purposes, trips to fields and travel to external sources of income. As yet women are generally precluded from bicycle use but this is starting to change.</p> <p>Ghana - bicycle use is not as common as in Sri Lanka and is mainly used for travel to external sources of income. However in some places it is used for household and agricultural tasks, marketing purposes and even for hiring.</p>
Bicycle Trailer	120	150	8	30		Sri Lanka - Notably promoted by IT Transport the trailer increases load capacity and can also be used as a handcart. For operation good roads and fairly flat terrain are required.

Source: Author's surveys.

## APPENDIX C

### Characteristics of animal powered vehicles

Animal Type	Approx. Cost (US\$)	Max Load Capacity (Kg)	Average Speed (Km/h)	Range (Km)	Cost/t/km (\$) (10km Trip Distance)	Animal Characteristics
Ox Cart	700	750	4	30	0.36	Zimbabwe - 2 oxen are usually attached to a cart but it can be as many as 4. In ploughing operations they use up to 6 where they provide good tractive power in hard soils. They are used for the transport of agricultural produce, farm supplies and household goods including water and firewood. Their range is limited but load capacity high. A family's status is judged by the number of cattle they possess.
	1065	1400	4	25	0.41	Pakistan - in the Punjab the oxen are bigger than Zimbabwe and a pair can pull up to 1400kg. As such they are often hired on a contract basis by rural industry or in urban areas and they can make trips of 25km. The bullocks can also be used for ploughing and the transport of fodder and agricultural produce.
	505	1100	4	20	0.22	Sri Lanka - The use of bullock carts is starting to die out in many parts of the country because of competition from power tillers which can provide all the same services. However they have an advantage in very wet areas where the power tillers sink in the muddy paddy fields, the bullocks are just used to trample the fields. They are often used in a marketing role e.g. selling kerosene from village to village. They are still used for transport of produce from the fields to the village and then on to market.
Pack Donkey	75	100	5	30	1.72	Pakistan - pack donkeys are used for off road transport where paths are steep or narrow. For example carrying agricultural goods, fodder, produce from market, personal belongings, building materials and firewood. In areas where ownership levels are high there is limited hiring but elsewhere pack donkey's are hired for all the above activities. They are cheap and easy to look after and control but have limited load capacity and low status.
Donkey Cart	200	420	6	30	0.43	Pakistan - a cart (flat bed and pneumatic tyres) is harnessed to 1 donkey, they are predominantly used in the flat agricultural heartland. As ownership is high there is little hiring. Farmers claim that personal mobility is the main advantage. They are used for many of the same activities as pack donkeys but additionally work in urban areas.
	375	500	6	50	0.27	Zimbabwe - a cart is harnessed to between 2 and 6 donkeys. The donkeys are not fed and just left to graze. Many households use them for domestic tasks such as the collection of water and firewood as well as agricultural marketing and supply of inputs. In some areas the donkeys are also used for ploughing.

## APPENDIX C (continued)

## Characteristics of animal powered vehicles

Animal Type	Approx. Cost (US\$)	Max Load Capacity (Kg)	Average Speed (Km/h)	Range (Km)	Cost/t/km (\$) (10km Trip Distance)	Animal Characteristics
Pack Mule	550	120	5	30	1.38	Pakistan - mules are usually used for hire purposes, their load capacity is greater than horses and donkeys as well as their work rate. They are used in much the same environment as pack donkeys but mainly in the transport of economic goods such as agricultural produce and inputs, and building materials.
Mule Cart	680	700	6	30	0.38	Pakistan - a cart (flat bed and pneumatic tyres) is harnessed to 1 mule. Mules are known for pulling heavy loads (greater than donkeys and horses) and working long hours. They need very little attention and have no special feed requirements. As such they are often used for commercial purposes either in urban areas or for rural industries. They are also used for agricultural transport. Owners of mule carts usually derive most of their income from this hire business.
Horse Cart	970	560	10	30	0.46	Pakistan - a cart (usually a boxed cart with large wooden wheels) is harnessed to 1 horse. The main advantage to horses is their speed, intelligence and hence good manoeuvrability. As such they are often used for passenger transport (in rural and urban areas) and marketing purposes where speed is more advantageous than load capacity. They are also used for agricultural transport. The disadvantages with horses are that their stamina and load capacity is less than for mules and they need a lot of attention and special food.
Pack Camel	450	320	5	30	0.60	Pakistan - are brought large distances from one agro-climatic zone to the next for transport of harvested crops. They bring crops from the fields to the road over distances from a few hundred yards to 10 km's. Their load capacity is high and their requirements relatively low. However they have difficulty with very rough terrain. During the land preparation season they can be used for ploughing. They can be sold for meat after their useful life.
Camel Cart	710	1200	5	30	0.29	Pakistan - one camel is harnessed to a 4 wheel trailer, they are capable of pulling very large loads. As such they are only usually used on good rural roads or in urban areas. They are normally owned by businessmen needing a transport vehicle or contracted out to business. The camels feet do not perform well on wet roads and a slip can lead to broken limbs which can reduce their marketability. In some areas there is also an unfamiliarity with these animals.

Source: Author's surveys.

## APPENDIX D

### Characteristics of Motorised Vehicles

Vehicle Type	Approx. Cost (US\$)	Max Load Capacity (Kg)	Average Speed	Range (Km) (Km/h)	Cost/t/km (\$) (10km Trip Distance)	Vehicle Characteristics
Motorcycle 50 cc	450	100	50	100	0.39	<p>Sri Lanka - richer households use motorcycles for personal mobility. However it is more common to be used in a marketing context e.g. selling dried fish from village to village or the transport of milk. In this context the speed and manoeuvrability is more important than the load capacity.</p> <p>Thailand - in certain parts of Thailand motorcycle ownership is very high. They are used primarily for personal transport but some are fitted with simple trailers for increased load capacity.</p>
Power Tiller	1,500	1,000	15	50	0.15	<p>Thailand - small scale industries have developed to supply power tiller's or walking tractors as they are known. The single cylinder diesel engines (normally 8.5 hp) are made in partnership with Japanese companies. They are multi-purpose machines - ploughing; pumping water (up to 48 hours at a time); threshing; for generating electricity; and transport. They are used for all agricultural and household needs as well as for hiring.</p>
	4,650	1,500	15	50	0.13	<p>Sri Lanka - machines are imported from Japan and China and are therefore much more expensive than in Thailand. Again they are multi-purpose but mainly owned by rural entrepreneurs. In addition to agricultural and household tasks they are also used for passenger transport</p> <p>Ghana - there have been attempts to introduce them but regulations in the transport market cause disincentives to fully utilise them. There have also been problems with inadequate maintenance and spares provision.</p>
Farm Vehicle	3,010	2,500	40	100	0.12	<p>Thailand - these vehicle are manufactured locally either at village level or in small scale industries. The wheels, axles, and transmission are from second-hand pickups. The springs are new and the chassis is constructed to order. The engine in theory can be interchanged with that from the power tiller, in practise they usually buy a bigger unit (12 hp). They are primarily used for the transport of agricultural produce but are also used for passenger transport. They are good on farm roads and are normally for hire. Some have a power take-off for threshing, chopping cassava and spraying.</p>

## APPENDIX D (continued)

## Characteristics of Motorised Vehicles

Vehicle Type	Approx. Cost (US\$)	Max Load Capacity (Kg)	Average Speed	Range (Km) (Km/h)	Cost/t/km (\$) (10km Trip Distance)	Vehicle Characteristics
Tractor MF 240 50hp	16,200	4,000	20	100	0.22	Sri Lanka - although in most cases tractors are bought for agricultural purposes transport provides an important component of their activities, anywhere up to 100%. Field sizes are small and in the wet zone very muddy, so tractors are not ideal. Instead they are used for agricultural transport and the supply of building materials. They are ideal vehicles to go down to river banks to be loaded with sand.
MF 240 50 hp	9,100	4,000	20	100		Pakistan - tractors travel from one agro-climatic zone to the next looking for work both ploughing and the transport of harvest. The transport of building materials is a very important component of their work in the off season.
MF 240 75hp	15,000	4,000	20	100	0.45	Ghana - tractors often come into their own on some of the very bad rural roads. They are often the only type of vehicle able to gain access. In parts of the country they are not able to be utilised fully because the land has not been cleared and there are limited resources to sow and fertilise the land. As such they are used for the movement of agricultural products and sometimes passengers. Again poor maintenance and supply of spares hinders efficient operations.
MF 240 50hp	25,000	5,000	20	100	0.36	Zimbabwe - tractor operations are more viable than in Ghana but operations are still hampered by poor maintenance and inefficient operating practises. The existence of subsidised tractors and public hire schemes reduces incentives to private owners. Evidence suggests that income from transport is greater than from ploughing. This is partly because of marketing boards and transport associations imposing freight charges.  Thailand - tractor use for transport is rare, there are plenty of more efficient transport vehicles in operation.

Source: Author's surveys.

## APPENDIX E

### Characteristics of Conventional Transport Vehicles

Vehicle Type	Approx. Cost (US\$)	Max Load Capacity (Kg)	Average Speed (Km/h)	Range (Km)	Cost/t/km (\$) (10km Trip Distance)	Vehicle Characteristics
Pickup	12,000	2,500	70	500	0.2	<p>Thailand - Their main advantages are high speed and large load capacity. They can easily move from one province to the next transporting produce from low price areas to high price areas. This is particularly the case for perishable goods. In a rural context they are used for transport from roadside to market and also for passenger (school children) movement.</p> <p>Pakistan - they are particularly used in relatively remote areas where distances are too large for animal transport and their speed and load capacity can get passengers and goods to markets and services quickly. Pickups can carry up to 30 passengers. In the urban and rural areas with good roads micro pickups are used for the same purposes.</p> <p>Zimbabwe - there are restrictions on the use of pickups for passenger transport but shop keepers and traders use them. Traders can easily access remote areas to buy produce.</p>
Truck	20,300	9,000	60	500		<p>Thailand - Trucks are normally used on interurban routes, but in many rural areas the richer farmers will own trucks for the transport of building materials, agricultural transport and any other activities. At harvest times the trucks will go down the better farm roads to the field sides, otherwise they will load at the road side.</p> <p>Pakistan - the truck industry is very competitive, particularly on the inter-urban routes, and tariffs are set according to supply and demand. The Bedford truck is the most common but the Japanese makes are starting to take over. Many of the trucks are modified to accept larger loads, chassis' are strengthened and additional axles added. In rural areas trucks compete with pickup trucks on the better rural roads to transport produce to distant markets.</p> <p>Ghana - the smaller trucks, known as mammy wagons, are responsible for all transport activities in the rural areas because of the lack of vehicle diversity. They are often hired by market women who buy agricultural produce directly from the villages. Otherwise they double up as goods and passenger vehicles.</p>
Buses						<p>Pakistan - The bus industry is very competitive with 70 seaters plying the interurban routes and into the rural areas, sometimes on quite bad roads.</p> <p>Sri Lanka - in many rural areas the people are totally reliant on the bus service for access to major service centres. The state run bus companies have been "peopleised" in order to make them more efficient but there are still villages with no service particularly during the rains.</p>

Source: Author's surveys.

## MORE INFORMATION

The Transport Research Laboratory has published the following other reports on this area of research:

SR 809 Accessibility, transport costs and food marketing in the Ashanti region of Ghana. J L Hine, J D N Riverson and E A Kwakye. Price code OS\_A.

SR 791 Accessibility and agricultural development in the Ashanti region of Ghana. J L Hine, J D N Riverson and E A Kwakye. Price code OS\_A.

LR 1046 Road planning for rural development in developing countries: a review of current practice. J L Hine. Price code OS\_A.

If you would like copies, photocopy and fill in the slip below. Enquiries to Overseas Centre, Telephone: 01344 770551 or 770187, Fax: 01344 770719.

To: Overseas Centre, Old Wokingham Road, Crowthorne, Berkshire, RG45 6AU.

Please send me the following Transport Research Laboratory reports (state report Nos and quantity)

Name .....

Address .....

Postcode .....

Telephone .....

## USE OUR EXPERTISE



The Transport Research Laboratory's researchers and facilities are available at competitive rates.

Our 330 scientists and engineers include many world-class experts on highways design and maintenance, transport structures, traffic systems, vehicle safety, road safety and the environment.

The Transport Research Laboratory facilities include a 3.8 km test track, a fully interactive driving simulator, an all weather facility for impact testing of vehicles, large structures test halls for static and fatigue testing, dynamic pavement test facility, dynamic and low cost impact test rigs, a pedestrian impact test facility, as well as advanced computer systems and a large specialist library with online access to worldwide information.

If you are planning a project where we may be able to help, contact the Transport Research Laboratory's Business Directorate at Crowthorne, Berkshire RG45 6AU, telephone 01344 770004, fax 01344 770356.