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S D ELLIS

THE ECONOMICS OF THE PROVISION OF RURAL TRANSPORT SERVICES IN DEVELOPING COUNTRIES

Supervisor: Dr C P Crossley

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ABSTRACT

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THE ECONOMICS OF THE PROVISION OF RURAL TRANSPORT SERVICES IN DEVELOPING COUNTRIES

By Simon Ellis

Rural accessibility planning in developing countries over the last few decades has primarily focused on increasing rural communities access to rural roads. It has been considered that road building improves access to health, education, markets and employment opportunities, and hence promotes economic development. It is argued in this thesis that accessibility, particularly in Sub-Saharan Africa, has not improved to the desired extent because the problem of mobility, in terms of access to vehicle services, has not been addressed. The provision of rural roads and transport services have been taken as synonymous with each other, but in reality this has not proved to be the case. This thesis attempts to redress that balance by seeking to change the mindset of policy makers to think about mobility and increase the emphasis placed on the promotion of transport services, both motorised and non-motorised.

The findings relate to surveys undertaken in Thailand, Sri Lanka, Ghana, Zimbabwe and Pakistan where data were collected on vehicle operating costs (VOC's) and performance for a wide range of commonly used rural vehicles. These included human porterage and non-motorised vehicles such as bicycles and animal transport, as well as motorised vehicles such as conventional trucks and pickups, agricultural tractors and simple engine-powered vehicles. Analysis of the data demonstrated large differences in the VOC's and transport charges for rural transport services between the generally efficient systems in the Asian countries and the inefficient ones in the African countries studied.

These findings form the foundation for the development of the Rural Transport Planner (RTP) and the framework which identifies the relationships between transport charges, VOC's, and factors relating to the vehicles operating environment. The RTP provides the first known attempt at producing a model for rural vehicle selection and for recommending interventions to improve the operating environment for rural transport services.

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CHAPTER 1

INTRODUCTION

In the past, the planning of accessibility in rural areas has been very much a roads based phenomenon. It has been assumed that building roads to rural areas would promote development through improved access to markets, health, education, alternative income sources and better information flows. These assumptions were based on the premise that roads were the most important component in connecting isolated and dispersed rural populations to essential services. It was also assumed that building roads would naturally produce a supply of vehicle services and consequently little attention was paid to the mechanisms by which these essential services would be provided.

These assumptions have led to a roads oriented transport policy which over the last decade has seen government and donor agencies investing heavily in new roads projects. In 1991 the World Bank estimated that in the previous 25 years it had provided US$ 1.7 billion (in constant US$ of 1988) in loans and credits for rural roads in Sub-Saharan Africa alone (Riverson et al, 1991). Despite this heavy investment in rural infrastructure projects, the returns in terms of increased rural development and improved accessibility have been disappointing. There have been two major problems. Firstly, insufficient resources were set aside for long term maintenance of roads and as a consequence much of the rural infrastructure has become impassable or little better than earth tracks. Secondly, the question of the provision of vehicle services has been insufficiently addressed and therefore rural communities can still remain isolated even though they have easy access to an engineered road. It is the mechanisms for best providing these vehicle services which will be the subject of this thesis.

Recent research has changed the way in which planners and policy makers look at rural accessibility. It is now understood that in many countries the bulk of transport requirements at the village level are conducted off road on a series of paths and tracks. Travel is largely for the provision of subsistence goods such as water and firewood, crop production and for internal marketing. Much of this transport is carried out on foot with a disproportionate burden falling on women. The use of transport vehicles and devices, either motorised or non-motorised, is rare. Vehicle ownership at the rural level is low and in many areas, particularly in Sub-Saharan Africa, the choice of transport mode is also low.

The provision of appropriate transport services at the rural level has the potential to reduce these mainly subsistence household burdens which can account for up to 40 hours per week (Dawson and Barwell, 1993). Better transport vehicles increase load capacity, speed and range as well as reducing the unit costs of transport. As a consequence they allow improved marketing efficiency and opportunities, and raise incentives to increase agricultural production through increased farm gate prices.

There is now a realisation that rural accessibility planning must take a more holistic approach so that the provision of roads is taken in conjunction with the supply of vehicle services, the location of key facilities, improved provision of paths and tracks and thought over the timing of service availability.

The PhD project described in this thesis forms part of a research scheme which has been funded by the British Overseas Development Administration's (ODA) Engineering Division as part of their on-going research strategy on infrastructure and accessibility in rural areas, and as part of ODA's global objectives of poverty reduction in the developing world. The objectives of the research scheme are given in appendix A.

In the widest context of rural accessibility the PhD project addresses the hypothesis that the improved selection of rural transport vehicles and a more efficient operating environment for transport services will reduce rural transport costs. A more efficient and lower cost transport system would (or potentially could) increase farm gate prices and therefore improve incentives for farmers to increase agricultural production. Many of the countries that face the greatest rural transport problems also face the highest transport charges and have access to the least amount and diversity of vehicles.

1.1 Project objectives

The aim of the project is to examine the supply of vehicle services in the rural areas of developing countries, with particular regard to the consequences of low vehicle numbers and diversity in rural Sub-Saharan Africa and the effect that this may have on transport charges, competition, operator efficiency and the reliability of vehicle services. The specific objectives are:

1) The collection of vehicle operating cost (VOC) and performance data for a range of commonly used vehicles in the rural areas of developing countries.

2) A vehicle database containing information on technical specifications, costs and common vehicle uses.

3) The collection of user cost data i.e. the charges that vehicle operators make to rural communities for transport services.

4) The identification of factors necessary for the introduction of new technology which will lead to an improved framework for the selection of rural vehicles.

5) Suggestions for local/national level changes that could enable the introduction of more efficient vehicles and create a more efficient operating environment.

6) The main objective will be the creation of a knowledge base to aid in the selection of appropriate transport vehicles for the rural sector of developing countries, and to increase the efficiency with which interventions are made to improve rural transport systems. This knowledge base will be in the form of an expert system with the hope that donor agencies, government ministries and transport consultants will adopt the tool when planning rural accessibility. The expert system will be based on the data obtained from the completion of objectives 1) to 5).

1.2 Methodology

1.2.1 Data Collection

It was felt that the best way to collect the varied information required for this type of study would be to undertake a comparative study of different rural transport systems in the developing world. Having consulted professionals in the transport field it was decided that the case studies should be carried out in Thailand, Sri Lanka, Pakistan, Zimbabwe and Ghana. These are described in chapters 4 to 8 of this thesis.

Each survey was conducted over one month so the collection of vast amounts of data was impractical. The emphasis was placed on collecting a broad range of information that would be brought together in order to draw conclusions on the factors affecting the adoption of technology and the efficiency of transport systems. Therefore a survey technique had to be adopted that would be rigorous enough to allow cross country comparisons but flexible enough that the design of the questionnaires and interviews was not influenced by the designer's preconceived ideas of the problem.

It was decided that "Participatory Techniques of Rapid Rural Appraisal" would be the ideal survey technique to encompass all these factors. This approach consists of a number of different survey techniques that allow the participants to carry the exercise forward in a way that they think is relevant. This technique was thought to be particularly relevant because of the lack of prior knowledge of the factors affecting vehicle adoption and transport efficiency in rural areas. More detail on the survey methodology is contained in chapter 3.

1.2.2 Model Formulation

Having collected the data from the five case studies using the above techniques an analysis process takes place in order to satisfy objectives 1) to 5). The vehicle and operating cost data then need to be used to construct a vehicle database and simple deterministic model to predict VOC's and performance. The results from this model and the data used to construct it will then be used to calibrate a more advanced mechanistic model which has already been developed by Crossley (1995).

It was understood from the outset that VOC's only represent one link in the matrix which allows an understanding of vehicle choice and the factors affecting rural accessibility. The qualitative data from the surveys would also need to be structured and a strategic model developed. This strategic model will encompass the VOC model and the other factors, which will be identified from the analysis of the qualitative data, relevant in promoting rural accessibility. The end result will be a tool which allows planners to understand, and make recommendations, on interventions which may range from the day to day intricacies of vehicle operation to central government economic and institutional policy. The strategic model will identify, and attempt to quantify, the links between these various factors (the completed strategic model is contained in appendix F).

The knowledge base generated from the formulation of the VOC and strategic models will then have to be presented in such a way that a diverse set of users could easily operate it without advanced skills. It was decided that an expert system would provide the ideal interface. An expert system is simply a computer programme which captures expertise on a computer and makes it available to non-expert users. The construction of the expert system is covered in detail in chapter 10. On completion of the expert system the success of the project will be judged on the global applicability of the results, ascertained through tests on other developing country case studies or possibly through a field visit, and the comments from other experts in the field.

CHAPTER 2

REVIEW OF EXISTING LITERATURE ON RURAL TRANSPORT

2.1 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.

Historically infrastructure in developing countries has developed to serve colonial interests rather than the needs of local populations. As the need to develop previously isolated or unexploited areas became apparent there was a shift in priorities away from the traditional colonial infrastructure towards rural and feeder roads. This strategy was supported by international development assistance agencies. For example, by the late 1970's a *quarter of World Bank loans were to the transport sector of which a half* were dedicated to the roads sector. Transport research was even more heavily weighted to this sub-sector with an estimated 94.5 per cent of funds going to the roads sector. However, this concentration on roads facilitated travel but failed to induce greater rural mobility (Dawson and Barwell, 1993).

Similarly, today, the institutional provision of roads is usually completely separate from any government control over vehicle services. Ministry of Works and Feeder Road Departments have no control or interest in transport services and there are no mechanisms for switching funds from road building to the provision of vehicle services.

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 in to 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) Summary of the major issues in rural accessibility

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.

2.2 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. He argues that isolation leads to a lack of education and poor access to essential services as well as to information that may be of economic value. 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.

A number of studies have shown that a significant proportion of the rural population in developing countries lack access to the road network. In India, for example, a government survey found that 70 per cent of villages did not have direct access to all weather roads while 53 per cent were not connected to any road at all (Carapetis, 1984). In contrast, Hine (1984) suggests that most rural people do in fact live close (i.e. within two to three kms) of vehicle access if not to specified "all weather roads". India for example, has one of the highest road densities of any developing country in the world. In recent years inaccessibility has been accepted as a major constraint to agricultural productivity and as such major donors have committed large proportions of their transport budget to the building of rural roads.

It is has been suggested, however, that road building may not meet the totality of rural transport needs. The recent publication of the book "Roads are not Enough" (Dawson and Barwell, 1993) has highlighted that transport requirements needed to satisfy basic needs in rural areas, particularly in many Sub Saharan African countries, represent a significant time, energy and cost burden on households. The evidence suggests that the time spent on subsistence tasks alone can reach up to 40 hours per household per week and that the formal roads network, and the conventional transport services that operate on them, fail to address the fundamental 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.
Dawson and Barwell (1993) suggest that if transport planners are to improve access to basic needs then a more integrated approach has to be adopted. Full account must be taken of the infrastructure relevant to them, appropriate modes of transport and the improved location of facilities. In many rural areas it is only the richest members of the community who can afford vehicles, and as such the predominant form of rural transport is by headloading. In many villages in Sub-Saharan Africa there is no vehicle ownership at all. In Asia ownership levels are higher; however Carapetis et al (1984) found that in Sri Lanka there are still less than two per cent of rural households who own tractors and only about 11 per cent who own bullock carts. He characterises farm level transport needs as the movement of small loads (10-150kg) over short distances (1-25 kms).

2.2.1 The basic needs approach

Recent studies designed to survey people's needs have found that transport represents one of their greatest problems. Even the poorest members of the community rank transport alongside factors such as insufficient rainfall and the lack of income generating opportunities. 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, economists 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 peoples 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. Barwell et al (1988a) define the second and third levels as accessibility to wider needs through access to major centres of activity (incorporating beneficial activities which are less essential for survival); and personal movement or travel for non-essential purposes.

2.2.2 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. Input targets refer to the number of kilometres of road built or the number of years in schooling. Output targets in contrast relate to mobility or the development of mental ability and are therefore far more difficult to monitor. 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 are very difficult to predict as is demonstrated by the literature on rural road evaluations which will be covered in more detail in section 2.3.

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 an all weather road; or all households within x km from a non-motorised transport service. The Sub-Saharan African Transport Policy Program's (SSATP) Pilot Integrated Transport Project in Malawi used exactly these sort of targets to represent the ambitions of the project in providing access to various basic needs. Their targets included to have access to water supplies within five minutes; access to health facilities within 30 minutes; and access to grindings mills within 60 minutes (Tighe and Strandberg, 1994).

2.3 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.

Too often in the planning of rural accessibility the provision of road access has been taken as synonymous with the provision of transport services. As a result, many areas have gained road access but no mobility, hence there has been no improvement in accessibility according to Creightney's definition. Consideration must therefore be given at the planning stage as to how constraints to vehicle supply can be removed. Additionally, too little attention has been paid to the provision and upgrade of rural tracks and paths, and the vehicles which operate on them, as this is where the bulk of household transport takes place.

It is becoming more apparent that transport, and accessibility in general, must take a more integrated approach. 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 (Tighe and Strandberg, 1994).

2.3.1 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. With the advent of road evaluations in the mid 1960's it was realised that this was by no means always the case.

Creightney (1993), Hine (1982) and Howe (1981) have conducted literature reviews on the impact of roads and rural roads on development and looked at the question of causality. Creightney poses the question "does transport lead to growth or does transport develop in response to the demand for transport as a consumption good or as an input into production ?". Drawing on work by Binswanger et al (1989) and Evans (1990), 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. Evans concludes that infrastructure investments should be targeted to areas where growth is already occurring or to where there is strong potential.

Similarly Howe (1981) draws on work by Wilson (1973) and Munroe (1966) and links successful transport investment with good economic potential. An overall dynamism is needed in order that economic opportunity can be sought and quickly exploited. The converse is summed up by Munroe - "depressed regions, have almost by definition, little of the unexploited natural resources or, especially, the economic dynamism that have been found to be necessary for successful transportation investment".

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. In contrast, it could be argued that the transport input should only be included at cost while the residual profits are attributed to the other inputs.

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 (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, Hine did find evidence that the more accessible villages had greater access to alternative sources of income such as from food marketing and the provision of rural services.

Despite the scepticism from some quarters of the impact of roads access to economic development many other observers have found good relationships between the two. For example Airey et al (1993) collected data with 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, a doubling of wages, while incomes from business and industry only increased by 17 per cent.

Most measures of accessibility are usually based on access to all weather roads as is the case with Airey's study. Mazlumolhosseini's (1983) study of rural transport on Cebu Island in the Philippines grouped villages into four categories of accessibility. His criteria were based on the proximity of the village to the nearest motorable road and its distance to the nearest town. In Bangladesh Ahmed and Hossain (1990) looked at the "most developed" and "less developed" villages in terms of their access to transport infrastructure. They all found that the most developed villages were the ones with the best access to physical infrastructure. However, 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.

In the rural areas of developing countries there are large differences in the level of accessibility between and within particular regions. Depending on the level of accessibility the type of appropriate intervention will vary greatly. For example some rural communities have all weather access, high levels of vehicle ownership, electricity and easy access to water and fuel supplies. In other places they may be cut off from vehicle access for periods of the year or indeed have no vehicle access at all. Their time and energy are almost entirely devoted to the satisfaction of basic needs. There are of course numerous stages between these extremes and they all require a different set of interventions.

Although the research conducted so far on accessibility and development is not conclusive, there is a growing feeling that accessibility cannot be measured by access to roads alone. In the context of the new holistic approach to transport planning there is a strong argument for using accessibility measures that better account for all rural transport, not just that which takes place on all weather roads. Measures of road access should be taken alongside vehicle availability; the cost of transport services; and measures of the burden (in terms of time or energy costs) in getting to essential services such as water, firewood, health and education. In this way interventions in rural accessibility planning that may not require the building of new feeder roads but measures that are cheaper and more relevant to specific needs.

Allum's (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 effectiveness as road building in 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 (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 road based accessibility measures more accurately reflect the true degree of accessibility that rural communities enjoy.

2.3.2 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 six to 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. Facilities may take advantage 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) find 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 (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.

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. Improved 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.

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.

2.4 Access to important social and economic facilities

The recent literature on travel patterns has concentrated on transport related to the provision of subsistence goods and that of agricultural production and marketing. However, travel for social needs such as to health facilities, education, religious centres, markets, government offices, employment and friends and relatives, is equally important and often overlooked. 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.

Barwell et al (1988) claim that 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.

2.4.1 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 transport charges represented the most important component of treatment costs to the patients. However, access to health services was not just restricted to geographical accessibility but also by institutional accessibility. These included factors such as the "ability of the household to pay for treatment, the religious denomination of the hospital and the attitude and opinions of rural peoples to the quality and type of service offered" (Airey, 1991).

Although transport charges can sometimes be the limiting factor in the use of certain facilities, improved access can result in reducing households' total transport budget. 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 2.1 gives a breakdown of the percentage of trips made for each category and by sex (Airey, 1990).

Table 2.1: Percentage of trips made by journey purpose and sex in the Meru District of Kenya

Trip Purpose	Percentage of Journeys (per cent)	
	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.

2.4.2 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 1 in 2 patients attend hospital, this figure falls to 1 in 46 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 incurred. 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.

2.4.3 The role of mobile services

Rural inaccessibility is not the sole problem of the developing world. A good deal of research has been undertaken in the developed world as well. Moseley et al (1983) has been at the forefront of this debate in the UK. They suggest 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.

As discussed earlier, 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 programs 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 and Harland, 1977). In Gambia motorcycles used to provide mobility for community health nurses became inoperational very quickly because of inadequate maintenance and repair. The failure of the programme was attributed to "weaknesses of implementation" (John, 1989). Poor management and/or the lack of prioritisation by host institutions for health vehicles in all three projects weakened the effectiveness of schemes.

Moseley et al (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 etc. that can be carried and the time spent in any one place.

It is clear from the evidence collected on access to essential economic and social facilities that access to roads alone is insufficient to ensure that rural populations can reach these services. Efficient vehicle services are necessary both to provide the mobility needed to reach these services, and as a means of bringing services to the people. For services such as health and education the cost of transport may actually represent the majority of the user cost.

2.5 Off-road transport as a burden in rural life and its differential effect on women

In the previous sections the role of roads building has been assessed with regard to its impact on rural accessibility and economic development. Reference was also made to the emergence of a new approach to accessibility planning where access to roads is only one component of a far wider accessibility problem. In this section, literature is reviewed on why the informal off-road infrastructure is so important in rural transportation as well as the role that women in particular play in this transport.

2.5.1 The off-road transport burden

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. There is now an increasing awareness of the burden that these activities impose on rural people and particularly women, both in terms of time and the quantities transported. Although it varies from area to area, cultivable land, grinding mills, health facilities and schools are often only accessible along local off-road infrastructure.

Dawson and Barwell (1993) have brought together probably the most comprehensive set of data on household transport. They have made clear the importance of off-road infrastructure and the overwhelming proportion of the household transport burden which takes place on it. In their analysis they make the distinction between “internal” (off-road) and "external travel" and thereby graphically illustrate the importance of internal transport. "Internal access" is defined as transport within the village, including water and firewood collection; trips to the field for crop production and harvesting; and marketing inside the village. "External access" is defined as transport outside the village, for example travel to health facilities and grinding mills; transport for external marketing; and trips within or beyond the district.

Dawson and Barwell (1993) studied the Tanga and Makete regions of Tanzania, villages in three regions of Ghana and the Aurora Province of the Philippines. The surveys concentrated on the transport duties carried out by individual households. Data were collected on trip purpose, number of trips, weight carried, distance covered and time taken. Internal travel accounted for an overwhelming proportion of total transport burden in terms of number of trips, time spent, weight carried and tonne-kms in all cases except for Aurora where external travel accounted for a greater proportion of tonne-kms made. In Makete for example, internal travel made up 91 per cent of number of trips, 80 per cent of time taken, 96 per cent of weight carried and 81 per cent of tonne-kms. 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.

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.

Travel to the grinding mill varied considerably between countries because of the nature of the vehicles used and the type of grinding required. In Ghana such trips represented only four per cent of total tonne-kms because of the preference for home milling. In the Philippines however, trips to the grinding mill represented 18 per cent of total tonne-kms compared with only 2.2 per cent of the total time taken because of the use of motor vehicles.

Box 2.1 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 kms from Sanyati, a thriving growth point. They are connected by a narrow but motorable gravel road which after 20 kms joins the main road to Sanyati which is good quality gravel. 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.

Box 2.1 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.

2.5.2 Water and firewood collection

Dawson and Barwell (1993) clearly demonstrated that water and firewood collection represents 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-kms 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. For example Curtis (1986) cites evidence from a survey in Kenya that round trip water collection times varied from under one hour (9 per cent of the sample) to six hours in the dry season (27 per cent of the sample). Cecelski (1985) states that fuel collection times vary from one hour per week in forested areas of Nigeria to 38 hours in Uttar Pradesh, India. 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, with 30 per cent having insufficient supplies. It is suggested that 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.

2.5.3 The differential effect on women

What is clear from many studies is that women are very often the ones who shoulder the bulk of the burden and in many cases this is made worse by male migration from rural to urban centres. 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. Makhera (1994) argues that these tasks stem 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. Additionally, Makhera (1994) suggests that 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 that 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).

Dawson and Barwell (1993) illustrate the differential effect of the transport burden on women. This varies from women taking 75 per cent of total transport in terms of time taken and 85 per cent of the total effort in Makete, to 50 per cent and 25 per cent respectively in Aurora. Much of this effort goes into the collection of water and firewood. It is not only transport studies that highlight this inequality but also studies looking at the broader picture in rural areas. In the dry zone of Sri Lanka women spend up to double the time on water and firewood collection than men and between 25 per cent and 35 per cent more when all activities are included (Momsen, 1992).

The extent of the time and effort involved, particularly, in the collection of water and firewood takes 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 and non 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 that by reducing women's current burdens whether they would engage in economic or income generating activities, take more leisure time, or actually collect more of the same subsistence goods. It is clear that in this respect more research is needed to better understand the likely economic and social benefits to any interventions. 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 the collection of water and firewood. A poor education will undoubtedly lead to lower productivity in the future.

Seasonality is also of significance in affecting the burden on women, this is particularly the case in the collection of water. Research has shown that as water sources dry up during the dry season, greater distances have to be covered by rural people in search of other supplies. For example Carr and Sandhu (1987) cite evidence from the Ethiopian lowlands where 85 per cent of water collection times during the rainy season are under one hour compared to 75 per cent of trips being over three hours during the dry season. In addition during the rainy season women run a greater risk of injury on slippery paths and illness from insects associated with water, such as mosquitoes, which carry disease.

2.5.4 Possible solutions to reducing the burden of off-road transport on women

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 Intermediate Modes of Transport (IMT's); improved location of services through spatial planning; improved access to credit facilities; and the educating of men to better understand the differential impact of transport tasks on women.

Intermediate modes of transport

These can be used to improve the speed and/or load capacity of traditional transport devices. The most commonly cited modes of transport are shoulder poles, wheelbarrows, bicycles, pack animals, animal carts or sledges and small motorised vehicles such as motorcycles and small tractors. These vehicles can carry greater loads than humans and have the potential to significantly reduce the time and effort required in day to day transport tasks. The advantages of these vehicles with regard to the marketing of produce are substantial. They serve to increase the distance over which produce can be marketed so that the best price can be found and they reduce the total costs of transportation. Assuming fixed prices in urban markets lower transport costs will have the effect of increasing farm gate prices and hence incentives to raise production.

It is not possible to generalise on the total burden of off-road transport or its differential impact on women. The variations from village to village and country to country are enormous. However, what is clear from the research to date is that the transport burden on women is lower where there is widespread use of IMT's. Women may not benefit directly from access to IMT'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 work traditionally thought of as women's work such as water and firewood collection to boys or young men. Interestingly, this would particularly be the case if the household owned large water drums.

Although in many cases the introduction of IMT's can reduce women's burden, there are circumstances where IMT's make very little impact or actually adversely affect women's welfare. For example, poorer households who do not own IMT's are unlikely to hire them for subsistence transport such as the collection of water and firewood whereas they would 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 IMT's and subsequent transfer of responsibility of these tasks to men can mean that women are displaced from income earning opportunities. Access to IMT's by women is a serious 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. Curtis (1986) found evidence that women would take small quantities of vegetables and fruit to sell at market to make a small return for the effort of trips to the grinding mill. This multi-tasking requires that women retain flexibility which may not be achieved with a single IMT.

ii) By the nature of subsistence transport tasks there can be no direct financial return. As a result, the purchase of IMT'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 IMT's can represent a large proportion of the households 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 IMT'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 IMT suitability are particularly relevant in mountainous and forested areas.

iv) Finally there is the problem of cultural taboos about women using certain IMT'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.

<u>Spatial planning and use of non transport technology</u>

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 IMT's. To dig a well equipped with a hand pump would cost around US$10-30 per capita rising to US$30-60 for a motorised pumping service or standpipe and US$60-110 for yard tap services. A centralised system of maintenance for the hand pump option would have an annual per capita cost of between US$0.50 and US$2.00. With a community-level maintenance system this cost could fall to US$0.05. 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 (Arlosoroff et al, 1987).

Not only does the cost of such schemes compare very favourably with IMT'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.

As with water the time and effort involved in the collection of firewood and other fuels is large and in many areas growing. There are certain 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. Cecelski (1987) suggests that 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.

Calvo (1992) cites evidence from Mali, Kenya and parts of Asia that fuel efficient stoves can result in a 30 per cent reduction in the use of fuel. She also concludes that there should be more participation by women in forestry projects, thereby increasing returns on investment and improving the possibilities for long term sustainability.

Educating men to understand the transport burden on women

By using participatory techniques and asking 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 IMT for household tasks.

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. 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 et al (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.

2.6 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. A road, track or path is 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. It will also attempt to identify some of the constraints to the successful operation and introduction of vehicles and target areas deserving of further research. This section will be 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

2.6.1 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 Banks "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. However, because of recent evidence demonstrating the importance of this type of transport, particularly in rural areas, the version of HDM currently being developed (HDM-4)will be capable of including animal carts as part of a country's vehicle fleet.

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 (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 53 per cent of tonnes moved in the northern region and 48 per cent in the southern region which rose to 73 and 55 per cent respectively 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, they only have 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.

NMT's 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 load capacity, speed and expand the range over which people can seek economic opportunities. Markets become more accessible which can have the effect of increasing farm gate prices and/or incentives to raise production. Access to health, education and information improves, allowing greater investment in human capital and, as already discussed, NMT's can reduce the drudgery of subsistence tasks. Additionally they are appropriate for operation on the existing network of paths and tracks without the need for expensive road building schemes.

In this section two categories of vehicles have been considered, human and animal powered devices, and vehicles. In certain areas transport by water should also be considered. They all increase the load a person is able to transport and or increase the operational speed and range. Any such device or vehicle if sufficiently utilised will reduce operating costs and the time and effort involved in transportation tasks to well below the level of headloading.

However, in many parts of Sub-Saharan Africa there is no realistic alternative to headloading or large trucks. The operation of trucks is often not viable 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.

2.6.2 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 areas to production and increase the intensity of cropping in others, the tractor has often seemed like an attractive proposal partly because of its diversity of use. 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 seasonal access problems. However, even with large subsidies tractor programmes have often come unstuck because the tractors are not sufficiently utilised or maintained.

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 in developing countries.

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 both because of culture 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. However, they can also be used for threshing, pumping water, as generators and when coupled with a trailer for transport activities. 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. The author has found in this study that in Pakistan, Zimbabwe and Ghana that transport can account for up to 100 per cent of tractor usage, and additionally that this work is 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, power generation etc. 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 (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 in areas with light soils or irrigated land they would make an ideal alternative. 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 very 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 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.

2.6.3 The provision of conventional transport services

Dawson and Barwell (1993) reveal that ownership of motor vehicles in their studies of African rural transport was extremely rare. In Makete 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) sum up by saying that "motor vehicle journeys comprise a minute proportion of total household travel time".

In an ideal scenario conventional vehicles would provide the last link in the transport chain. Goods would be transported from the fields by headloading. Animals or other modes of intermediate transport vehicles would then 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 conventional vehicles, owned by urban based businessmen and traders, are used to purchase and transport the farmer's produce directly from the farm. In so doing the farmers become isolated from markets and institutional credit facilities as the traders can satisfy all their needs. 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, 1983b). The result is that traders are in a position to exploit farmers who may have no access to alternative transport services.

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 2.4 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 manoeverability 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.

The provision of conventional transport services is usually provided most efficiently where they operate in a deregulated environment where tariffs and the supply of vehicles respond to market forces. Generally, conventional vehicles will mainly operate on the major route network. For example, in Kenya 64 per cent of the kilometres travelled by motorised vehicles are on trunk routes compared to only four per cent on minor roads (Gaviria, 1991). The opposite is the case for IMT's.

Section 2.4 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. Small trucks and pickups serve both as goods and passenger vehicles and are ideally suited for low demand 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.

One of the major problems facing rural communities is the lack of bus services which, because rural routes are not economically justifiable, often result in state owned companies operating large buses. 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).

2.6.4 Constraints to the operation and introduction of vehicles

Institutional factors

The most commonly stated reasons for the slow take-up of IMT'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. The attitudinal problems stem from centrally located institutional bodies who think that rural transport is "roads and motor vehicles", and that IMT's represent an outdated and backward technology. Carapetis (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).

The custom or lifestyle element relates to cultural 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).

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. Authors such as Boserup (1981) and Pingali et al (1987) stress the importance of the relationship between the intensity of agricultural production and population density i.e. the higher the population density, the more demands there will be on the available land and therefore the more intensive the farming systems have to be.

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 household goods but the movement of these goods does not generate any economic return, or more specifically any financial return. As a result there is very little effective demand for new vehicles. Hence, where population density is low the same is likely to be the case for the level of agricultural intensity and therefore the demand for transport. Additionally in this environment markets will be less accessible and the demand lower for marketable agricultural products. The result of poor access to markets is often lower farm gate prices caused by isolated production and high transport costs. Consequently, farmers have little incentive to use more modern techniques and increase production.

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. As such 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. However in 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 IMT'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.

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 are 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.

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.

2.7 The role of the market in the provision of rural transport services

In the 1994 World Development Report the theme 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.

2.7.1 Rural roads

The 1994 World Development Report attempts to categorise various infrastructure services 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). In terms of infrastructure services these might include telecommunications, water supplies, railways and ports etc. To a lesser extent urban and interurban roads might be included in that congestion might make them "rival" in nature, and modern technology can exclude or charge users for their services particularly in urban areas. In contrast, rural roads under this definition would be categorised as a pure public good. 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.

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 sub-national level, regional 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).

2.7.2 Rural transport services

The provision of the physical rural infrastructure will have to stay in the public domain with any improvements coming from increased institutional efficiencies. However, the supply of rural transport services is a very different matter and one in which the market must play an important role. 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 on 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. Many rural communities are only served by motorised vehicles once a week and even this can be unreliable particularly during the wet season. 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). 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. The result is that the buses leave the rural areas very early in 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 et al, 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 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 in-operational 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 their 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.

2.7.3 Rural entrepreneurs

In addition to the deregulation, or more careful regulation, of transport markets any interventions can be more carefully targeted to those who are likely to be providing the transport services i.e. the rural entrepreneurs. According to Biggs et al (1993) the rapid spread of two wheel tractors in Sri Lanka was primarily because of rural entrepreneurs, i.e. not only the operators of vehicles themselves but also the small scale artisans running rural repair and maintenance shops, and large scale urban machinery manufacturers and importers. It was the skill and forward planning of these entrepreneurs which meant that early fears about inadequate backup services and spares for the imported tractors were not realised. The problem of inadequate maintenance and poor availability of spare parts 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 and importers, and rural artisans and vehicle operators means that the latter are forced to operate in an information vacuum. This is particularly 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.

Rural transport operators

Transport operators should be targeted for training, particularly in maintenance practises. It has been shown that the effectiveness of maintenance varies from one location to the next and that inefficient practises can substantially increase the costs of vehicle operation. Not only do repair costs go up but there is increased down time and operators are unable to maximise vehicle utilisation.

Additionally operators should be kept informed of new technologies coming onto the market and of the most efficient operating practises. They should be encouraged to diversify their operations in order to increase utilisation. Factors which may affect operators' decisions on whether to undertake certain routes, such as incentives to police, should also be eradicated.

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 developed to service 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 program 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.

Urban manufacturers and importers

There should be good lines of communication between urban manufacturers and importers and rural operators so that the former are able to respond effectively to rural demands. Manufacturing capability should also be encouraged so that less reliance is placed on imported machinery and spares and greater reliance on domestic manufacturing capabilities. Domestic firms are more likely to respond to the requirements of rural operators in terms of price and quality. 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.

Credit institutions

Mosley et al (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 IMT'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 rapidly redesign schemes 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 services. However, heavily subsidised rural credit schemes have a very poor success rate and default rates are high. Wherever possible, rural credit schemes should attempt to "piggy back" already established credit institutions, both formal and informal. 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.

2.8 Summary of the major issues in rural transport

A general theme that has run through this literature review has been the preoccupation by transport planners on roads, which has quite often been to the detriment of the transport services that operate on them and on the informal network of paths and tracks at village level. When physical infrastructure is planned there is often little attention paid to constraints on the availability of vehicle services which in many cases lead to shortages in supply and high transport costs. It has been pointed out that high transport costs can adversely affect farm gate prices and therefore incentives to increase production. They can also represent the major accessibility constraint on the use of other social and economic facilities such as hospitals and education.

2.8.1 Rural transport services

Research has shown that there are large differences in the comparatively low costs of transport of many Asian countries and the high cost of transport in Sub-Saharan

Africa. The Asian transport market is characterised by high competition, vehicle diversity and good vehicle backup services.

A number of factors have been proposed as possible solutions to high transport costs and they revolve around the role of the market. Markets should do the bulk of the work in the supply of transport services but government and donor agencies have a role to play in creating the right environment through the provision of training and regulation which does not restrict competition. The specific factors discussed are:

(i) Competition in transport markets
(ii) Rural transport operators
(iii) Routine maintenance
(iv) Vehicle backup services
(v) Credit
(vi) Dissemination of information
(vii) The role of urban manufacturers and importers

2.8.2 The role of NMT's

It is also evident that the number and diversity of vehicles in Sub-Saharan Africa is far below the levels found in parts of Asia, particularly for animal and other NMT's. There are a number of factors contributing to low vehicle diversity including the lack of acceptance of NMT's by government officials; the slow diffusion and take-up of technology caused by cultural attitudes; and the relationship between farming systems, population density and the consequent inaccessibility of markets.

The last factor in particular may mean that the promotion of NMT's in certain parts of Sub-Saharan Africa may be inappropriate and that other vehicles, although not necessarily owned within the communities, may provide more efficient and cheaper alternatives.

2.8.3 Household transport

At the household level there has been an substantial amount of research on the importance of off-road transport, its composition and the burden that it places on women in particular. The results have brought a growing awareness that conventional transport interventions on their own are unlikely to meet the needs of rural households and as such a more holistic approach is being promoted. This includes a greater emphasis on the location of services, appropriate vehicle technology and prioritising the upgrade of paths and tracks.

Whilst the scale of the problem is evident the benefits from these types of intervention have yet to be quantified. There is evidence that unless these services are sited correctly and with the full participation of local communities, the benefits will be short term or only accrue to small sectors of the community. Any accessibility planning, particularly at the community level, must involve the co-operation and participation of local people. Although there is much lip service paid to participatory techniques by donor agencies they are probably not sufficiently practised in the field.

2.8.4 Accessibility

Access to social, medical and economic facilities such as schools, hospitals, markets and places of formal employment is extremely important in developing human potential. It has been shown that access to health facilities in particular is important for economic development.

Many authors have found a positive relationship between income growth and accessibility. However, the evidence is unclear as to whether infrastructure leads development in the right direction or whether it follows economic potential.

CHAPTER 3

SURVEY METHODOLOGY

3.1 Introduction

It was judged that the best way to collect the varied information required for this type of study would be to undertake a comparative study of different rural transport systems in the developing world. Having consulted professionals in the transport field it was decided that the case studies should be carried out in Thailand, Sri Lanka, Pakistan, Zimbabwe and Ghana.

The five countries chosen have distinct rural transport systems. Thailand is the only country in the study classed as a middle income country according to the World Bank classifications, the rest being in the low income category. Thailand represents the most advanced transport system with most of the rural population in the study area having access to simple motorised vehicles. Sri Lanka has high population density, easily accessible markets and high vehicle diversity. In many rural areas there is a transition from non-motorised to motorised modes of transport. Pakistan has an extremely efficient transport system with knowledgeable operators and high vehicle diversity, and it was recommended that it would be a good country in which to collect vehicle operating cost data. Zimbabwe has one of the best transport infrastructures in Southern Africa and has successfully managed to introduce animal carts. Ghana has an inefficient transport system and as a consequence the rural population is very isolated. The majority of rural transport is conducted by headloading and vehicle numbers and diversity are very low.

Each survey was conducted over one month, so the collection of vast amounts of data was impractical. The emphasis was placed on collecting a broad range of information that could be brought together in order to draw conclusions on the factors affecting the adoption of technology and the efficiency of transport systems. Therefore a survey technique had to be adopted that would be rigorous enough to allow cross country comparisons but flexible enough that the design of the questionnaires and interviews were not influenced by the designer's preconceived ideas of the problem.

It was decided that "Participatory Techniques of Rapid Rural Appraisal" would be the ideal survey technique to encompass all these factors (Chambers, 1992). This approach consists of a number of different survey techniques that allow the participants to carry the exercise forward in a way that they think is relevant. This technique was thought to be particularly useful because of the lack of prior knowledge of the factors affecting vehicle adoption and transport efficiency in rural areas. The techniques used during the surveys are covered in the following sections.

Survey sites within the countries were chosen with the help of agricultural and transport organisations with detailed knowledge of the characteristics of different areas of the country. The data was collected by the author with help from survey assistants who acted as translators and facilitators for group discussions.

3.2 Participatory Techniques of Rapid Rural Appraisal

Participatory Techniques of Rapid Rural Appraisal or PRA encompasses a growing number of "approaches and methods to enable local people to share, enhance and analyse their knowledge of life and conditions, to plan and to act" (Chambers, 1992). In this approach the local people are seen as the experts and the researcher as merely a facilitator to guide and structure the discussion. The researcher should enter the group exercises without preconceived ideas of the problems and their solutions, and seek to learn from the accumulated knowledge of the local people.

Although the use of PRA techniques in transport studies has been rare, it has been used successfully in other areas of rural development. Examples include gender and health care issues (Welbourn, 1992), environmental and sustainability issues (Pretty, 1993), and agriculture (IIED, 1992).

PRA can be used for research, as in this study, to identify, study and quantify issues of importance; in the planning process, participation can be used to inform, involve and seek advise from local people in order to make them the owners of particular initiatives; it can also be used to educate and train local people on issues such as primary health and the disproportionate burden on women in rural life. Participation has been seen as the key to successful projects, particularly with regard to routine maintenance.

3.2.1 Methods of PRA used for the surveys

There are many different techniques that can be used in PRA and they each suit the collection of different types of data. The following are the methods which have been used for this study, they have been adapted from other studies but also evolved with experience from the survey exercises.

Many of the results from these various techniques are presented in the five case study chapters. The village statistics for example are based on a combination of secondary information and the discussion exercises with villagers.

Semi-Structured Questionnaires - a large component of the survey was the collection of vehicle operating cost data and transport charges, and for this a vehicle questionnaire was developed. This questionnaire was designed to be answered by vehicle operators who would provide information on vehicle operating costs, transport charges and the factors that influenced their decision to buy particular vehicles. The questions were laid out in a structured manner, but in such a way that the interviewer could adjust his questioning to elicit the best response.

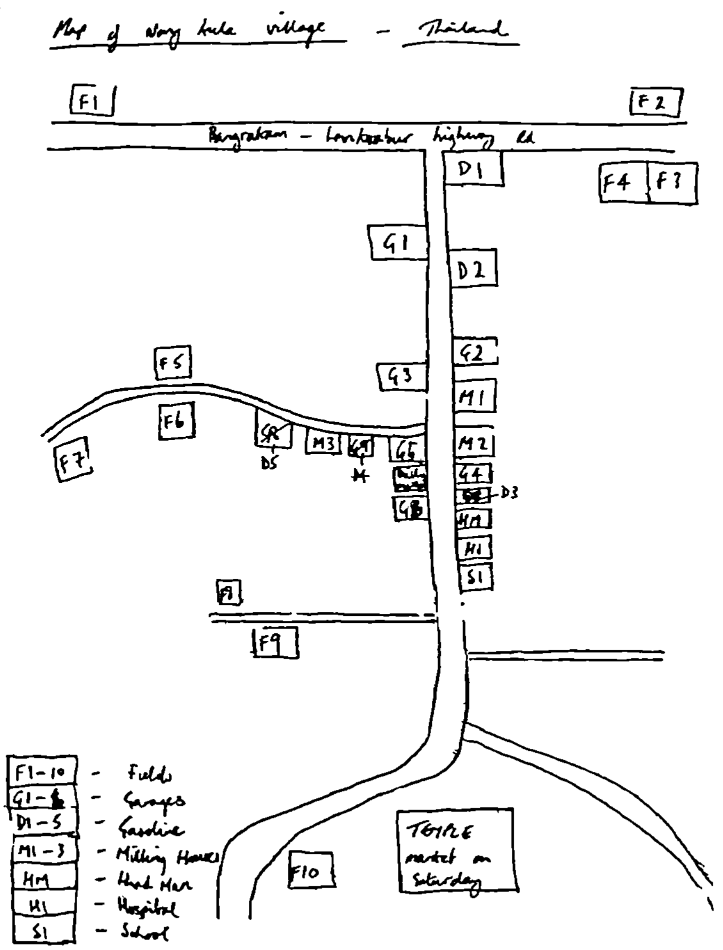
A household questionnaire was also developed in a similar way, in order to ascertain the transport requirements of households in particular areas. This questionnaire was normally answered by members of the village who did not own vehicles in order to verify the transport charges quoted by vehicle owners. This questionnaire was also important to provide a picture of the vehicle modes used for particular transport activities and the frequency and distance over which these trips were undertaken. Box 2.1 was constructed on the basis of the information acquired from a household questionnaire conducted in Zimbabwe. The vehicle and household questionnaires are in appendix B.

Secondary Information - another important source of information is that which can be gained from key informants either at the village level or from agricultural extension officers, research organisations or government ministries. This information includes village level statistics as well as the official view on the problems that are faced at the village level. The help received from these sources is essential in setting up the surveys and understanding the problems faced by rural communities especially when survey periods are relatively short.

Transect Walks - walks were taken around the survey villages with key informants to see the roads/tracks/paths that are used. This provided a first hand impression of the problems faced by rural communities in their day to day transport tasks, and the solutions that were adopted to overcome these problems.

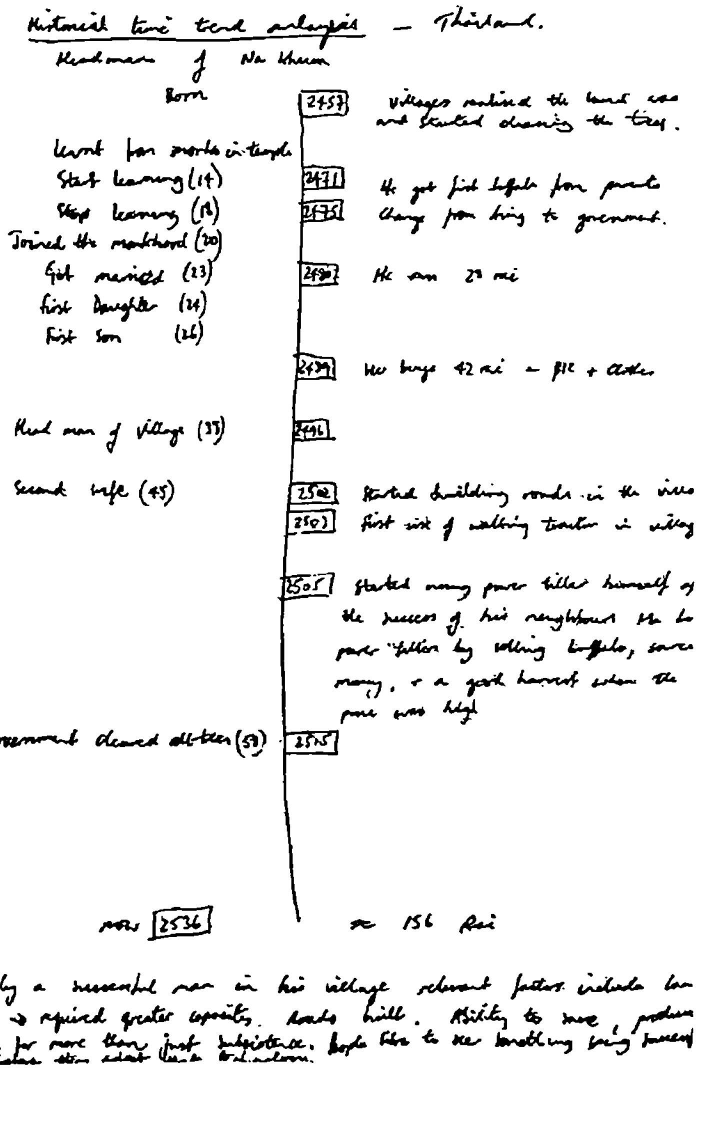
Participatory Mapping - this involved a group of villagers drawing maps of the village indicating key destinations such as markets, fields, places of worship, vehicle repair facilities, health centres and schools. The distances were also added along with the major roads/tracks/paths used. It allowed a general discussion to take place so that the main problems of the transport system could be identified and discussed. This was often a good time to ask for village level statistics such as population, number of vehicles and average field size; the intensity of farming techniques; and issues not relating to transport that were of particular concern. An example of participatory mapping can be seen in figure 3.1.

Figure 3.1: An example of Participatory Mapping for Nong Kula village in Thailand



Historical Time Trend Analysis - this involved discussion with older members of the community to try and ascertain what has changed with regard to village level transport during their life time. Respondents are asked to identify significant milestones in their lives such as their marriage or the birth of their first child. These events are dated and act as markers for key events in the development of the village transport system. An example of this method is shown in figure 3.2. The respondent is asked to state when certain vehicles were introduced, when roads were built and the factors which led to these developments. This technique was particularly used in Thailand where the pace of development has been so fast that enormous changes have been seen within one person's lifetime.

<u>Figure 3.2: An example of an Historical Time Trend analysis conducted with the Headman of Na Khum village in Thailand</u>



Vehicle Preference Matrix - the different vehicles in use in the study area are compared against a set of important characteristics which are likely to affect the villagers' choice of vehicle. These characteristics include the purchase price, speed, load capacity, ease of repair and maintenance, and performance in the field. The vehicles are then ranked against each characteristic in order to ascertain the major criteria for vehicle choice in rural areas. An example of a vehicle preference matrix is shown in figure 3.3.

Figure 3.3: An example of a Vehicle Preference Matrix completed in Nong Kula village in Thailand

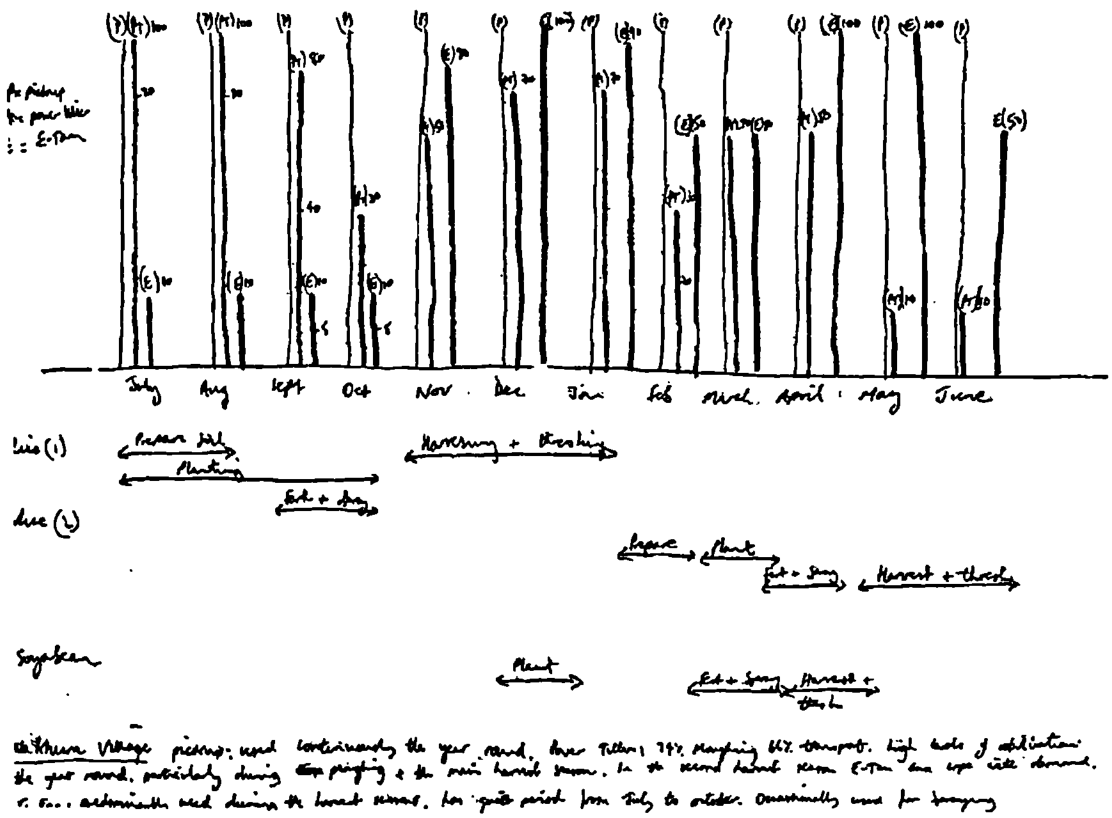
Nong Kula village - Thailand

	Tricycle	Walking tractor	Tractor	E-Tan	Pickup
Low cost (3)	1	2	5	3	4
Low cost of maintenance	1	2	5	3	4
Low cost of spares + repairs	1=	1=	5	3	4
Load capacity	5	4	1	2=	2=
Durability / strength of vehicle	5	4	1	3	2
Diversity of use (2)	5	1	4	2	3
Status	5	4	1	3	2
Income generation	5	4	1	3	2
Performance in field (1)	4=	2	1	3	4=
Speed	3=	5	3=	2	1
Ease of repair + maintenance themselves	1	2=	5	2=	4
With one choice which vehicle	5	1=	3	1=	4

Other ranked factors in order = load capacity, speed, low cost of maint., low cost of spares + repair, income generation, status.

Seasonal Diagramming - this is a group exercise designed to show the major activities in the community's agricultural calendar and to demonstrate seasonal fluctuations in vehicle usage. For each crop grown in the village the major agricultural activities are listed and the months over which they are undertaken are drawn. Similarly, for each vehicle in use the respondents are asked to draw lines to depict vehicle usage for each month, divided into use for transport and agricultural purposes. This diagram gives a good indication of the extent of vehicle utilisation throughout the year, an example of which is shown in figure 3.4.

Figure 3.4: An example of Seasonal Diagramming as completed in Na Khum village in Thailand



3.2.2 Problems faced in using PRA techniques

Whilst there are many proponents of the PRA survey methodology there are also those who have doubts over the statistical validity of the data collected, the reliability of the participants responses and the ease of making comparisons between data collected in different areas. It is also argued that the participatory approach does not take sufficient account of the social hierarchy, the power structure over information and the problems of outsiders not really understanding what they are told. Biggs (1995) concern is that PRA does not relate to experience or address the issues of control over information. He also feels that the management approaches and tools cut it off from a critical reflective understanding of technical and social change.

The use of PRA techniques in this study allowed an excellent opportunity to understand in a very short period of time the problems faced by rural communities. The methods force the researcher to enter discussions with an open mind, since in a group discussion you will be told what is of importance to that group of people. However, difficulties were encountered using this method both in terms of the way the data is collected and the ease with which it can be analysed. These are:

Survey assistance - the success of the PRA technique is largely dependant on the enthusiasm and competence of the persons conducting the interviews. They have to understand the survey techniques, explain them to the local people and develop the discussion. This ideally requires some training in PRA techniques which was not always possible. As a result, the success of the group exercises in particular varied from country to country. In general it can be said that the PRA techniques were more effective in the Asian countries studied than in the African countries. This was compounded by the fact that education levels of rural communities in the African countries were lower and that many of the exercises were vehicle based, which deemed them largely irrelevant, particularly in Ghana.

Discussion bias - there are a number of ways in which group exercises can be biased either by the mix of people involved or by the participants' preconceived ideas of what the researcher wants to hear.

- In organising a group exercise it is important that there is a representative sample of the village population i.e. that views are expressed both from the most affluent and least affluent members of the community as well as the ones in between. The problems faced by different groups may be very different. In reality it is very difficult to have any control over the selection of people, because it is reliant on a village representative who may naturally favour his friends.

- In some cases it was clear that responses were made because it was felt that these were the "right" responses or those which may increase the chances of receiving some help. Similarly, it may be that a vocal member of the group dominates the discussion and it cannot be ascertained whether their views are actually in line with those of the other members.

Analysis of the data - because the survey techniques were participatory and by their very nature unique, it made it difficult to collect totally comparable data. For example it was not possible to compare the same set of vehicles against the same set of characteristic for every country because each country has a different set of vehicles in use and different set of relevant characteristics.

3.3 Conclusions of the use of PRA techniques

Techniques of rapid and participatory rural appraisal is becoming increasingly recognised as a quick method of collecting data, assessing needs, educating and training. Its main appeal is that it should make rural communities part of the decision making process and thereby making them the owners of development initiatives. It stems from the belief that many development projects have failed because outside "experts" have assessed needs and demand incorrectly. Sustainable projects rely on the stakeholders taking responsibility for development initiatives. This is most likely in an environment where the stakeholders have themselves stated their needs.

With regard to this project it is felt that the adoption of PRA techniques was on balance the correct approach. It allowed a great deal of latitude in the discussions which undoubtedly brought out issues that would not otherwise have surfaced. Much of the data collected from group discussions could later be verified by secondary sources and often proved to be at least as reliable and sometimes far more believable. With regard to the collection of VOC's the semi-structured questionnaire enabled the questioner to put questions in a way that would elicit the best response. Transport charge information was collected from a number of sources, including group discussions, questionnaires and secondary sources. A far bigger conventional survey would have to have been mounted to get the same coverage.

As with any survey there was a large difference in the quality of the results, with generally the best information coming from the Asian countries. As the later analysis will show, it is thought that this in itself is significant, particularly with regard to knowledge on routine maintenance. However the difficulties in collecting information often meant that the most educated persons in a village were sought for the survey. This in itself must have had a certain bias both in terms of what was representative for the village and how information may have been filtered to suit the perception of what the researcher wanted to hear. An example of this occurred in a Ghanaian village where it was asked whether a group discussion could be set up. After hurried discussions the village elders agreed to talk with us. The discussion started off with them telling us that they wanted a road, chain saw and tractor - any information collected in this environment could be regarded as having doubtful validity!

To sum up the PRA technique allowed the collection of a wide range of economic and social data. However, the quality of this information depends largely on the level of education both of the personnel conducting the interviews and more importantly that of the respondents.

CHAPTER 4

CASE STUDY - THAILAND

4.1 Introduction

Thailand is known as one of the "Asian Tigers" or "Little Dragons" because of the impressive growth that it has experienced over the last decade or so. Between 1980 and 1993 it has seen an 8.2% growth in Gross Domestic Product (GDP) and an 11% growth in manufacturing. Industry now accounts for 39% of GDP (World Bank, 1995). Agriculture is taking an increasingly back seat role in the development of the Thai economy.

Traditionally the cultivation, processing and export of agricultural products, especially rice, has been the mainstay of the Thai economy. However, the government felt that an over dependance on rice made the economy very vunerable to world price fluctuations. This vunerability was reduced by diversifying the economy into light manufacturing, particularly textiles and electronics. Much of the investment for this process was Japanese. Tourism now also plays an important part in the Thai economy.

Table 4.1: Key data for Thailand

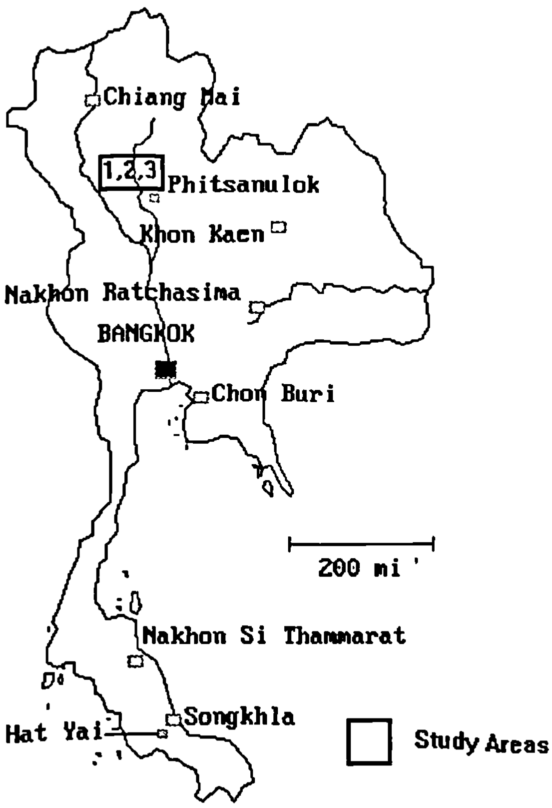
Characteristic	Number
Population (millions)	58.0
Area (thousands sq. km)	513
Population Density (pop/sq. km)	113
Rural Population (%)	65
GNP per Capita (US$)	1840
Road Length (km)- Total:	73,135
National Roads	16,814
Provincial Roads	27,594
Other roads	28,727
Road Density (km per million pop)	1261

The surveys in Thailand were conducted in July 1993.
The exchange rate was US$1 = 24.5 Baht and £1 = 37.5 Baht.

As a result of this rapid industrialisation the contribution that agriculture makes to GDP has gradually been falling. In 1990 crop cultivation, livestock breeding, and fisheries accounted for only 14% of GDP. This sector has also experienced falling growth rates with a drop to 2.5% from 4.8% the year before. This has been combined with increasing pressures on available land to supply ever increasing demands for food. In 1988/89 it was estimated that 23.65 million hectares, out of the 29.7 million hectares suitable for agricultural production, had already been used and a forecast that all land would be utilised by 1995 (Ministry of Agriculture and Co-operatives, 1991).

The result has been the need for higher yields, more intensive forms of production and increased agricultural inputs, of which mechanisation is one. The Seventh National Economic and Development Plan (1992-1996) set out for the first time a clear mechanisation policy which emphasised the promotion of local manufacture and extension activities.

Figure 4.1: Map of Thailand marked with the study areas



4.2 Description of the study areas

The Phitsanulok Province is situated in the Lower North Region of Thailand and is one of the more agriculturally developed provinces with high vehicle ownership levels. It is divided into nine districts. The surveys were conducted in three villages in Bang Rakam, Phrom Phiram and Wat Bot districts.

The province is predominantly flat and has high yields of paddy, maize and soyabean. In the hillier parts agricultural productivity is not so high and the main crops are supplemented with cassava and fruit trees.

Study area No.1: Nong Kula Village
Bang Rakam District

Nong Kula is a reasonably affluent village typical of the plains area in the Phitsanulok Province. Most farmers cultivate rice twice a year but maize, soyabean, mungbean and various fruits are also grown. The farming is very intensive and requires large amount of inputs. For example, in the most common case where farmers crop rice twice per year seed, fertiliser and sprays amount to 140 kg per rai[1]. The annual paddy yield is 1400-1700 kg per rai and added to this is the straw. Box 4.1 shows the agricultural cycle and demonstrates the high demand for vehicle services to transport inputs to the farm but also the harvest to the village and to market.

Vehicle ownership and vehicle diversity are very high in this village. Most people derive their incomes from agriculture but they are able to cultivate twice per year and there are many markets where they can sell their produce. The Bank of Agriculture and Co-operatives (BAAC) provides credit for farmers, either for farm inputs or for agricultural machinery. The credit is easily available and the conditions are not too stringent. All essential services are within easy reach. They are either located in the village such as schools and health centres or at district centres which can be reached using their own or hired transport.

Every household in Nong Kula owns a vehicle and in most cases they own more than one. The bicycle and motorcycle serve most of their day to day transport requirements such as visiting friends, relatives and to go on outings. There are also some motor

[1] 1 Rai = 1.600 square metres = 0.16 Hectares

tricycles which are used for commercial purposes, either for the transport of passengers of goods. They are also used as mobile shops.

Table 4.2: Nong Kula village statistics

Variable	Number
Population	1553
No. of Families	442
Total Agricultural Area	10,663 Rai
Water Supply	Taps
Firewood Supply	Charcoal
Electricity	Yes
Schools	1 (in village)
Health Facilities	1 hospital (in village)
Vehicle Repair Facilities	6
Mills	3
Markets	1 daily (in village) 1 weekly (in village) 1 weekly (district - 13km)
Vehicles: Power Tiller & Trailer Farm Vehicle (E-Tan) Pickup Conventional Tractor Truck (10 Wheel) Car Motorcycle Passenger Tricycle General Tricycle Bicycle	 500 100 10 7 1 2 200 2 5 600

The power tiller is probably the most versatile of the vehicles available in the village and ownership levels are extremely high. They are used for agricultural preparation, threshing, irrigation and when attached to a trailer for all transport activities. In some households there is more than one power tiller, as such there is little demand for hiring. The use of the power tiller for transport activities is mainly around the village but they are used to go to service centres up to 30 kms away.

Box 4.1: The agricultural cycle for a typical farmer cultivating two crops of rice

The agricultural cycle starts in June with the preparation of the land using a power tiller and 2 disc plough. The farmer will normally work for 8 hours per day and complete 5 rai in that time. The land is irrigated by pumping underground water for up to 72 hours (which will cover 15 rai). The engine from the power tiller is used for this purpose. The rice is transplanted in July by hand where a person can plant 3/4 rai per day. In August the land is sprayed using a handpump. Fertiliser is applied, by hand, 90 days after planting and a 50 kg bag will cover 5 rai. From November into January harvesting and threshing will take place. The crop is cut by hand and then threshed using the power from either the power tiller, e-tan or tractor. Normally the power tiller and trailer is used to take the harvest to the thresher and the paddy will then be taken away to mills or markets by e-tans, pickups or trucks. The first harvest yields between 600-700 kg of paddy.

The second rice crop is cultivated more intensively. The land is prepared in January after the last harvest. Planting is done by spreading seeds by hand, 30kg per rai. The crop is sprayed in March and then 15 kg of fertiliser is applied per rai. The harvest is done in April and May and the yield is between 800-100 kg of paddy per rai.

In addition to the power tiller is the farm vehicle or E-Tan as it is locally known. This is a locally manufactured transport vehicle which can carry upto two tonnes and travel over 100 kms. This vehicles is mainly used for the transport of agricultural produce but is also used for passenger movement and building materials. The single cylinder diesel engine also provides the power for threshing, chopping and spraying. In addition there are pickups and trucks for the longer distance transport movements. The plentiful supply of transport vehicles means that tractors are used entirely for agricultural preparation and for threshing at harvest time.

Study Area No.2 **Na Khum Village**
Phom Philam District

Table 4.3: Na Khum village statistics

Variable	Number
Population	771
No. of Families	211
Total Agricultural Area	-
Water Supply	Taps
Firewood Supply	Charcoal
Electricity	Yes
Schools	1 (secondary)
Health Facilities	hospital - 15 km
Vehicle Repair Facilities	2
Mills	1
Markets	5 shops (in village) 1 weekly (in village) provincial - 24 km
Vehicles: Power Tiller & Trailer Farm Vehicle (E-Tan) Pickup Truck Motorcycle Bicycle	 150 27 4 1 98 226

Na Khum has much the same agricultural characteristics as Nong Kula. Again farming techniques are quite intensive and the main crops the same. However in Na Khum there is not so much effort put into the cultivation of the second crop. One of the main reasons for this is the proximity of Phitsanulok, the capital of the Province, and the abundance of work opportunities there. Many of the villagers go into the city each day to work on the construction sites where they can earn far more than in the agricultural sector. Each day pickups come to the village and take up to 100 people into the city.

A labourer can earn twice as much on a construction site than as an agricultural worker, and a skilled craftsman can earn much more.

As a result the main complaint in the village is with regard to the shortage of labour during the busiest agricultural seasons, particularly the harvest. This is one of the reasons why mechanisation has been so necessary as well as why it has been able to be financed. For example in this village they now use combine harvesters to harvest the paddy. They have moved directly from harvesting by hand, which they prefer because there is little wastage, to using the combine harvester.

Study Area No.3 **Thanong Village**
Wat Bot District

Thanong is situated in the hills of Wat Bot district about 30kms from the district town, Wat Bot. This was the least developed of the study areas and had problems with access which were not present in the other villages. Agriculture in this area is dominated by cassava and maize, but rice, sesame, soybean and fruit are also grown. Yields in this area can be as good as in the lowlands but they are much more affected by the lack of rainfall so they tend to have peaks and troughs in their incomes.

The village is connected to Wat Bot by a good gravel road and there are very few steep gradients. Vehicle ownership in this village is far lower than in the lowlands. The money to buy the vehicles comes from work in industry or construction sites. The BAAC is not active in this area and the supply of credit is limited. Part of the problem is that the farmers have settled in this area but have no legal title to the land which means they cannot use their land as collateral for loans.

The lack of vehicles has meant that many of the farmers are reliant on traders to transport their produce to market. The power of the traders caused the agricultural extension officers much concern and as a result the government has funded a market which also has storage facilities. It is hoped that, now the farmers have a market which is closer to them and where they can store their produce for the best prices, they will be more inclined to buy vehicles to transport their produce there.

Table 4.4: Thanong village statistics

Variable	Number
Population	422
No. of Families	100
Total Agricultural Area	-
Water Supply	100m (foot with shoulder poles)
Firewood Supply	5 km (vehicles)
Electricity	Some
Schools	1 (primary)
Health Facilities	Health centre - 7.5 km Hospital - 33 km
Vehicle Repair Facilities	Nearest - 31 km
Mills	1
Markets	5 shops Market - 31 km
Vehicles:	
Power Tiller & Trailer	19
Farm Vehicle (E-Tan)	5
Pickup	2
Motorcycles	20
Working Buffalo	7
Bicycles	36

As a result of the relative scarcity of vehicles there is much more hiring than in the other villages. The power tiller is often hired for short farm to village trips. The farm vehicle also acts as one of the major sources of passenger transport. In this area there is still some use of buffalo for agricultural preparation and transport. The buffalo are usually used for the transport of firewood and small amounts of harvest. It is no longer a common form of transport and will soon disappear altogether.

4.3 Vehicles in operation

The number and diversity of vehicles in use in Phitsanulok Province was very large with many of them being locally manufactured. The most widely used vehicles in rural areas are listed below:

The power tiller - every day farming and transport activities at the village level are dominated by the use of power tillers (they are commonly known as walking tractors). In the lowland areas of the province the local people estimate that in most cases every farming household owns and operates one. It was estimated that in 1989/90 there were 660,685 power tillers in operation in the country (Ministry of Agriculture and Co-operatives, 1991).

They are based on imported Japanese power tillers, the design of which has been copied and modified to suit local conditions and manufacturing capability. The chassis' are entirely manufactured by local companies using engines built by joint venture Thai and Japanese companies. The result is a rugged machine that is not only appropriate to the needs of the farmers but to the maintenance and repair facilities available to them.

The vehicles are used for every conceivable purpose including land preparation, ploughing, pumping water, harvesting, threshing, transport of produce, passenger transport and in some cases the generation of electricity. For work in the field the power tiller is fitted with metal paddle wheels, but these are replaced by pneumatic tyres for road work. The process of changing the wheels takes 10 minutes.

The use of the walking tractor is somewhat restricted by its lack of brakes and therefore its illegality on the roads. For this reason they are primarily used for short hauls on rural roads although they are also operated for short distances on major highways. Their load capacity is in the region of one tonne and they cost between B34,000 and B50,000 depending on the size of engine, number of gears and whether it is Thai or Japanese manufactured.

The Farm Vehicle - these vehicles (locally known as e-tans), are widely used in the Province of Phitsanulok and other similarly flat areas of Thailand. The number of registered farm vehicles in 1990 stood at 73,733 but this must significantly under state the true levels of ownership (Srisakda and Chivasant, 1992). In the survey areas looked at in this study the majority of owners did not register their vehicles.

They are locally manufactured using second-hand parts from Japanese pickup trucks, the body is made to order and the buyer can specify the length of body and whether they want a driver's cab or not. The quality of the trucks varies widely with the best vehicles coming from formal factories and the worst from mechanics based in the villages. As with the power tillers the chassis is constructed to be used with a single cylinder diesel engine. In theory it is feasible for the same engine to be transferred between the power tiller and e-tan. In practice this does not happen, mainly because the preferred size of engine for a power tiller is smaller than that for an e-tan. As such the cost of a farm vehicle can be as little as one fifth of the price of a pickup i.e. between B60,000 and B86,500 depending on whether they have cabs or not.

E-tans have the potential for a lot more use as far as transport is concerned. However many of the vehicles are not maintained with regard to their lights etc. and their drivers often do not register the vehicles or have driving licenses. The load for an e-tan is officially one tonne but they are often loaded to three tonnes.

The pickup truck - the use of pickup trucks for the transport of agricultural produce is also widespread. The owners of pickup trucks are predominantly merchants or the more wealthy farmers. Owners of pickup trucks use them very intensively for all sorts of activities. For example for passenger transport; transport of inputs; transport of harvest; in a marketing role transporting produce from one agro-climatic zone to another; in cities as a taxi; and for the purchase of household items or for shops. Due to the diversity of uses the pickup is fully utilised throughout the year and as such are very desirable vehicles. Many farmers will sell land in order to buy a pickup as they realise that returns can be higher than from agriculture.

As a result of the high demand many of the dealers report problems in keeping up with demand. The pickup trucks are predominantly Japanese i.e. Nissan, Toyota and Izuzu etc. with a designed payload of one tonne but regularly carrying up to three tonnes. They have 90 hp diesel engines and cost about B300,000.

The conventional tractor - these vehicles are used entirely for agricultural preparation and during the harvest season for threshing. None of the tractors in the survey villages were used for transport purposes and hence there were no tractor trailers. The main reason for this is that during the ploughing season and harvesting season when transport requirements are high the tractors are fully utilised in the fields. The existence of many other forms of transport vehicle, particularly the e-tan and pickup, also reduce the demand for extra load carrying capacity. The farmers also perceive the tractor and trailer as being an expensive option because of the high maintenance and repair costs associated with the tractor.

Unlike the power tiller and farm vehicle the tractors are almost entirely imported. The numbers in operation according to ministry of agriculture statistics is 51,279. The most common tractors available are second hand Ford 6600 which cost about B500,000.

Motorcycle technology - motorcycle ownership was very high in the villages studied and their use was mainly for personal mobility. Motor tricycles (B 15,500 with a 72cc Honda engine) act as load and people carriers with a payload of 500 kg. Some motorcycles are also fitted with trailers of similar capacity. Although there is some ownership of load carrying motorcycle technology in the villages they are mainly for use in the urban areas.

The bicycle - the bicycle was not an important load carrying vehicle. It's use was centred upon the village for trips to friends and family, to the shops and by children for playing. Occasional trips were also made to the fields when it is unnecessary to use the power tiller.

4.4 Vehicle operating costs

The diagrams that appear in this section detailing vehicle operating costs (VOC's) have been generated by a spreadsheet model using the data collected from the survey sites. These data are presented in appendix C. The variables used from the survey data in the spreadsheet model are the purchase price, the economic life of the vehicle, payload, average speed and the fuel, maintenance, repairs, tyres and wages costs per kilometre or hour. The information available in appendix C relates to every country and vehicle for which data were collected.

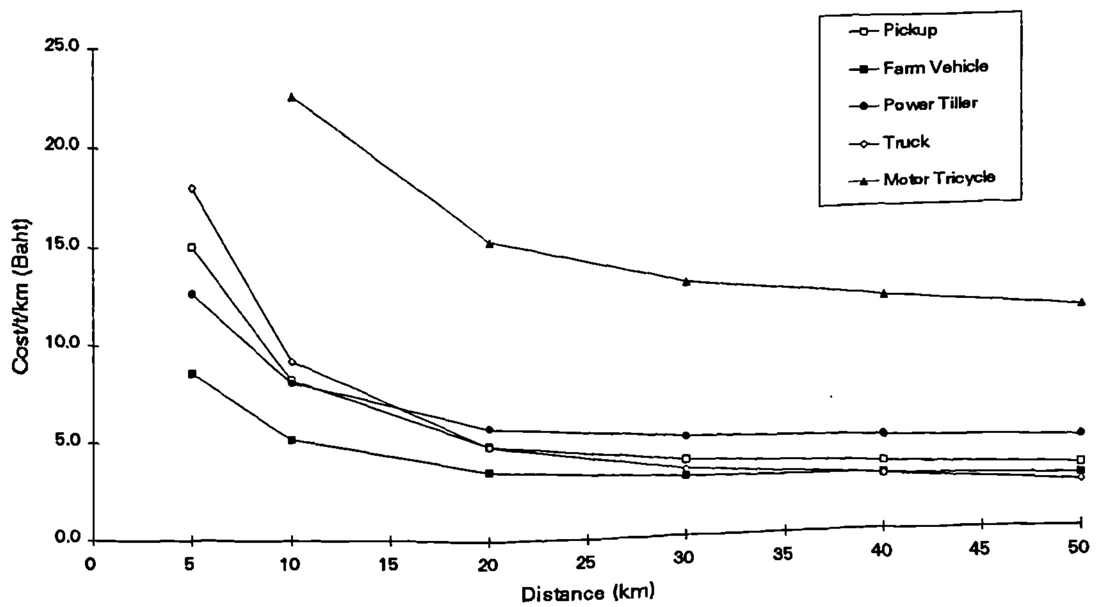
For the purposes of this analysis vehicle lifes (economic life) were assumed to be fixed irrespective of annual utilisation. Total annual utilisation is limited in the spreadsheet model by constraints on the hours per day, days per week and weeks per year that the vehicle is operated. The values returned from the model are also presented in appendix C in local currency terms. The analysis has been conducted in exactly the same way for the Sri Lanka, Ghana, Zimbabwe and Pakistan case studies.

What immediately becomes clear from figures 4.2 and 4.3 is that for the relatively short distances that are typical in the rural areas of Thailand the farm vehicle is cheapest to operate. This is true up to about 50 kilometres when the annual demand is 1000 tonnes, and up to about 1500 tonnes at a distance of 25 kilometres. The low initial investment and low maintenance costs make the farm vehicle ideal for relatively short, low demand routes.

The power tiller is actually cheaper than the farm vehicle only for very low demand, less than 100 tonnes per year at 25 kilometres. This again explains why rural people often use their power tiller for household tasks. The power tiller is normally not used for transporting produce at harvest time but only for transport within the field to the thresher. However, figure 4.2 shows that the power tiller still remains cheaper than conventional vehicles for distances of less than 10 kilometres.

The figures also show that the pickup and truck have cost curves that are as expected. The pickup is cheaper for shorter distance, lower demand work but as the distance and available load increase the truck's cost curve becomes lower than that of the pickup. It is also the case that the conventional vehicles cost curves pass below the locally manufactured vehicles cost curves as distance and demand increase.

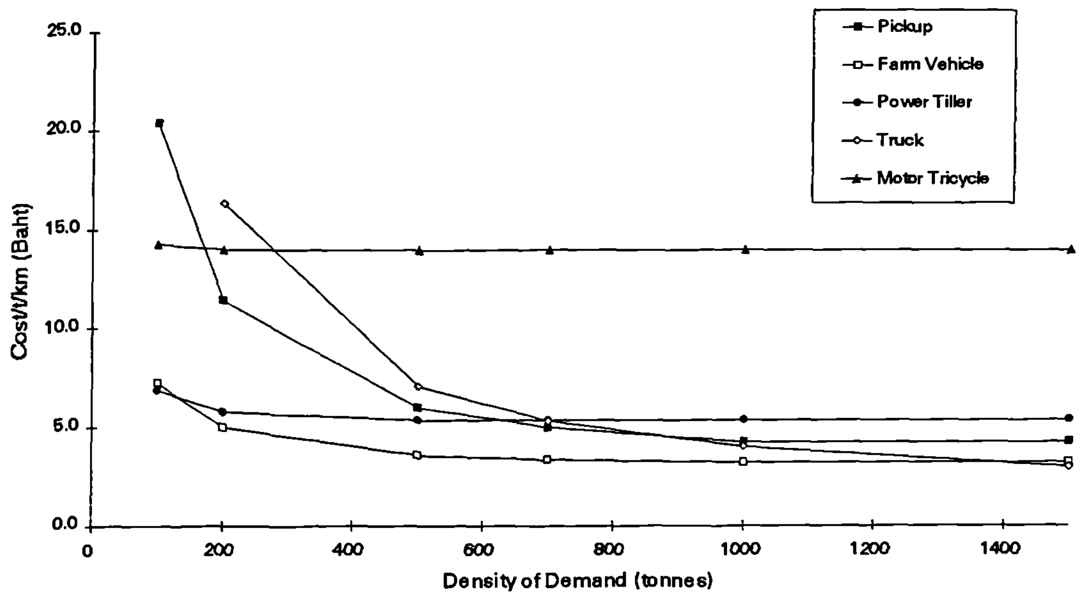
Figure 4.2: Vehicle operating costs at 1000 tonnes per year



The motor tricycle performs a slightly different purpose from the other transport vehicles mentioned above. It is very much used for short distance very low demand work and so is particularly suited to use in urban areas and even within villages. As a result the cost curve of the motor tricycle is higher than the other vehicles except for very low demand work.

The diversity and number of transport vehicles means that each vehicle can be used for its most efficient purpose. Trucks for long distance, high demand loads; pickups for long distance marketing and for jobs when speed is of the essence; farm vehicles for transportation at the farm and village level; motor tricycles for short distance marketing and passenger movement; and power tillers for joint agricultural and transportation purposes at the household level. This abundance of transport vehicles at the rural levels means that vehicles such as the tractor can be used entirely for agricultural preparation.

Figure 4.3: Vehicle operating costs for a 25km trip and various levels of demand



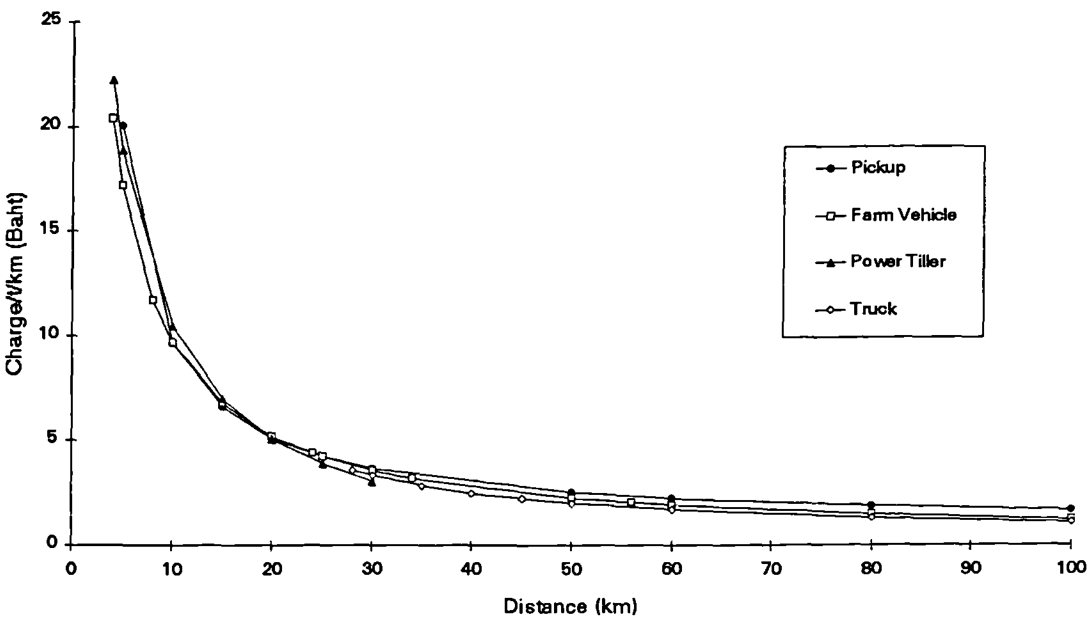
4.5 Thailand transport charges

As figure 4.4 clearly demonstrates the market for transport services in the rural areas of the Phitsanulok province is very competitive. The diagram shows data collected from all vehicle modes for operation within the province or district. One of the features of the lowland market for the transport of rice was the uniform rate irrespective of vehicle mode or distance. Any trip within the district was charged at

B100 per tonne of paddy. This made short village level transport quite expensive but longer trips to district centres relatively cheap. The rates were probably set like this because of high vehicle ownership levels making vehicle hire over short distances rare. In the Wat Bot district where vehicle ownership levels were lower, short routes from farm to village were individually priced.

Although there was a uniform rate, there was no outside interference or price control. For trips outside the district and for goods that were not paddy, routes were priced individually according to the destination.

Figure 4.4: Thailand transport charges



4.6 Factors affecting the provision of rural transport services

4.6.1 Infrastructure

The rural road network in the province is extremely good with most roads between district centres being paved and village access roads being of good quality gravel. The roads are regularly maintained and remain passable throughout the year. Roads from the villages to fields are generally earth roads but are still maintained and remain passable for all but a couple of days in the year. The quality of the roads does not restrict access to any vehicle type.

The infrastructure in the Wat Bot District was of a slightly lower quality and many of the main feeder roads were gravel and not paved. However they were well maintained and motorable the year round. Village level and field roads were of a lower standard and may not have been passable to conventional vehicles particularly in the hillier regions. However they were all passable to buffalo and almost all to power tillers.

4.6.2 Credit

The availability of good credit facilities has had large implications for the degree of mechanisation in rural areas and the high vehicle ownership levels. There are many commercial banks, development banks and finance companies, retail outlets are also prepared to give credit, and in the least developed areas the traders provide loans.

In the rural areas the most important credit organisation is the Bank of Agriculture and Co-operatives (BAAC) which provides loans for agricultural inputs, farm machinery and longer term agricultural projects such as plantations. Farmers wishing to qualify for a machinery loan must receive their equipment directly from the BAAC who have a department buying machinery in bulk from manufacturers. This has two main advantages. Firstly it means that farmers can buy their machinery cheaper than from conventional retail outlets and have a guarantee that the quality is good. Secondly the BAAC can ensure that the loan is being used for its intended purpose.

The BAAC provide their loans at an annual rate of interest of 12 % repayable over 2-10 years. Commercial banks, finance companies and retail outlets charge an annual rate of interest in the range of 20-30 %. The traders charge in the region of 5 % per month but borrowers must also sell their produce to the trader which can potentially lead to exploitation. Although the traders charge by far the highest rate of interest, in the areas where they operate rural people prefer to use them rather than the formal institutions. They claim that the BAAC for example, does not understand the way they live with regard to their seasonal income flows. An official from the BAAC will come around every month to collect repayments whereas traders will only collect their money after the harvest.

The BAAC has a novel way of getting around the problem of security for loans. Farmers who do not have deeds to land or other collateral to secure their loan can form groups with other farmers in their village and they all take responsibility for the loan. In this way if the farmer who has applied for the loan defaults on repayments the whole group becomes liable for his debts. This effectively places the borrower under considerable peer pressure to repay and also places a considerable incentive to the others to make sure he does, even to the point where ultimately they will repay the loan themselves in order that they do not jeopardise their chances of receiving a loan in the future. The more formal institutions require conventional security for loans and the traders rely on detailed knowledge of the trustworthiness of their clients.

4.6.3 Local Manufacture

As described above the local manufacture of power tillers and farm vehicles provides the power sources for the majority of farmers in the Phitsanulok Province. The industry has developed quickly and responds well to the demands of farmers. The local manufacture of these vehicles together with many other types of farm machinery such as sprayers, seed drills and combine harvesters has made mechanisation available to a large number of people. Box 4.2 details the manufacturing process of these vehicles together with some of the characteristics which make them ideal for operation in rural Thailand.

4.6.4 Vehicle Backup Services

The villages either have formal garages for the repair of all the major vehicles in the area, or informal mechanics who attend to 90 % of repair needs in the community. Spares are in good supply and relatively cheap because of the high content of locally manufactured vehicles and parts. Village level mechanics are extremely skilled, innovative, and have much of the equipment needed for all types of repairs.

Many of the factories which have sprung up to produce power tillers and e-tans etc. also offer after sales backup services for up to a year after purchase. They have vans which go around the village repairing vehicles that are under warranty.

Box 4.2 Local manufacture of power tillers and farm vehicles

There are some 80 factories producing power tillers and farm vehicles in Thailand at the moment and despite fluctuating demand due to variations in producer prices, the success of this industry is set to continue. In both cases the vehicle chassis' are manufactured in the factory, while the rest of the vehicles is made up of second-hand conventional vehicle parts, new conventional vehicle parts and parts that are assembled in the factory. For example, it is now common for the transmission mechanism in the power tiller to be assembled using gears that have been imported from china. The result is a vehicle that is cheap to buy, easy to maintain and easy to find and replace spare parts.

Power tiller specifications

	Thai Manufactured Chassis	Japanese Manufactured Chassis
Gear Box	Welded case of mild steel - heavy but easy to repair.	Cast iron case.
Transmission	Sprocket and Chain - cheap and easy to maintain.	A compact gear system.
Clutch	Four teeth at right angles to each other - the wear is greater but they are cheap to make.	Multi-teeth dog clutch.
Brakes	No. Must disengage the transmission to stop.	Yes. Drum brakes.
Power Take Off	No.	Yes.
Gears	1 - 3 gears.	4 gears.
Dimensions WxLxH (mm)	1,080 x 3,250 x 810	1,080 x 3,250 x 810
Engine	8 - 11.5 hp	8 - 11.5 hp
Price - Chassis Engine	B11,000 - B15,000 B23,000 - B29,500	B25,500 B23,000 - B29,500

In addition, the factories also provide after sales support so that the farmers have a guarantee for reliability. For example, a power tiller factory in the Sukhothai province provided a 3 year warranty for faulty parts and labour costs. They also had a service vehicle that travelled around the villages providing doorstep service. Their production had increased from 1000 to 2000 units in a year.

Farm vehicle specification

Chassis	Manufactured at the factory from general steel
Rear Axle	From Toyota pickup, brakes are replaced but nothing else is done.
Suspension	New suspension from Izuzu pickup for the rear (very hard) and new suspension from Toyota for the front (softer).
Transmission	From an old Toyota pickup, it is checked over and has new transmission oil.
Electric's	Built up in the factory.
Tyres	Goodyear 6.00 - 14 Nylon 6 ply rating.
Dimensions WxLxH (mm)	1,560 x 2,700-3,500 x 2,160
Engine	8.5-16hp supplied with or without engine
Cost - Chassis Engine	With cab - B66,500 No cab - B40,000 With cab - B86,500 No cab - B60,000

4.6.5 Routine Maintenance

All vehicle owners carry out a comprehensive regime of routine maintenance and also dealt with a large number of their own repairs. Repairing their vehicles at home is simplified because of the simple nature of much of the technology. The farmers in the Phitsanulok province have great pride in their vehicles and look after them accordingly.

4.6.6 Markets and Storage

Markets are very accessible in rural Thailand. Most villages have a Saturday market where they can buy and sell produce, some villages have daily markets and they all have shops.

Traders do not provide an important service in the lowlands but they do purchase produce directly from farmers in the highlands and transport it to their stores.

4.7 Overall impressions of the provision of rural transport services

It can be concluded that transport needs in the rural areas of the Phitsanulok Province of Thailand are very well satisfied. The vehicles are operated efficiently in a competitive environment and as such transport charges were low and uniform over much of the province. There was a wide diversity of vehicles available for all types of transport including the movement of small loads over short distances; the movement of large loads over long distances; the marketing of high value goods between provinces; and the movement of passengers.

The rural transport system benefited from easily available credit from numerous sources; a good infrastructure at the district and village level; locally manufactured vehicles which meant that they were cheap to buy and maintain; a good network of garages and skilled mechanics; and an efficient marketing system.

High demand for transport services both from intensive agriculture and numerous rural industries meant that vehicle ownership levels were high. Labour shortages were acute in many of the villages which resulted in mechanisation at a fast rate. Much of the income generated from external employment was returned to the farms and often in the form of agricultural machinery and transport vehicles.

CHAPTER 5

CASE STUDY - SRI LANKA

5.1 Introduction

Sri Lanka has one of the highest population densities in the developing world but has still managed to achieve some of the best results for human development indicators. For example, it has a literacy rate of 88%, infant mortality at 19 per thousand live births and a fertility rate of 2.4. Despite its outstanding performance in human development it has not managed to achieve the same results in economic growth. Although it achieved a steady rate of growth of 2.5% between 1950-1993 it did not adopt the policies that would support the rapid economic growth that the "Asian Tigers" experienced.

Table 5.1: Key data for Sri Lanka

Characteristic	Number
Population (millions)	17.4
Area (thousands sq. km)	66
Population Density (pop/sq. km)	263
Rural Population (%)	79
GNP per Capita (US$)	540
Road Length (km)- Total: National Roads Provincial Roads Local Roads Settlement & Forest Roads Urban Roads	94,800 11,000 15,000 50,000 16,000 2,800
Road Density (km per million pop)	5,450

The worse than expected economic growth was partly because of the Bandaranaike's policy of nationalisation and the creation of state monopolies. This process was only

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The Sri Lanka surveys were conducted in November 1993.
The exchange rate was US$1 = Rs 49 and £1 = Rs 71.5.

stopped in 1977 when the United National Party (UNP) adopted a policy of economic structural adjustment which placed far greater emphasis on the market. The policies included the lifting of price controls, import liberalisation, exchange rate devaluation and the imposition of positive real rates of interest. Unfortunately these policies saw another set back during the 1980's but they have been introduced with renewed vigour in the 1990's and the economy is now expanding at 4% in real per capita terms (World Bank, 1995a).

In addition to Sri Lanka's investment in human capital there is also an impressive roads infrastructure. Of the 94,800 kilometres of road on the island roughly a third are paved and the network per inhabitant is larger than in any other South Asian country and double the average in East Asia (World Bank, 1995b). However, there are problems with maintenance and congestion particularly on the major routes. The freight and passenger services are deregulated and competitive, nearly 80% of freight in Sri Lanka being transported by road.

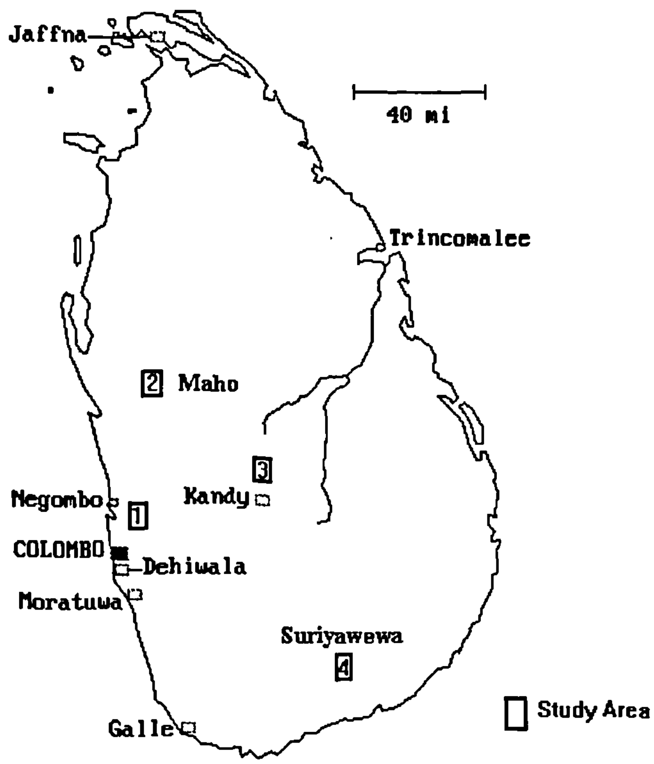
In 1992 the agricultural sector accounted for 26% of GDP and provided employment for 40% of the work force. Rice accounts for the largest share (19%) followed by coconut, tea and rubber. Transport at the rural level is dominated by the bicycle for personal travel and marketing functions, but ox carts and two and four wheel tractors transport the bulk of the produce.

5.2 Description of study areas

Although Sri Lanka is a small island, only 66,000 sq kms, it has a diverse topography ranging from the flat plains of the coastal regions to the highlands in the South Central Zone. As a result, the climatic variations between regions are quite distinct. The country is split in to three climatic zones, the wet zone, intermediate zone and dry zone.

There are two main agricultural seasons, the Yala season (April to September) and Maha season (October to March). It is only in the wet zone that cultivation can be guaranteed in both seasons. However, the whole island benefits from the rains in the Maha season. The four study areas are typical of those in the different climatic and topographic zones.

Figure 5.1: Map of Sri Lanka marked with the study areas



Study Area No.1 **Malagala Village**
Hanwella Divisional Secretariat
Colombo District
Western Province

Malagala is in the wet zone of the country and paddy can therefore be cultivated in two seasons. In the Hanwella area production is primarily geared towards large scale rubber and tea plantations. However, this village has 50 % of its land set aside for paddy cultivation and the rest for small holder rubber and coconut plantations. Although the Hanwella area does have some hilly parts the area around Malagala is predominantly flat. The village is accessible along a single track paved road, five kms from Parduka the main service centre. Average farm sizes are very small, in the region of a ¼ acre. As such the bulk of production is purely for subsistence with any excess being bought by traders to sell in Parduka. The small amounts of cash crops available would make individual trips to market unprofitable.

Table 5.2: Malagala village statistics

Variable	Number
Population	1,864
No. of Families	351
Total Agricultural Area	218 acres
Water Supply	Household wells
Firewood Supply	Around house / hired vehicle
Electricity	Yes
School	1 primary (in village) 1 secondary (in village)
Health Facilities	1 health centre (in village)
Vehicle Repair Facilities	2
Mills	1
Markets	5 shops (in village) 1 weekly (6 km)
Vehicles:	
Power Tiller & Trailer	10
Tractor & Trailer	1
Truck (5 tonne)	1
Bus (large)	1
Van (15 passengers)	2
Motorcycle	20
Oxcart	1
Bicycle	263

The village has good access to all major services. Goods transport is used mainly for building materials, firewood and a relatively small amount of agricultural produce. Vehicles are primarily used for personal transport and in particular to get to alternative sources of income. These sources include work on large plantations, textile factories, as labourers, traders or government servants. Some people even work in Colombo a three hour bus journey away.

The bicycle is the predominant form of transport vehicle for most people and it satisfies nearly all of their needs. These include travel to markets, friends and relations, employment, grinding mills, fields and for the harvest from the rubber plantations. Richer members of the community use motorcycles for these tasks. There is a regular bus service which provides travel for most activities outside of the immediate vicinity of the village.

The power tiller is used for agricultural preparation and village level transport including the transport of fertiliser, harvest, firewood, building materials and to local markets. Oxen are also used for agricultural preparation but in this village their use for transport has all but finished due to competition from the power tiller. Tractors are used almost entirely for transport because the paddy fields are so wet that they cannot hold the weight of a tractor. They are also used for threshing during the paddy harvest.

Study Area No.2 **Madiyawa Village**
Maho Divisional Secretariat
Kurunegala District
North Western Province

Madiyawa is in a flat area and situated in the dry zone, so paddy can only be cultivated during the Maha season. The villagers were unanimous in stating that the lack of irrigation was holding back development more than any other factor. About 50 % of the land is set aside for paddy with the rest for highland crops such as green gram, sesame and cowpea. The highland crops are purely rainfed whereas the paddy is irrigated when there are sufficient water supplies.

The nearest service centre is Maho which is 10 kms from the village along an earth road which becomes all but impassable during the rainy season. The most common form of transport is either by bicycle or foot. The lack of a bus service causes the villagers to feel very isolated, unable to visit anyone outside the village and restricted in the work they can accept because of their limited travelling range. As a result, the more dynamic members of the community leave altogether.

Vehicle usage follows much the same pattern as in Malagala village with the bicycle providing the predominant transport role. The role of the bicycle is perhaps more important in this village because of the lack of a bus service. The services provided by the power tiller are becoming increasingly important and the owners of ox carts are seeing the demand for their services fall. Motorcycles are used by traders (dried fish is a popular product), shop keepers and the richer members of the community for personal travel. Motorcycle owners are often asked to transport the sick to hospital.

Table 5.3: Madiyawa village statistics

Variable	Number
Population	657
No. of Families	180
Total Agricultural Area	658 Hectares
Water Supply	250-550 metres (by foot)
Firewood Supply	Around house/3 km (by foot)
Electricity	Some houses
School	1 primary (3 km)
Health Facilities	1 hospital (10 km)
Vehicle Repair Facilities	0
Mills	1
Markets	2 shops (in village) 1 main market (10km)
Vehicles: Power Tiller & Trailer Motorcycle Oxcart Bicycle	 6 12 5 150

Study Area No.3 **Aluwathugirigama GSN Area**
Kundasala Divisional Secretariat
Kandy District
Central Province

The Aluwathugirigama GSN area consists of four small villages (Melagal Gammadda, Deniya Gammadda, Mada Gammadda and Peterkanda Colony - the last of which is a recent government resettlement scheme designed to provide ¼ acre plots to landless families). This area is in the wet zone and the terrain is described as steeply dissected, hilly, rolling and undulating. It is the terrain which presents the major problem to the villages. Only 10 % of the land is used for paddy cultivation with the rest being used for highland crops and spices.

There is a lack of easily cultivable land and the physical infrastructure in terms of roads, tracks and paths is inadequate. Travel within the villages is almost entirely by footpaths which are in the main unsuitable for anything other than humans. In the rainy season it becomes difficult even for them. Any roads or permanent paths suffer from being washed away by heavy rains which can turn roads into rivers in a matter of minutes.

Table 5.4: Aluwathugirigama GSN area statistics

Variable	Number
Population	1126
No. of Families	296
Total Agricultural Area	325 acres
Water Supply	100 metres (by foot)
Firewood Supply	2 km (by foot)
Electricity	Some
School	1 primary (in village)
Health Facilities	1 health centre (in village)
Vehicle Repair Facilities	0
Mills	0
Markets	7 shops (in village) 1 main market (7km)
Vehicles: Van (15 passengers) Motorcycle Bicycle Handcart	 1 5 20 2

As a result of the poor village level infrastructure the level of vehicle ownership is very low. Consequently, goods have to be transported to the roadside by headloading (the paved road is on average two kms from the village) from where the villagers are reliant on the bus services. Traders rarely operate in this area because of the difficulties of getting into the village. There was a village level scheme to build appropriate roads into the village using local contractors. Although the local contractors had experience in maintaining the existing network, it was not clear that the design of the road was going to prevent it from being washed away with heavy rainfall.

Alternative income sources primarily came from the surrounding large tea plantations with some people travelling into Kandy. There were a number of small businesses in the village including store keepers, bakers, a small textiles factory and grinding mill. All complained that poor access adversely affected their business as did the lack of credit facilities.

Study Area No.4 **Venivallara Village**
Suriyawewa Divisional Secretariat
Hambantota District
Southern Province

Venivallara is in a flat area and located in the dry zone and so cultivation is only possible during the *Maha season. This village is slightly different from the others in* that it is a government sponsored resettlement scheme where landless people have been allotted two acre plots to develop as agricultural land. These resettlement villages are supposed to be connected to a maintained road network and irrigation system, but as Venivallara is on the outskirts of the scheme these facilities have not yet become available. As a result the road to the village is an earth road which becomes difficult to pass during the rainy season.

There are a number of seasonal problems that stem from the road. Firstly, there are a number of small traders who have to cease trading during about three months of the rainy season. Secondly the bus service which stops three kms away during the dry season suspends services altogether during the rains.

The seasonal access problems have intensified the role of the power tiller in this area as it is now used for passenger transport to Suriyawewa, the nearest service centre. The relatively large agricultural plots that have been assigned to the farmers under this resettlement programme have also increased the viability of power tillers. Bicycles and motorcycles are used as in the other villages for personal transport and trading. The demand for ox carts is falling but some people prefer this mode for the transport of bananas because they feel there is less damage.

Table 5.5: Venivallara village statistics

Variable	Number
Population	640
No. of Families	160
Total Agricultural Area	507 acres
Water Supply	250-1000 metres (by foot)
Firewood Supply	Around house
Electricity	No
School	1 primary (in village)
Health Facilities	1 hospital (10 km)
Vehicle Repair Facilities	0
Mills	2
Markets	5 shops (in village) 2 main markets (5 & 7km)
Vehicles: Power Tiller & Trailer Motorcycle Oxcart Bicycle	 10 7 1 140

5.3 Vehicles in operation

The number and diversity of vehicles being used in Sri Lanka is very large with both motorised and non-motorised modes being used. All motorised modes are imported vehicles while non-motorised modes are constructed locally. The most widely used vehicles in rural areas are listed below:

The bicycle - the bicycle is undoubtedly the most widely used vehicle in rural Sri Lanka. According to the Ministry of Policy Planning and Implementation (MPPI, 1989) there are approximately 446,000 in use around the country. They are primarily used by men, but the slow process of the acceptance of women riding bicycles has started. It is normally women engaged in professional activities such as school teachers who are taking the lead in using bicycles. However, there is still a feeling that women riding bicycles are trying to behave like men and that this behaviour is culturally unacceptable. As a result, many of the household tasks are still conducted by women headloading water and firewood to the house. The presence of bicycles has reduced their burden by transferring some of the work onto men, in particular for travel to the grinding mill and to markets. The women also benefit from the bicycle because they can travel as a passenger on the rack at the back.

The main uses for the bicycle include travel to external sources of income for example to schools, factories, offices etc.; travel to markets to buy or sell produce; travel for personal reasons for example to see friends and relatives, and to health or educational facilities; travel to and from fields during the crop production season; and travel in a marketing role, for example selling fish or coconuts around the village or between villages. A bicycle has load capacity of around 70kg.

It can be concluded that the widespread use of bicycles has had a fundamental benefit in improving personal mobility. It has the effect of bringing far more income earning opportunities within the reach of individuals and relieving the transport burden of everyday subsistence tasks. The benefits will increase as it becomes more culturally acceptable for women to ride bicycles. One of the main reasons for the success of the bicycle is the relatively short distances that need to be travelled to essential services. This is combined with the affordability, reliability and ease of finding spares. A new bicycle costs between Rs 3,000-3,800, the cheapest coming from Raleigh of India and the most expensive coming from China.

The hand cart - the hand cart is predominantly used in the hilly areas for transport of firewood and agricultural produce etc. They are locally manufactured and consist of a wooden box mounted on two axles with four small wooden wheels. These vehicles can only be found on paved roads and would be inappropriate for use on rough roads because of the primitive nature of the wheels. The carts vary in size and require between one and four people to push them.

The motorcycle - the motorcycle performs many of the same functions as the bicycle and is the next step up the ladder as a vehicle for personal mobility (they can carry most of the family). The car is the top of the ladder. There are approximately 325,000 motorcycles in operation in Sri Lanka. As such motorcycle owners who just use the motorcycle for their own mobility tend to be the richer members of the community. However, the motorcycle can also be used as a commercial vehicle, mainly for marketing, milk, dried fish, village shop supplies and other high value perishable commodities. A motorcycle has a load capacity of around 100kg.

The motorcycle is ideal for use on rough rural roads but some riders complained of having to cease trading during the wet months (up to three months per year) due to muddy roads. There are many motorcycles in use from 50cc scooters to 100-125cc motorcycles. Many of the motorcycles bought in rural areas are reconditioned models from Japan and Honda is the most popular make. A brand new 100cc motorcycle can cost up to Rs 58,500 but a reconditioned 50cc scooter can be bought for Rs 22,000. Maintaining and servicing motorcycles is of little problem with spares being available either at the village level or at the nearest service centre.

The power tiller and trailer - the power tiller was first introduced into Sri Lanka in 1956, nearly 11,000 units being imported up until 1975 (Plumbe and Byrne, 1981). From this date the use of power tillers has risen rapidly with well over 2,000 units per year being imported. This rising trend has only started to subside since the late 1980's (Biggs, Kelly and Balasuriya, 1993). The Farm Mechanisation Research Centre (FMRC) estimated that in 1991 there were between 133,000 and 183,000 power tillers in operation based on a survey where it was found that 2.7% of farmers owned a power tiller of which 57% hired them out (FMRC, 1991).

The power tiller is rapidly becoming the most important multi-purpose agricultural and transport vehicle. It is ideal for the small field sizes and the relatively short distances needed to be travelled in rural Sri Lanka. It is used for ploughing, threshing, pumping water, and the transport of harvest, firewood, produce to market, for marketing and passenger movement. A power tiller can plough one acre in four hours and has a load capacity of around one tonne when attached to a trailer.

They are owned by richer members of the community and are used for their own purposes and for hire. It is very rare that farmers can afford to operate them solely for their own use. The multi-purpose nature of the vehicle means that they can be utilised all the year round and therefore provide a good alternative income source to farming.

There are a number of different vehicles available varying in cost, power and reliability. The most expensive model is the Japanese Kubota K75 which has an 8hp engine, and a rotary cultivator. It sells for Rs 195,900, the trailer costing another Rs 30,000. At the other end of the scale is the Chinese Agrimec 5hp model which sells for Rs 44,000. However, farmers are under no illusion about value for money. The Kubota model is by far the most reliable which means that repair costs are lower. Many people buy a Kubota as a hedge against inflation or as a store of value.

The power tillers are very well looked after and the owners have very reliable information on their repair and maintenance requirements. As a result they can be operated intensively for many years, some of the Kubota's being well over 20 years old.

Ox carts - oxen are the longest standing form of animal draught power in Sri Lanka. They can be attached to a plough, when four animals can plough an acre in a day. Two animals attached to a trailer can pull one tonne or more depending on the size of the animals. They are used for the transport of firewood and paddy at the village level and will be taken to market for the sale of harvest.

A feature of the rural scene in Sri Lanka is the gradual phasing out of the use of oxen for draught power. They are facing direct competition from the power tiller which performs all the same functions but with a lower labour requirement. As farming echniques have become more intensive, the available land for grazing animals has reduced, feed has become more expensive and a greater premium is placed on timeliness. As a result, oxen are used less intensively and are only really required at times of peak activity. However, the FMRC survey found that 15.4% of farmers own at least one buffalo and 10% own at least one bullock. Buffalo numbers are estimated to be around 1,500,000 and bullock numbers around 1,000,000 which still makes them an important source of draught power (FMRC, 1991).

However, there are still activities which the oxen can perform more efficiently. In some wet zone areas, oxen are used for ploughing because the soil is too wet and deep to be able to support a power tiller. The oxen are basically taken into the fields to trample the soil. The ox cart is preferred for the transport of very delicate perishable goods such as eggs and bananas. The cart moves so slowly it is unlikely to do much damage to the produce on rough roads.

One of the reasons it has taken so long for the use of ox carts to be phased out is the Buddhist faith which discourages the owner from selling their animals for slaughter. It is also very difficult to get credit to upgrade to a power tiller, as the difference in price is quite large. A pair of oxen cost in the region of Rs 16,000 and a trailer about Rs 25,000. To buy a power tiller and trailer can be up to eight times more expensive than buying oxen and a cart.

Tractor and trailer - tractors were initially imported into Sri Lanka as part of a series of measures to increase agricultural production. In 1952 a large consignment of over 400 tractors were imported from Great Britain and Australia, which effectively tripled the countries fleet of tractors. These vehicles were entered into co-operative tractor pools but due to poor management and lack of spares they were under utilised and became inoperative (Biggs, Kelly and Balasuriya, 1993).

Since this experience the private ownership of tractors has become more widespread. The process was helped by favourable foreign exchange entitlements for the import of tractors and tractor spares. The opposite was the case for lorries and lorry spares which faced an almost complete import embargo in 1962 due to severe balance of payments problems. The result was that tractors became a competitive alternative to lorries for road haulage and they dominated the market, particularly for relatively short haul movements. Even after the relaxation of controls on the import of tractors in 968 the high foreign exchange premiums to be paid on both vehicles gave a considerable price advantage to tractors (Plumbe and Byrne, 1981).

Despite attempts by the government to requisition tractors not used for tillage during the cultivation season, the use of tractors for haulage has continued to grow and it still remains an important part of their work today. However, the continued success of the power tiller has meant that the number of tractor imports has declined over the years. For example, in 1978 new registrations of tractors were over 2,000 per year, but after 3 years this figure was falling to 500-600 new registrations per year . The total number of tractors in operation is estimated at between 16,000 and 38,000 (Biggs et al, 1993 and FMRC, 1991).

Although today tractors are primarily bought for agricultural purposes, transport still remain an important part of their work. In the wet zone where fields are very wet and muddy, a tractor will sink. In these regions tractors are used almost entirely for transport. In other areas they will be used for the transport of agricultural inputs and harvest, the transport of building materials, firewood and for use on road maintenance and building projects.

Passenger transport - although bus transport is not a component of this study it should be noted that the bus was a very important component of rural transport in Sri Lanka. This was particularly the case for access to health facilities, schools, alternative income, markets and for the supply of inputs. In the Aluwathugirigama GSN area the bus provided the transport for virtually all transport requirements that were external to the village.

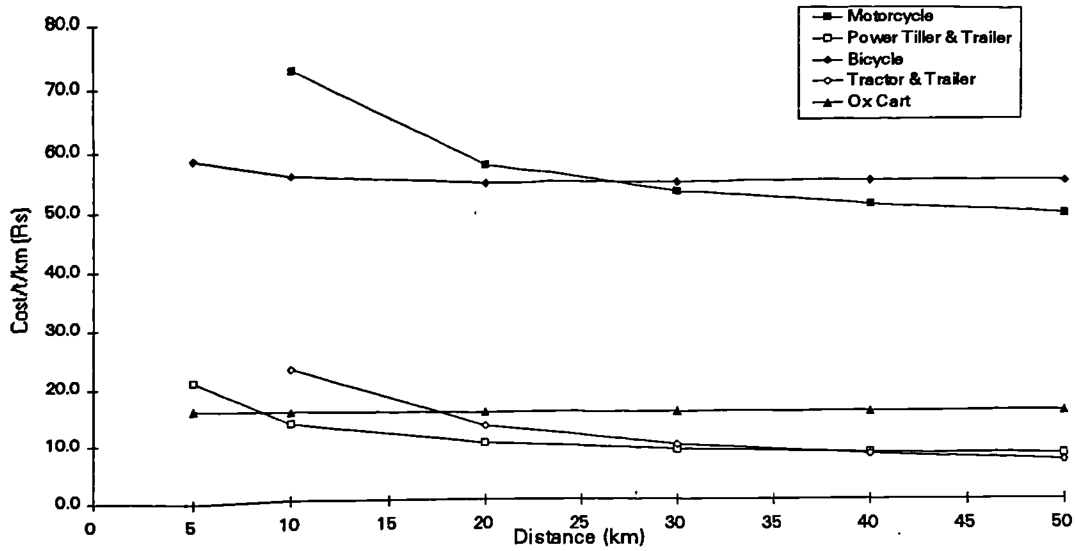
The bus service has benefited from "peoplisation" which opened up the industry to private sector participation. According to the MPPI, the private sector saw a rapid expansion in the number of buses in operation after privatisation. Between 1987 and 1988, 4,000 new buses were added to the fleet of privately operated buses which brought their total to 12,000 (MPPI, 1989).

5.4 Vehicle operating costs

Figure 5.2 shows that the ox cart is the cheapest vehicle to operate up to about 8km with an available load of 500 tonnes. When the available load is varied over a 10km distance as is the case in figure 5.3, the ox cart still remains substantially cheaper until about 410 tonnes per year. At very small levels of demand, up to about 10 tonnes, the bicycle is the cheapest form of transport (this is not shown on the diagram). These types of loads would only be found at the household level and for very small business'. As loads become greater so the bicycle becomes'less attractive.

Of the motorised vehicles the motorcycle is the cheapest form of transport over a 10km distance and up to about 40 tonnes per year (this is not shown on the diagram). After that for relatively small distances and small levels of available load the power tiller and trailer dominates. It benefits from a load capacity of 1 tonne, a speed of 15km/h and a multi-purpose use i.e. for agriculture and transport.

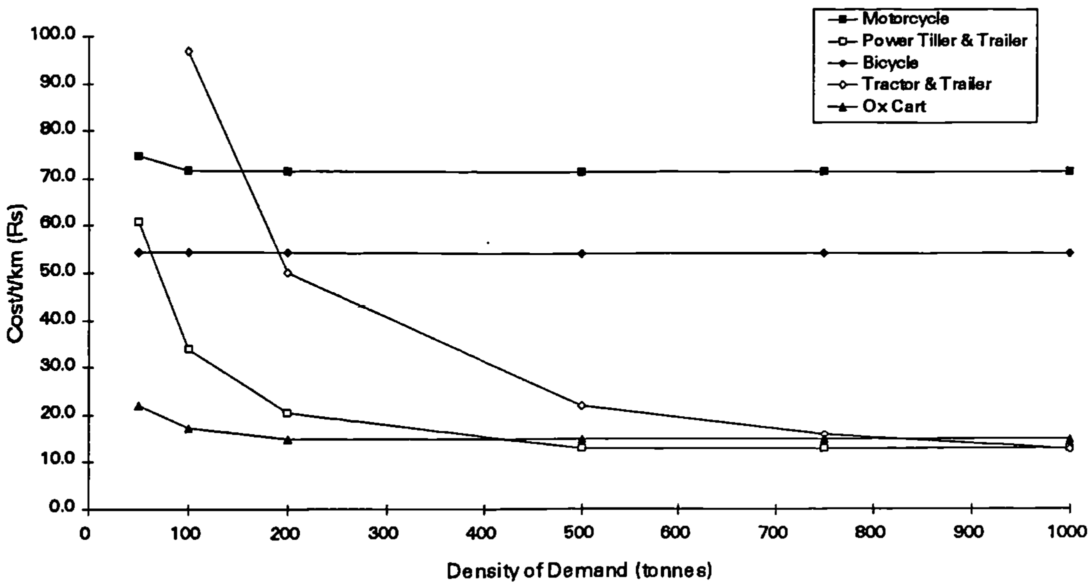
Figure 5.2: Vehicle operating costs at 500 tonnes per year



What is most interesting in the rural transport systems of Sri Lanka is the competition between the power tiller and draught animal power. The two modes perform exactly the same tasks but draught animal power is more labour intensive. Since the introduction of power tillers there has been a decline in the use of draught animal power. Agriculture has become more intensive which has reduced the area on which it is possible to keep animals, feed costs have gone up as have labour costs. The result has been a move to a vehicle with better productivity as the variable costs of draught animal power have risen and the demand for agricultural and transport services increases.

The power tiller remains the cheapest option until the tractor and trailer takes over at 1000 tonnes at 10km or at 40km with a load of 500 tonnes. The tractor is again a vehicle that has been affected by competition from the power tiller. Although the tractor is used for ploughing, the fields are generally too small to make it practical. The power tiller is more suited to small and often water logged fields. As a result the tractor is used to a greater extent for transport purposes including the movement of produce after harvest and the movement of building materials and firewood for the rest of the year. Tractors are also used on road works for the haulage of road building materials.

Figure 5.3: Vehicle operating costs for a 10km trip and various levels of demand



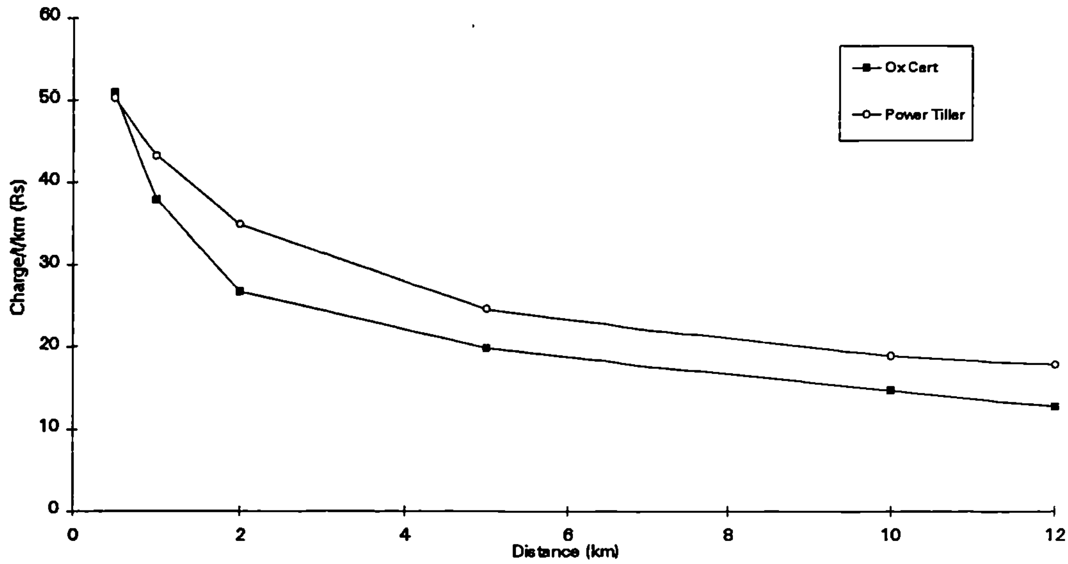
5.5 Transport charges

The only reliable data collected on rural transport charges was for the power tiller and ox cart as shown in figure 5.4. The rates for tractors, the other major vehicle conducting transport services were often quoted in terms of days or half days which made it very difficult to convert into charges per tonne per kilometre. Smaller vehicles such as bicycles and motorcycles were not hired out for transport services, but would be lent to neighbours in an emergency.

As direct competitors it would be expected that the ox cart and power tiller would have roughly the same transport charge curves. Figure 5.4 shows that the power tiller has a charge curve that is between 15-30% above the ox carts curve. This difference could be caused by inaccuracies in the data but it is also apparent from figures 5.2 and 5.3 that the ox carts operating costs are actually cheaper over the short distances that this data refers to. This would suggest that operators are very aware of their operating costs and therefore power tiller operators charge a premium for their services.

It is also possible that there is a premium value placed on the services of a power tiller, since with regard to transport services the power tiller has a clear advantage in speed. The power tiller has more clear cut advantages in terms of land preparation where timely cultivation and reduced effort may be valued quite highly. On the other hand as the power tiller continues its ascendancy the ox cart owners may feel that the only way to gain business is to undercut the services provided by the power tillers.

Figure 5.4: Sri Lanka transport charges



5.6 Factors affecting the provision of rural transport services

5.6.1 Infrastructure

The rural feeder road network in Sri Lanka is generally good and most rural communities have good access to these roads. On some of the resettlement programmes the villages situated furthest from the service centres do have problems because of lack of maintenance and poor design of roads in the construction stage. In these places seasonal inaccessibility can be a problem particularly with regard to the curtailment of bus services and traders unable to conduct their business. In the Venivallara villages problems with seasonal inaccessibility can last up to three months.

The internal village infrastructure does not pose a problem in most low lying villages but it is a serious problem for those in highland areas. For example the Aluwathugirigama GSN area was totally reliant on a network of village level paths which provided infrastructure for the movement of produce, farm inputs, trade between villages and access to roads. These paths were totally unsuitable for any vehicle other than walking and in the rains they became difficult to pass even on foot. In this case priority should be given to the upgrade of village level paths and tracks.

As already mentioned the state of the more major rural routes and inter-urban routes are desperately in need of maintenance. Many of the routes have unavoidable potholes, ineffective culverts and bridges that are in need of repair. The biggest complaints from villagers were related to seasonal inaccessibility and the inability of conventional buses to reach their village.

5.6.2 Credit

There are many sources of credit available in rural Sri Lanka but for the poorest they are either very expensive or unavailable. There are many commercial banks that lend money at reasonable rates of interest and a large percentage of the richer farmers use this source to buy agricultural machinery. The FMRC estimate that around 44% of farmers buying agricultural machinery use bank loans or a combination of bank loans and savings. The MPPI estimate that commercial banks only account for 15-25% of credit provided to the farmer and that only 4.5% of farmers have access to formal short term credit. This survey has found that for people buying smaller vehicles such as bicycles, motorcycles and ox carts that the regulations and bureaucracy surrounding commercial banks have meant that they are either unable or do not try to get such loans. For example, they will either require collateral or witnesses that pay income tax, both of which are impossible to find for the poorer members of the community.

In addition to commercial banks there are a number of informal sources such as traders and village money lenders. Their rates are very high, around 12% per month, but they provide an invaluable source of credit to rural people. The lenders necessarily have good knowledge of their clients, and repayments are structured to suit their seasonal income flows. However, if farmers are unable to keep up repayments it is possible for them to become merely labourers on their own land.

There is also a social welfare programme in operation in Sri Lanka called "The Janasaviya Programme" (JSP) which provides resources valued at Rs2,500 per month to the poorest members of the community. Part of this must be saved and part can be used for consumption in return for a productive activity which is largely of their own choosing. The savings accumulate and can serve as collateral against loans with the International Development Association. The JSP, whilst providing invaluable credit for the poorest families, can occasionally lead to distortions that affect vehicle choice. For example, a small shop keeper in the survey sold his motorcycle in order that he may be eligible for the JSP and bought a bicycle instead. It proved a lot more difficult for him to stock his shop than before.

5.6.3 Vehicle backup services

The larger villages such as Malagala had vehicle repair facilities for both motorised and non-motorised vehicles. The other villages had repair facilities in their nearest service centres which were never more than 10-15kms away. Spare parts were easily available and often manufactured within the country. The only complaint from the farmers was that the spare part suppliers were increasing the price of spares very rapidly but it is impossible to say whether the suppliers were passing on costs or whether they were making excess profits.

The mechanics are very skilled and innovative and were capable of adapting vehicles as customers required. For example, when ITDG were trying to introduce bicycle trailers into the Hambantota district there was no problem in finding skilled mechanics who could do the work to the necessary standard with the available equipment.

5.6.4 Routine maintenance

A with the mechanics the farmers had good knowledge of their vehicles and knew the value of routine maintenance. The vehicles looked in very good condition and this was backed up by the vehicle longevity in the rural areas. Many of the ox carts were 30-40 years old and some of the power tillers were over 20 years old.

5.6.5 Marketing and storage facilities

Most villages in Sri Lanka have easy access to a market or "Polla" where people go to buy their weekly supplies and where large urban traders come to buy produce. The markets are open to everyone although people setting up a stall have to pay a small fee. There are complaints that the farmers can not sell directly to the urban traders and have to go through the smaller rural traders who mark up the produce vastly just for buying from the farmers and then transporting it across the market. The farmers are forced into this arrangement because they are often reliant on the rural traders for credit to buy farm inputs and there are also reports of a certain amount of physical intimidation.

The high population density in Sri Lanka also means there are a lot of traders marketing goods either between villages or towns. These traders vary from those using headloading to transport their produce to those using bicycles, motorcycles, ox carts, tractors and trucks. This entrepreneuring spirit makes for a very efficient marketing system.

5.7 Overall impressions of the provision of rural transport services

It can be concluded that transport needs in the rural areas of Sri Lanka are generally fairly well satisfied. The levels of vehicle ownership are high and in most study areas almost every household owned a bicycle, the exception being the Aluwathugirigama GSN area in the highlands around Kandy. Problems occurred in the wet seasons when villages served by earth roads could become isolated, and this was particularly relevant for bus transport. In most villages there was vehicle diversity and the backup service facilities to support them. Markets were easily accessible and traders would pick up small quantities of produce from farmers not wanting to market their produce themselves.

There was a lot of competition between the multi-purpose type vehicles such as power tiller, tractor and ox cart (oxen). All these vehicles play an important role in Sri Lankan village life because they are used for passenger and goods transport as well as agricultural activities. It appears as though the power tiller is winning the race between the three modes as it perfectly fills the productivity gap between ox carts and tractors.

The market for transport services is competitive and there are no price controls on transport tariffs. In the passenger market private minibuses run alongside the recently privatised (or "peopleised") state bus service.

CHAPTER 6

CASE STUDY - GHANA

6.1 Introduction

Ghana is one of the poorest countries in the world despite the fact that prior to her independence from Britain in 1957 she was the world's largest exporter of cocoa and held 10% of the world's gold reserves. In the 25 years that followed, falling international cocoa prices and economic mismanagement led to economic stagnation.

The blight finally came to an end in mid-1983 when Ghana adopted major policy reforms, including the devaluation of the cedi, which left the door open for IMF assistance. By 1984 Ghana showed the first growth for 10 years and now has one of the most successful structural adjustment programmes in Sub-Saharan Africa. Despite Ghana's success in policy reform, current per-capita income growth of 2% per annum means that the average poor person would not cross the poverty line for 50 years (the poverty line is defined as cedis 32,981 in 1987/88 Accra prices which is households with per capita expenditure below two thirds of the mean). The private investment to GDP ratio is half that of East Asia in the 1960's, trade ratios are low and functional literacy is estimated to be between 35-40%. Most developing countries that have experienced rapid economic growth have had near universal literacy (Chhibber et al, 1993).

Poverty in Ghana is largely a rural phenomenon, with 43% of rural inhabitants living below the poverty line. For example, the incidence of rural poverty is more than 13 times that in Accra (Oti Boateng et al, 1990). In a country where 60% of the population derive their income from agriculture, policy measures to relieve rural poverty must be a priority.

Agriculture is generally at the subsistence level with any excess produce being sold at market or to traders. Farming is primarily a slash and burn operation which requires low technology implements (hand hoes), few inputs and therefore has correspondingly low outputs. Labour is the most important input into the farming process. Most of

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The Ghana surveys were conducted in February 1994.
The exchange rate was US$1 = 935 Cedis and £1 = 1380 Cedis.

the rural population grow food crops such as cassava, yams, maize and cow pea; in some areas cocoa is grown; income is supplemented by the rearing of livestock and work in rural industries and services. Farmers in Ghana have demonstrated that they respond quickly and significantly to crop price changes. For example, production of root crops is estimated to increase by 4% in response to a 10% price increase the previous year, while the increase is 5% for cereals (Chhibber et al, 1993). A reduction in rural transport charges could have the effect of increasing farm gate prices and therefore lead to significant increases in production.

Table 6.1: Key data for Ghana

Characteristic	Number
Population (millions)	15.8
Area (thousands sq. km)	239
Population Density (pop/sq. km)	66
Rural Population (%)	65
GNP per Capita (US$)	450
Road Length (km)- Total:	36,188
Trunk Roads:	
Paved	6,000
Gravel	8,400
Feeder Roads:	
Bitumen	301
Gravel	9,680
Earth	11,807
Road Density (km per million pop)	2,290

Government spending on rural services has been far below the levels in urban areas. For example, access to primary health and preventative care is very poor in rural areas. The same is the case for spending on rural roads and transport services. When this is combined with very low vehicle ownership and diversity in rural areas it becomes apparent why rural Ghana is referred to as a "footpath economy". Much of the transport associated with crop production, marketing, provision of subsistence goods and access to essential services is conducted along paths and by headloading. This

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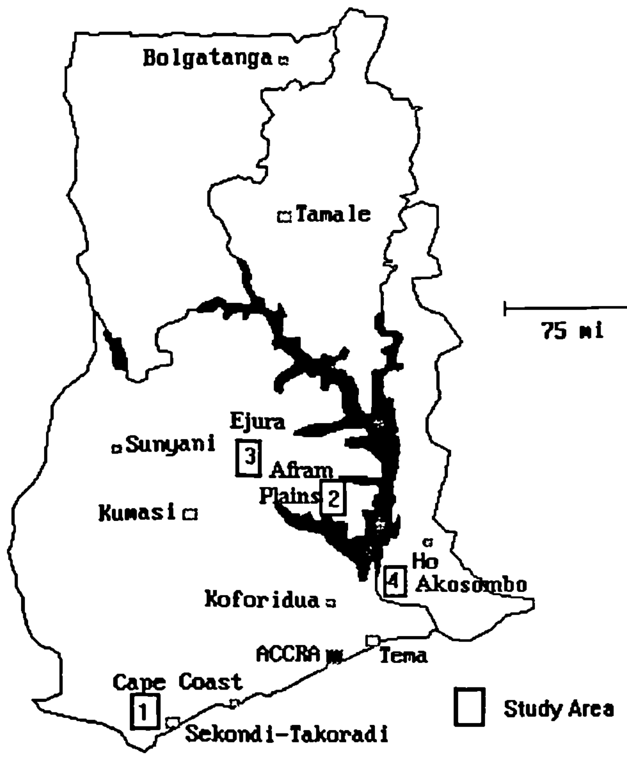
very inefficient and expensive rural transport system undoubtedly creates one of the greatest obstacles to economic growth in rural areas.

An inefficient transport system is made worse by a long marketing chain where there can be up to five intermediaries between farmer and consumer with scope for monopolistic collusion at all stages. As a result marketing costs (excluding transport) as a proportion of final market prices are high, around one third (Hine, 1993). This compares to Ministry of Transport estimates that wholesale transport costs account for 11% of the final market price in Accra for maize and 25% for tomatoes.

Figure 6.1: Map of Ghana marked with the study areas



As a result, an 8 year National Feeder Roads Program has been developed for 1992-99. The program aims to fully rehabilitate 8,400 kms of high priority feeder roads, gravelling of 8,850 kms of fully rehabilitated high priority feeder roads, and spot improvements and culverting of 1,500 kms of additional lower priority feeder roads. There have also been schemes to introduce appropriate vehicles to reduce the costs of headloading. These have included bicycles, bicycle trailers and draught animal power projects. Despite attempts to introduce other vehicles, the rural transport policy in

Ghana can better be described as a roads policy. Academics and donors have long attributed the high costs of transport and poor access in Ghana to poor quality feeder roads. In this chapter other factors will be discussed which also contribute to high transport costs, such as the lack of vehicle diversity, low ownership levels, union control over pricing and routes, the lack of credit facilities, and insufficient operator and mechanic training.

6.2 Description of the Ghanaian study areas

Ghana is a predominantly flat country and this is a fair description of all the study areas. The coastal region is dry scrubland but this soon makes way for thick forest which extends to the Northern third of the country. The most lucrative agricultural area is Ashanti Region in the centre of the country which has traditionally been the home of cocoa production. Ghana has three rainfall zones, the coastal region is flat with light rain in April to June and October, the rainfall becomes heavier inland as the forest gets thicker and reduces in the North where there is only one rainy season from May to September. The main geographic feature in Ghana is Lake Volta which is the world's largest man made lake and is twice the size of Luxembourg.

Study Area No.1 **Nyameliekyere Village**
Takoradi
Western Region

The village is situated in the Western Region which falls within the forest zone of Ghana and receives the highest rainfall averaging at 1600mm per year. The village is typical of those visited in the Western Region. Its main crop is cassava from which Gari (the staple food) is made by grating the crop and then fermenting, drying and roasting. Other villages in the area produce coconut oil and palm oil. An organisation called Technoserve, with World Bank and Ghanaian government funding, has provided credit for the machinery to be installed in villages to make the Gari and oils. The money is lent to co-operatives who then run the machinery as a business. Based on the current situation in the villages visited on this project, it can be said that there was a 90% failure rate. The most common problems were people running off with the co-operatives money and a lack of routine maintenance leading to mechanical breakdown, the result being non payment of loans and idle machinery.

All villages visited had adequate vehicle access although vehicle ownership at village level was practically zero. The main complaints were of seasonal inaccessibility and the infrequency of vehicle services. Most villages only had access to a vehicle once per week and as a result headloading was employed to take the produce to the main road. The quality of the infrastructure could in no way be blamed for the shortage in supply of vehicle services, although village access roads could benefit from spot improvements to ensure year round accessibility.

Table 6.2: Nyameliekyere village statistics

Variable	Number
Population	150
No. of Families	-
Total Agricultural Area	-
Water Supply	250 metres
Firewood Supply	Around house
Electricity	No
School	1 primary (2 km)
Health Facilities	1 health centre (20 km)
Vehicle Repair Facilities	0
Mills	1
Markets	1 weekly (20 km)
Vehicles:	1 vehicle for hire visits once per week (and not at all during the rainy season).

An immediately noticeable feature of all these villages was that the bulk of the burden for all manufacturing, marketing and transport activities fell to the women. Almost all subsistence and marketing transport activities are undertaken by women headloading.

Study Area No.2 **Afonsu Village**
Afram Plains
Eastern Region

There is only one major link between the Afram Plains and Odonkawkram, the capital of the region. This involves a ferry crossing across the Volta Lake (quite a drama because heavy trucks are expected to land on the beaches where they inevitably sink) and then a 50 km drive along a rough and dusty gravel road to Odonkawkram. Although the roads were not well maintained a wide variety of vehicles used them, many of which did not appear to have the necessary ground clearance. The volume and type of traffic using the road suggests that there is plenty of demand in this area.

Table 6.3: Afonsu village statistics

Variable	Number
Population	300
No. of Families	3
Total Agricultural Area	-
Water Supply	5 km - supply a problem in the dry season and of poor quality.
Firewood Supply	Around house
Electricity	No
School	1 primary (9 km)
Health Facilities	1 health centre (17 km)
Vehicle Repair Facilities	0
Mills	0
Markets	1 weekly (17 km)
Vehicles: Tractor and Trailer Bicycle	 1 3

The government has tried to promote agricultural development in the area by clearing land so that it would be suitable for cultivation by tractor. In conjunction with this there has been a tractorisation project set up by the Food and Agricultural

Organisation (FAO) and the Italian government. Under the terms of the project co-operatives were set up consisting of up to 14 farmers working 50 acres of land. Each bought one of 87 "Same" 75hp tractors which included a trailer, plough and harrow. The cost of the tractors and implements in 1988 was cedis 5,300,000. The co-operatives had to put down a deposit of cedis 200,000 and make six instalments over five years of cedis 850,000 each, with no interest component.

Unfortunately, the project has not been sustainable as the co-operatives have not been able to keep up repayments on their loans or, in many cases, to maintain and repair the equipment. As a consequence many of the tractors are in disuse or have been reclaimed by the project for distribution to other co-operatives. The resident agricultural engineer stated that the major reason for this was the inability to get good prices for produce. He quoted an example of maize prices where a 110 kg bag in Odonkrakrum could be sold for cedis 9,000, whereas in Accra it could be sold for cedis 16,000. The high costs of marketing and distribution have undoubtedly played a part in the failure of this particular tractorisation project but there are a number of other reasons as well. These include the problems of management in co-operatives; the almost non-existent routine maintenance regimes leading to high repair costs; the lack of adequate vehicle backup services; and lack of training by operators in book- keeping and vehicle maintenance.

Afonsu village, as with the other villages in the area, is connected to the main road by an earth access road. The 34 km return journey took 5½ hours by a 4 wheel drive vehicle, the main problem being the excessive rutting caused by the tractors in the wet s son. The use of tractors along this road has effectively made the area inaccessible to all other vehicle types except bicycles. A fully loaded tractor takes 5 hours to complete the journey one way.

Despite the problems with the implementation of the project and the adverse effects that the use of tractors on muddy roads has on the use of other vehicles, the tractor has many advantages in this rugged environment. The villages would become more isolated without tractor services both in terms of goods and passenger movements. However, the tractor does not solve all transport problems. In this area all household tasks and travel to the fields are completed on foot and usually by women. There are a number of bicycles (brought in by another aid project) but these are solely used by men.

Study Area No.3 **Bonyo Village**
Ejura
Ashanti Region

The main crops grown by the villagers are maize, yam, cow pea and cassava. There are a number of big farms in the Ejura area and consequently quite a few tractors for hire. However, the majority of farms are under 2 hectares (85% of households) and the fields can be up to a distance of 15 kms from the village. There are farm roads, but most people have to walk, therefore many people actually live on the farms during the production season. The roads although rough during the dry season are motorable, but in the rains the roads become muddy with deep streams to cross. In the rains the only viable motorised vehicle for these roads is the tractor.

Table 6.4: Bonyo village statistics

Variable	Number
Population	250
No. of Families	-
Total Agricultural Area	-
Water Supply	Handpump in village
Firewood Supply	up to 1 km
Electricity	Some
School	1 primary (3 kms) 1 secondary (3 kms)
Health Facilities	1 Health centre (3 kms)
Vehicle Repair Facilities	0
Mills	0
Markets	1 weekly (3 kms)
Vehicles: Tractor and Trailer Bicycle Motorcycle	 1 5 1

The village has very few vehicles apart from a co-operatively owned tractor and trailer, and a few bicycles which are used mainly by people working in Ejura. The result is that during the harvest season much of the crop remains in the ground because there is an insufficient supply of vehicle services, and headloading alone cannot satisfy the demand. The village itself is close to a maintained gravel road which later becomes paved, consequently there “should” be good access to vehicle services and service centres.

One of the most striking characteristics of this area is the control exerted by the Ghana Private Road Transport Union (GPRTU) over all transport activities both on inter-urban, rural and farm routes. All vehicles have to be licensed to operate on particular routes and all transport charges are set according to the commodity, weight and distance. Lifetime membership of the GPRTU costs cedis 50,000 and the annual renewal fee costs cedis 2,400. On top of this, for every load carried a 1% commission is charged. The policing of this system is "vigorously" enforced by the GPRTU.

The tractor operators complained of the insufficient supply and high cost of repairs. As a result many operators resorted to the cannibalisation of other tractors. The fleet of tractors is old, poorly maintained and has very long downtimes. One operator complained that his tractor was out of action for at least a day a week during the main ploughing season.

In a nearby village there was a project to try and promote draught animal power in the region. In a discussion with the villagers on some of the alternatives to the use of t ctors, they clearly had no interest in learning how to use animals for ploughing and transport. They had seen that the work rate of a tractor was substantially greater than that of animals and could not be convinced of their advantages. The talk was of how much money could be made with a tractor in a day, and there was no concept of the actual costs of operation. This is probably the main cause of high tractor failure rates. The existence of mainly subsidised tractors in these areas makes the promotion of other vehicle types very difficult.

Study Area No.4 **Asutsuare Village**
Akosombo
Volta Region

Asutsuare is at the centre of a 400 hectare irrigation scheme to promote rice cultivation in the area. There are 564 registered farmers on the scheme and each has a five year tenancy agreement. As part of the contract they must crop in two seasons, participate in communal labour and repay any loans that they take out. There are about 20 power tillers operating in the scheme of which about five are based in Asutsuare.

Table 6.5: Asutsuare village statistics

Variable	Number
Population	500
No. of Families	-
Total Agricultural Area	-
Water Supply	Handpumps in village
Firewood Supply	around houses & charcoal
Electricity	Some
School	1 primary (in village) 1 secondary (12kms)
Health Facilities	1 health centre in village 1 hospital (12kms)
Vehicle Repair Facilities	0
Mills	1 in village (paddy threshing)
Markets	1 weekly (12 kms)
Vehicles: Power tiller and Trailer Pickup Bicycle Taxi	 5 1 (broken down) 5 1

The power tillers were first imported from India about five years ago by the Agricultural Development Bank. Unfortunately after three months they were all out of action and the farmers were either unable to afford to repair them or unable to get the spares. As a result the farmers defaulted on all loans. Now, a new batch of power tillers have been imported from Korea and have been introduced far more successfully. However, there are still problems in finding spares and major repairs have to be carried out near Accra. This results in the power tiller being in-operational for up to two weeks at a time. As with the tractor projects the lack of routine maintenance means that large repairs and engine overhauls are more common, and downtime due to repair is therefore a major issue.

The power tillers are used predominantly for agricultural preparation but also for transporting paddy to mills and to a central drying and storage area. The maximum trip length is therefore about 5km. Unlike in Thailand and Sri Lanka the power tiller is used for very little else, for example pumping, trips to market, passenger transport or harvesting and threshing. For transport purposes the power tiller is only used on the farm roads and not on the larger feeder roads. This is partly because farmers usually use mammy wagons to transport their produce and themselves to market. They do not perceive a demand for power tiller transport services on these routes. Part of the problem is the regulations imposed by the GPRTU on route licenses and price controls.

Other vehicles in operation in the area include mammy wagons, taxis, and bicycles (surrounding villages also have tractors). The mammy wagons transport large quantities of produce and farm inputs as well as passengers to distant destinations such a Accra (65 kms). The taxis provide a more local service around the farm roads and to nearby service centres. They are usually used for personal travel and for the transport of small loads such as a bag of fertiliser or items from the market, and they work on the same basis as the mammy wagons but for smaller loads. Bicycles are starting to be introduced into the area and there is even some hiring. At the household level headloading is still the most prevalent form of transport but essential services are not as distant as in the Affram plains for example.

Asutsuare and the surrounding area are quite well connected and so the supply of transport services is quite good. However, as is the case in the rest of Ghana the vehicle fleet is old and poorly maintained.

6.3 Vehicles in operation

The number and diversity of vehicles operating in rural Ghana is very low. There is a heavy reliance on headloading and imported vehicles that are often supplied under aid schemes. The most widely used vehicles in rural areas are listed below:

Headloading - headloading is by far the most common form of transport in rural Ghana. Survey work there suggests that in average households (6.47 adults) total travel accounts for 93 hours per week and 216 tonne kilometres per year. Of this 93% of trips and 76% of total tonne kilometres are internal (transport of subsistence goods, travel to fields, village marketing) and almost without exception this will be carried by headloading. When this is further examined it is found that women shoulder three times the burden of men in terms of time and four times greater in terms of tonne kilometres (Howe and Barwell, 1987).

Mammy wagons - Ghana is one of the few countries in the world that has a matrilineal society. One of the roles that women undertake that would normally be thought of as a man's job is trading. Women hire vehicles from urban service centres and visit rural areas to buy produce directly from the farmers. They then transport the produce to market where they use their contacts to sell it. As a result the vehicles that they use are called mammy wagons. A mammy wagon is not one particular type of vehicle but they are usually trucks with payloads that vary from 3-10 tonnes. It was estimated that in 1986 there were 9,100 trucks of this nature which included 5,000 government owned vehicles (TECNECON, 1987).

These vehicles provide the bulk of transport services to rural communities. In places such as the Western Region they provide the only motorised vehicle services both for the movement of agricultural goods and passengers. As mentioned earlier the supply of transport services is highly regulated which reduces competition and causes inefficient operation. The mammy wagons can spend long periods waiting for loads (up to 2 weeks have been observed in Kumasi and Accra) which results in excess supply in some areas and excess demand in other, usually rural, areas. Low utilisation of an old inefficient fleet of vehicles means that motorised transport services to rural areas are infrequent, unreliable and expensive. The vehicle operating cost data for mammy wagons used in figures 6.2, 6.3 and 6.4 has been taken from research undertaken in to vehicle efficiency and agricultural transport in Ghana (Delaquis, 1993).

Tractors - tractors have been gradually introduced in to Ghana since 1957 as part of a mechanisation policy to increase food production for people and agro industries. According to the department of mechanisation 2,600 tractors were imported during the 1960's and this rose to 7,000 in 1985. In 1985 detailed records of imports were stopped because of relaxed import constraints. However, it is estimated that only 2,500-3,000 tractors are still in operation today. The true figure may be lower still, for example TECNECON suggested a figure of only 500 in 1987. Tractors in Ghana are mainly used in the Northern, Upper and Volta regions.

In some areas tractors are used for agricultural preparation and transport purposes. They would appear ideal for fields with high weeds and very rough rural roads. However, their introduction in to rural areas has not been successful and there are a large number of tractors out of operation. The tractors are usually subsidised and introduced through aid schemes into areas that are not able to support them either because of inadequate technical skills and backup, managerial skills or low rural incomes. The tractors are extremely badly maintained and eventually high repair costs cripple the owner or owners in the case of co-operatives. The high level of subsidy has the effect of reducing incentives for private operators to enter the market even though they may be able to compete on price.

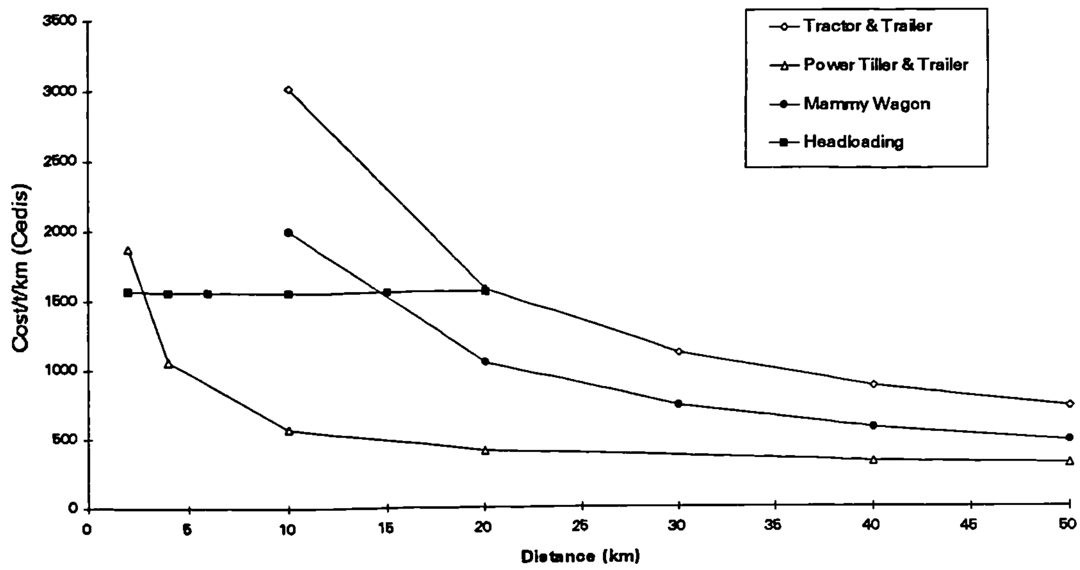
Power tillers - the power tiller is not widely found in Ghana but there are a number of p jects around the country where they are being used. As with the tractor, they have been introduced with subsidy and by aid schemes and many of the problems have been the same. The power tillers used at Asutsuare were Indian or Korean but Italian and Japanese models have also been imported.

6.4 Vehicle operating costs

Calculating the costs of headloading, particularly in rural Ghana, is very difficult. The most important component of the cost calculation is labour rates. The difficulty is in deciding on the opportunity cost of labour in areas where most production is for subsistence purposes and any hired labour is only employed on a seasonal basis. The problem is compounded by the fact that the majority of the burden falls on women who will probably have less income earning opportunities than men.

Figures 6.2 and 6.3 show a cost curve for headloading that is based on a cost of labour of C 800 per day and a food requirement of C 100 per day when an eight hour day is assumed. The figures show that for very short distances headloading is actually the cheapest option. The power tiller becomes cheaper at about 3kms at a demand of 100 tonnes per year but as already mentioned the power tiller is normally not an option. It is not until the 15km mark that the mammy wagon becomes cheaper.

Figure 6.2: Vehicle operating costs at 100 tonnes per year for various distances



If the same analysis is done assuming that the opportunity cost of labour is half that of the prevailing labour rate, and fuel costs are zero, then it becomes clearer still why headloading predominates. As figure 6.3 shows, over the effective distance of headloading (20-30 kms) neither the mammy wagon nor tractor have costs curves which fall below that of headloading for 100 tonnes. The power tillers' cost curve will cross at about 7 kms.

Figure 6.3: Vehicle operating costs at 100 tonnes with the opportunity cost of labour at 50 per cent of the agricultural wage for headloading

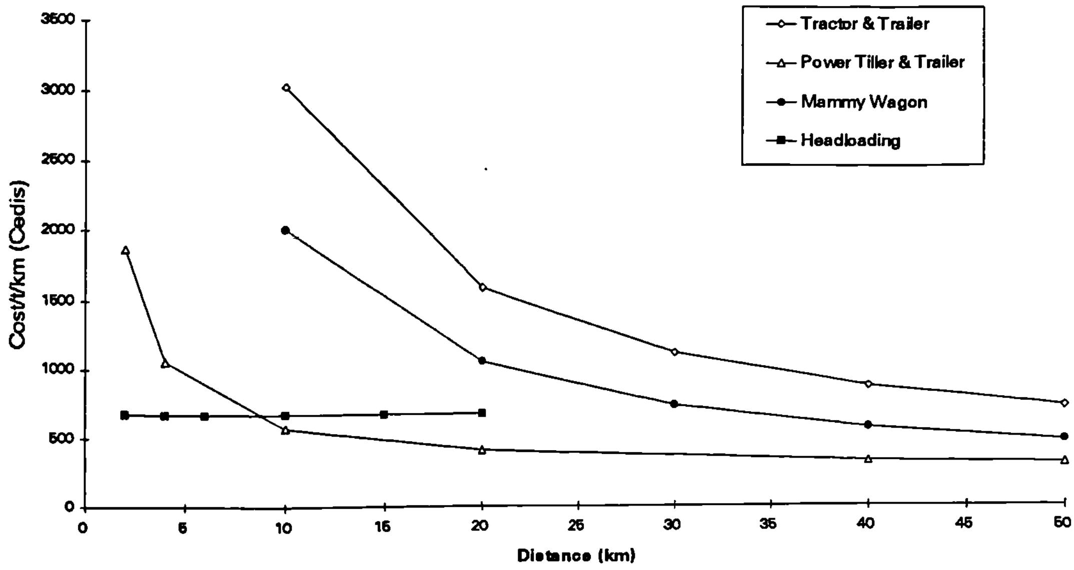
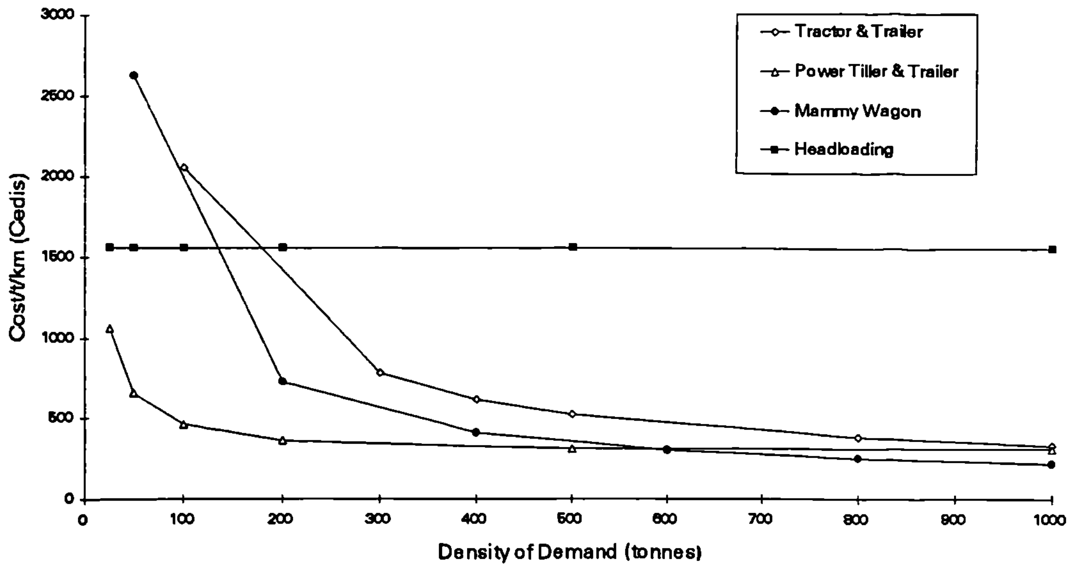


Diagram 6.4: Vehicle operating costs for a 15km trip and various levels of demand



Much of the discussion above on headloading has assumed very low levels of demand at 100 tonnes per year. At this level of demand conventional vehicles are very expensive to operate. Figure 6.4 shows that as demand increases then conventional vehicles become substantially cheaper than headloading. In figure 6.4 the mammy wagon is cheaper at all demand levels than the tractor and trailer, although it would normally be expected that the tractor and trailer would be cheaper over this distance and these loads. The discrepancy occurs because of the inefficiency of the tractor operation. As it is normally introduced on a subsidised basis the operators often do not look after them properly and as a result repair costs are very high. The cost curves in these figures assume the full cost and interest repayments of the tractor even though in reality not all of these would be paid. The power tiller remains cheaper than both the tractor and mammy wagon until about the 1000 tonne mark at 15kms.

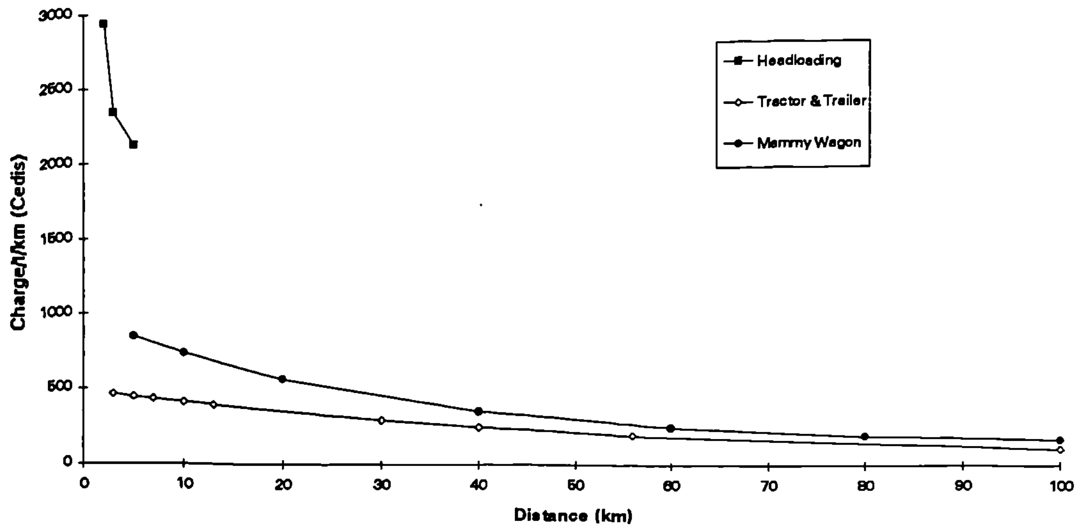
6.4 Ghanaian transport charges

The disparity between the charges made for head loading and other modes of transport is graphically illustrated in figure 6.5. Although charges for headloading are only made over relatively short distances these are between 2.5 times more expensive for mammy wagons over 5 km's and 5 times more expensive for tractors. In most rural areas people have no choice but to headload because conventional vehicle services are not available. It should also be noted that many conventional vehicles would not be able to operate on the off-road infrastructure that is so important in rural Ghana. Even if the vehicles were available and could use the infrastructure it is unlikely that the loads available would make it cost effective to use them. It is clear in this situation that rural Ghana is crying out for appropriate vehicles to fill this technology gap.

Another anomaly is that the tractor's charge curve is below that for the mammy wagon which is opposite to the way that the vehicle operating cost curves would have suggested. There are a number of reasons for this:

a) There have been many tractorisation schemes in Ghana that have attempted to introduce tractors on a subsidised basis. As a result operators are using tractors that they have bought at below cost price, at subsidised rates of interest or where even the subsidised costs have not been repaid. For example in the Affram plains tractorisation project, only a tiny percentage of the co-operatives were making the full, but subsidised, repayments. Although this position will not be sustainable in the long term, it is possible in the short term that transport charges only reflect variable costs.

Figure 6.5: Ghana transport charges



b) The other major distortion in the setting of transport charges is the influence of the transport union, the GPRTU. This organisation licenses vehicle owners to operate on certain routes and sets all charges for the transport of goods and passengers. In most areas the GPRTU only concerns itself with mammy wagons, although in some areas it does control the movement of tractors as well, and so this may tend to keep charges in this sector high. The result of this regulation is that operators work inefficiently, have very low levels of utilisation and hence provide an irregular and expensive service in rural areas.

c) Another possibility is that because there are so many distortions in the transport market, operators have no idea what their operating costs are, and have no incentive to find out. The lack of competition undoubtedly leads to inefficient operating practises and owners who have no idea how to service and manage their vehicles.

6.6 Factors affecting the provision of rural transport services

6.6.1 Infrastructure

The feeder road network has been very poorly maintained and is often impassable during the rainy season. Only about 3,300 kms of the country's feeder road can be described as in good condition and passable the year round, and nearly 13,000 kms are categorised as in poor or very poor condition (Chhibber et al, 1993).

Although the rural infrastructure is in very poor condition, access is still possible for vehicles that at first sight would appear totally unsuitable for the conditions, for example fully laden taxis with virtually no ground clearance. In the worst conditions journey times are long and repair costs extremely high. Vehicles are prepared to travel along these routes because there is demand for their services at the destination. The lesson here is that maintaining basic access is the priority. The main cause for basic access to be denied is the rainy season when roads become water-logged and eventually impassable. This can happen for up to three months per year and is serious not only in terms of the evacuation of produce but also because of problems in getting access to health, education and other services. For these reasons rural communities are at their most vulnerable during the rains.

It is important when looking at transport requirements in Ghana that the off-road infrastructure of paths and tracks are not overlooked. As discussed earlier much of the internal and external travel in villages occurs on this infrastructure and upgrading it can provide very real benefits to rural communities.

6.6.2 Credit

The availability of credit facilities for the purchase of vehicles in rural Ghana is practically non-existent. This is the case for formal and informal credit. Commercial b nks have found that repayment rates for loans to the agricultural sector have been very low and therefore regard the activity as risky and commercially unattractive. Specific, usually donor funded, projects also provide loans and usually at heavily subsidised rates. Again repayment rates are low and they are usually not sustainable in the long run.

Credit in the informal sector is also far less prevalent than in some of the Asian countries studied. Traders will sometimes provide credit to be repaid after harvest for agricultural inputs but they do not provide credit for larger purchases such as farm machinery or transport vehicles. There are also some Rotating Savings and Credit Associations but again they do not represent a significant source of credit.

The lack of credit in rural Ghana is a severe obstacle to growth because even the cost of a bicycle or simple farm implement can represent more than a year's income to many rural households. If more widespread credit facilities were to be introduced a good deal of training would be required both for the employees of such an organisation and the borrowers. Education would be required to promote savings and to stress the importance of planning for interest repayments.

6.6.3 Vehicle backup services

Vehicle backup services at the village level in almost all cases did not exist. This was mainly because most villages had no vehicle owners, even of non-motorised vehicles. As a result vehicle owners were usually situated in the towns and this is where backup services are located. However in Ghana it is fair to say that vehicle backup services with regard to both skills and equipment are very centrally located. The largest area for vehicle servicing in Ghana is based at the Aswami in Kumasi, where people with skills and machinery have congregated together. As a result the diffusion of skills and technology from Kumasi to regional centres and to rural areas has been very slow. Box 6.1 describes the Aswami and measures that are being taken to transfer technology and skills to other areas.

6.6.4 Routine maintenance

It became apparent from the vehicle questionnaires that vehicle operators were not fully aware of the importance of the routine changing of oil, filters and greasing. R spondents were either unable to answer these questions, gave very long intervals between routine maintenance (up to a year), or gave answers that appeared to be word for word out of the handbook.

The lack of routine maintenance was found to have significant effects on a vehicle's variable costs of operation, mainly showing itself in the frequency of major engine overhauls. In the Affram Plains tractorisation project, tractors were undergoing engine overhauls after only two years. In Asutsuare the first set of power tillers from India were almost all off the road after three months, while the Korean machines have almost all needed major work doing after only one year.

Box 6.1 The role of GRATIS in Ghanaian transport

GRATIS (Ghana Regional Appropriate Technology Industrial Services) was established to disseminate information and provide training for vehicle mechanics around the country. The scheme started in the Kumasi Magazine where 60,000 artisans have grouped together to provide vehicle backup services. Each artisan specialises in anything from the manufacture of nuts and bolts to full engine rebuilds. The Kumasi Magazine is not just the centre for vehicle services in Ghana but also for neighbouring countries such as Togo and Cote D'Ivoire.

Kumasi University decided to set up an Intermediate Technology Transfer Unit (ITTU) at the magazine in order to exploit and develop the skills already available there. In conjunction with SIDA they provided second-hand machine tools to the most entrepreneuring artisans and conducted training courses on their use and in vehicle servicing in general. GRATIS was formed to take the concept of ITTU's to all regional centres in Ghana and eventually into rural areas as well. The ITTU at Kumasi now provides training and advice to the other centres.

This sort of scheme is essential in order to provide the skills and basic manufacturing capability that will keep Ghana's vehicle fleet on the road and running smoothly.

Whilst collecting operating cost data on vehicles in rural areas is very difficult, it is apparent from the condition of vehicles, and the number that are inoperative that there is a serious problem with the lack of routine maintenance.

6.6.5 Union influence

The market for motorised services is dominated by the GPRTU which licenses owners to operate on certain routes, fixes charges for goods and passengers, polices the roads, and charges commission. It is in the authors opinion that this practise induces a lack of competition and inefficient operating practises. This leads to low vehicle utilisation, high variable costs of operation and results in infrequent and costly services to rural areas. The power of the GPRTU is described in more detail in Box 6.2.

Box 6.2 The power of the GPRTU in Ghana

Ghana Private Road Transport Union (GPRTU) controls the urban, inter-urban and rural markets for transport services. If operators want to conduct business on any route in Ghana they must join the union and apply for a permit for each route they want to operate on. In addition, the prices for each route are set according to whether it is passengers or goods. For all goods transport the union charges a one per cent commission.

The control is not just limited to the main roads; in some areas, depending on the strength of the local union, charges are also set for ploughing and transport from field to village. The result is that there is over-supply of vehicles on the most profitable routes and under-supply on particularly the rural routes. There have been reports of trucks waiting two weeks at truck stops to pick up loads. Vehicle fleets are extremely old, outdated and utilisation is low. With such low levels of utilisation there is no incentive to update fleets. Consequently the service is slow, unreliable and more importantly, expensive.

Although the existence of the GPRTU causes large distortions in the market for transport services they also provide services which would make curtailing their powers a politically sensitive task. For example they are the only effective police force on the roads, and if a driver of a goods or passenger vehicle is reported for reckless driving the union has the power to take his license away. Additionally the union collects road tax and in some areas will send out parties to complete road maintenance.

6.6.6 Marketing and storage facilities

The marketing of produce in Ghana at the small holder level is an inefficient process which is dominated by traders or market women. Hine describes the process of marketing in Southern Ghana, which is typical of all the study areas visited in this survey, in the following way (Hine, 1983b):

"Food marketing in Southern Ghana is dominated by a large number of independent operators, most of whom are women. They collect produce in rural areas (rural assemblers), arrange for its transport to town (travelling wholesalers), transport the produce (transporters), wholesale the produce in urban areas (non travelling urban wholesalers) and finally sell it to the urban population (retailers). The produce may pass through the hands of up to five intermediaries between farmer and urban consumer. Sometimes the chain is much shorter when the farmer sells directly in a local village for local consumption, or when he travels to town to sell directly to the urban consumer at the lorry park at his arrival point in the town. The marketing chain can also be longer if the produce is sold between wholesalers for onward movement to other urban markets."

Chhibber et al (1993) claim that there is a "catalytic role" to be played by the public sector in upgrading rural and urban markets. Markets for the sale of food produce tend to be very primitive with little or no storage facilities. The result is that the sellers' bargaining power is reduced, as is their willingness to enter into the market economy.

The survey in Ghana clearly showed that the lack of storage and marketing facilities and the over-reliance on traders affects the demand for vehicles at the rural level. If there are no rural markets or stores, or if when farmers get there they do not have the proper contacts, then farmers will have no incentive to buy vehicles for transportation. Similarly, if farmers are reliant on traders for an inefficient and expensive marketing system, then low farm gate prices will reduce incentives for increased production. As already mentioned, the level of rural production is extremely price sensitive. Poor access to markets and stores, which is partly a function of low population densities, hinders the uptake of transport and agricultural technology, and reduces incentives for increased production.

6.7 Overall impressions of the provision of rural transport services

Ghana has a very inefficient transport system both at the rural and inter-urban level. The vehicle fleet is old and poorly maintained, downtimes are long because of lack of spares and insufficient backup services. Transport services are controlled by a transport union called the Ghana Private Road Transport Union (GPRTU). They license operators to trade on certain routes, charges are fixed by the union and all trips made are liable to a commission. The result is a lack of competition, poor operating practises, queuing for loads and excess supply of vehicles on some routes and a deficit on others, usually rural.

Insufficient and unreliable supply of vehicle services at the rural level causes problems with the evacuation of produce from fields to stores, marketing and access to essential services for the rural communities. As a result crop wastage is high, farm gate prices are low and rural communities are unable to invest in their human capital. The overall effect is to reduce incentives to increase production.

The transport problem is particularly acute at the village level where travel is conducted primarily by women on an off-road infrastructure. Vehicle ownership is very low and in many villages it is non-existent. The diversity of vehicles is also very low, and there is a large gap between headloading and the use of mammy wagons which are the two options that most rural communities have. Rural areas are desperately in need of appropriate transport vehicles such as bicycles, animal carts or even simple motorised vehicles. The biggest problem is that agriculture in Ghana is characterised by low inputs and low outputs when expressed per farmer or per hectare of land. This means that not only is the demand for transport low but that incomes with which to buy the vehicles are also limited.

There are many constraints to the development of improved rural transport services. These include the lack of credit, poor operator practise, insufficient backup vehicle services, price controls and the lack of the dissemination of information on alternative vehicle types.

CHAPTER 7

CASE STUDY - ZIMBABWE

7.1 Introduction

After Zimbabwe received independence in 1980 priority was given to investment in human resources and support for small holder agriculture. During the period 1980-85 agricultural GDP grew by 3.6% with most of this growth resulting from increased output in the small holder sector. Agriculture during this period benefited from favourable producer prices and improved seed varieties, but it also benefited from government policy. The key benefits to smallholders included increased access to agricultural credit, improved extension and veterinary services, provision of an improved marketing infrastructure and a resettlement program which moved 50,000 households from marginal land to productive land.

Table 7.1: Key data for Zimbabwe

Characteristic	Number
Population (millions)	10.4
Area (thousands sq. km)	391
Population Density (pop/sq. km)	26.6
Rural Population (%)	71.5
GNP per Capita (US$)	570
Road Length (km)- Total: National Roads Provincial Roads Other Roads	90,778 4,104 7,674 79,000
Road Density (km per million pop)	8,728

Despite a very promising start to agricultural reform in Zimbabwe much of the early gains have been lost and there is now a net decline in agricultural output at the

The Zimbabwe surveys were conducted in June 1994.
The exchange rate was US$1 = Z$8.0 and £1 = Z$ 11.9.

smallholder level. This has been partly due to drought conditions, particularly in 1992, but also because of falling producer prices and government policy which placed less emphasis on the factors mentioned above. As a result, in 1991 31% of the rural population were below the poverty line compared with 10% in urban areas, with 88% of the total living in rural areas. (Mckay et al, 1995).

Agricultural land in Zimbabwe can be split up into 4 categories: (i) large scale commercial farms which are over 750 acres in size and on the most fertile land. They are farmed intensively and primarily white owned; (ii) small scale commercial farms are between 250 and 750 acres in size, are farmed fairly efficiently and are usually mechanised. They are predominantly owned by rich blacks who are often based in the city; (iii) farms on settlement schemes are between 25-50 acres and the farmers have been relocated from more marginal and less accessible lands by the government; (iv) farms on communal lands are normally between 5 and 15 acres in size and this way of farming represents the most traditional form of farming for the majority of poorer blacks.

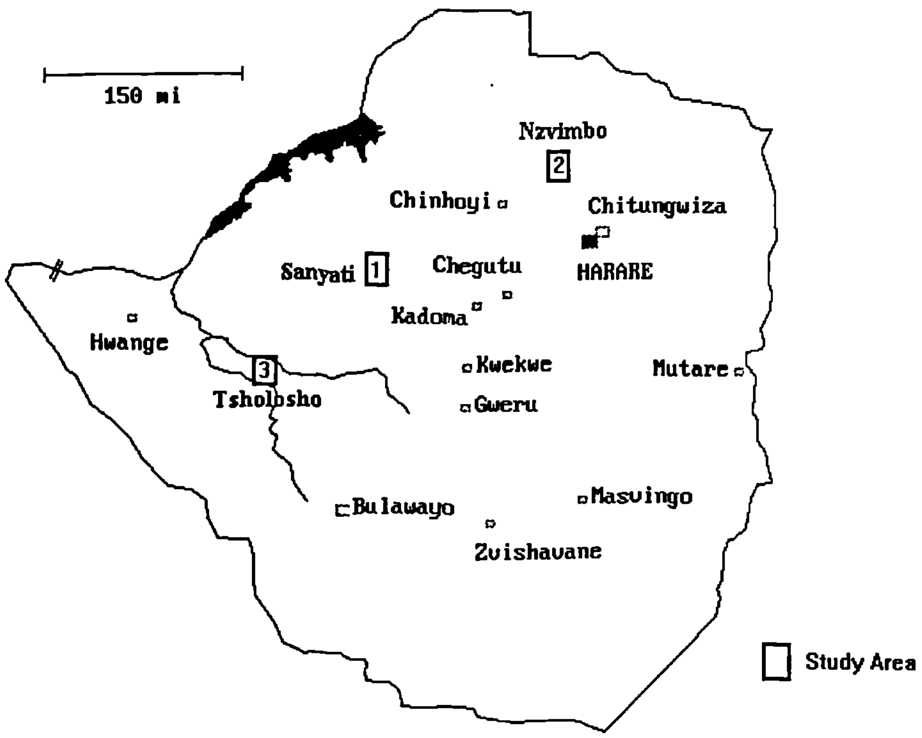
The farms in the last two categories vary in productivity depending on the fertility of the land and the quantity of inputs. Generally yields are low, only part of the harvest is used as a cash crop and mechanisation is the exception. In fact machinery only accounted for 16⁰ o of farm power compared to 20% for animals and 64% for human power (Agri-Motor Industry, 1989). It is these last two categories that this case study concentrates on.

Z'mbabwe is regarded as having one of the most advanced transport systems in Sub-Saharan Africa. It has a large network of well maintained paved and unpaved roads and a relatively efficient transport services industry despite acute shortages of vehicles in the late 1980's and early 90's due to an overvalued currency and scarce foreign exchange. However, this transport infrastructure has mainly developed around white colonial interests and mainly serves commercial farming interests. The road network to the communal lands has historically been largely ignored. This however is changing and there is now an increasingly well developed network serving the communal lands and particularly the settlement areas.

Rural transport in Zimbabwe has also benefited from attempts to introduce other vehicle types such as wheelbarrows, animal carts and less successfully the tractor.

However, there are still less productive areas where the rural population relies almost entirely on headloading for their means of transport.

Figure 7.1: Map of Zimbabwe marked with the study areas



7.2 Description of the study areas

The survey sites were in three distinct areas of Zimbabwe. The area around Sanyati is largely flat and the main crops are cotton and maize. There is a wide area around Sanyati (over 100 kms distant in some cases) which relies on the town for the supply of agricultural inputs, marketing of produce and other essential services. The Chiweshi District is one of the main tobacco growing areas in Zimbabwe and has therefore one of the most prosperous rural economies. In addition they grow maize and vegetables. The relative proximity of Harare means that there is always a good market for produce. In contrast to the relatively high production areas of Sanyati and Chiweshi, Tsholosho has been hit harder by drought and has far lower production because of poorer soils.

Study area No.1: **Village 9 (Mzeze 1 Resettlement)**
Sanyati
Kadoma West District

Table 7.2: Village 9 statistics

Variable	Number
Population	300
No. of Families	39
Total Agricultural Area	-
Water Supply	30mins - 6 times/day (headloading)
Firewood Supply	1km - 3 times/week (Headloading)
Electricity	No
Schools	40 mins - primary school 2 hrs - secondary school
Health Facilities	health centre - (25km by foot or scotchcart)
Vehicle Repair Facilities	0
Mills	30km - scotchcart
Markets	1 shop (10km) 1 main market - (40km by truck/tractor)
Vehicles: Scotchcarts Bicycle Wheelbarrows	 3 2 3

Village 9 is located approximately 40 kms from the Sanyati growth point and is typical of many of the villages in the area. The terrain is predominantly flat although there are some hills around Village 9. The main crops grown are cotton and maize which are both sold to the respective state owned (in the process of being privatised) marketing boards in Sanyati. The survey was during the harvest period and long queues of vehicles could be seen waiting outside the marketing boards to deliver their cargoes. Some drivers had been waiting for up to two weeks. The marketing board had organised it so that scotchcart (locally made animal carts) owners had priority on a particular day, this countered the problem of animals waiting for long periods without food and water.

Generally the infrastructure to the villages, particularly on the resettlement schemes was good. Roads were gravel or earth but in a fairly good state of repair and certainly motorable. Vehicle ownership varied from village to village and seemed to depend as much on the quality of the land as the distance from Sanyati. The villages that were most distant from Sanyati and did not have access to motorised transport had the biggest problems. For example, scotchcarts have a maximum range of about 30-50km before it becomes impractical to use them. The problem is as much the waiting at marketing boards when they get there as the journey itself. Without motorised transport it also becomes difficult to get to essential services such as markets, schools and health facilities. In fact the most commonly voiced concern of those in the most inaccessible areas was the difficulty in getting to health facilities. They complained that if a person was taken ill in the middle of the night there was absolutely no way of getting attention and as a result many died.

At the household level most transport for subsistence goods such as water and firewood is by headloading. Richer households have access to wheelbarrows which are also used for transport to grinding mills and for rural industry such as brick making. Bicycles are male owned and operated but are used for some household tasks but generally not for the collection of water and firewood.

The scotchcart is used primarily for the transport of agricultural produce and inputs and in some cases building materials. Owners of scotchcarts will also provide a for hire service for these activities. Where households own a scotchcart they will often be used for the collection of water, where there are water drums, and firewood. In village 9 there is no tractor ownership so they have to travel to neighbouring villages if they want to hire them. The tractors that are available in the area are generally very old and not in a good state of repair. However they are used for ploughing, the transport of harvest and building materials.

In the Sanyati area bus transport, and passenger services in general, are not widespread. The service is irregular and timetables are inconvenient because the buses come early in the morning or late at night. Para-transit services are not common because of strict regulations governing their use. Box 2.1 gives the day to day transport pattern of another similar village in the Sanyati area.

Study area No.2: Bare Village
Nzvimbo
Chiweshe District

The Chiweshe District is one of the more fertile areas in Zimbabwe and as a result the population is relatively affluent and have few accessibility problems. The principal crop in the area is maize followed by tobacco, cotton, sunflower and ropoko. Due to high population densities and relatively high crop yields, (maize yields 3,150kg per hectare), the area has been targeted for a tractorisation program which has been set up by the Institute of Agricultural Engineering in Harare and the French government.

Box 7.1 Why the Bare tractor co-operative succeeded

The Bare tractor co-operative is one of the few successes in a French Technical Co-operation project to introduce tractors into the Chiweshe District of Zimbabwe. A number of co-operatives were set up using highly subsidised Renault 70-32 tractors. Everyone received training in book keeping, tractor repair and maintenance, and driver training. However, most of the other co-operatives could not keep up repayments and experienced managerial problems normally resulting in someone absconding with the money. This was often the case when tractors were given to village elders who were used to traditional farming methods and viewed the tractors as a gift.

By contrast the managers of the Bare co-operative were young, dynamic and educated. They kept good records on everything coming into and out of the co-operative. The tractors were maintained regularly and utilisation was very high. They looked for opportunities outside of ploughing and actually spent 65 per cent of their time in transport operations which brought them 72 per cent of total income. The four main activities were ploughing; transport of tobacco to Harare (120 km each way); transport of grain to the Grain Marketing Board (30 km each way); and local transport. On average the tractor was utilised for 1400 hours per year.

The co-operative did so well in this fertile area that they have now bought a second tractor at market rates.

As with many tractorisation programmes, subsidised tractors have been sold to co-operatives with subsidised credit. The recipients received training in book keeping and operator training and a workshop was set up in the area to provide maintenance and repair facilities for these tractors. Unfortunately the success rate was not high and many co-operatives failed to keep up their repayments. The Bare co-operative was a notable exception as detailed in Box 7.1.

Table 7.3: Bare village statistics

Variable	Number
Population	350
No. of Families	-
Total Agricultural Area	-
Water Supply	some taps/ hand pumps
Firewood Supply	charcoal/ around houses
Electricity	some
Schools	1 primary school - in village 1 secondary school - 30 kms
Health Facilities	30 kms
Vehicle Repair Facilities	simple jobs at co-operative main garage - 30 kms
Mills	1 - in village
Markets	shops in village GMB - 30 kms
Vehicles: Tractor Trucks Scotchcarts Bicycle Wheelbarrows	 3 2 12 20 10

The existence of subsidised tractors and government pool tractors also creates a poor environment for private tractor operators to enter the market. Private tractor operators do operate successfully but many complain about the unfair competition from subsidised machines.

Although the success of tractors in the Chiweshe district has been a mixed story, the success of scotchcarts has been unequivocal. The agricultural extension officer in Nzvimbo estimates that between 80-90% of households (probably an over-estimate) in the area own a scotchcart. This is backed up by the local scotchcart manufacturer who makes around 140 per year. Located in the rural areas he produces simple scotchcarts from second-hand car axles and wheels and then attaches them to the box which is made from flattened oil drums. The only piece of equipment needing regular maintenance is the bearings; if they are looked after well they can last for 8 years but if not they will not last a year. The scotchcarts vary in price from Z$1,600-2,000 depending on the size. They do not look pretty but are extremely functional, cheap, easy to maintain, easy to collect from purchase and therefore highly demanded.

Study area No.3: Mutsvaio Village
Tsholosho
Tsholosho District

Tsholosho is in one of the drier regions of Zimbabwe, its terrain is flat and its soil is very sandy and as a result the agriculture is not as good as the two other study areas. For example, the maize yield at 450kg per hectare as stated by the Tsholosho agricultural extension officer is one seventh of the level in Chiweshe District. As a result scotchcart ownership is stands at only 30% of households (probably an over-stimate) and there are only 10 tractors in the whole district. Land preparation is conducted primarily by draught animal power and this is the cause of the main problem. The cattle in the area become very weak during the dry season because they are left to graze and have few supplements. As a result, they need the grass which comes with the first rains in order to build their strength to plough, consequently planting occurs much later than optimum and the seedlings miss the first rains.

The lack of transport in this area increases the reliance on headloading and bus services. As in the other areas the rural bus service does not sufficiently meet the needs of rural communities. There is also a problem in the manufacture of scotchcarts. The small workshops do not have access to the necessary equipment or component parts. The main component to the scotchcart is the axle and wheels and these are in very short supply. The result is that the price of scotchcarts in this area can be more than twice the price (Z$4,000) as in areas such as the Chiweshe district.

Table 7.4: Mutsvaio village statistics

Variable	Number
Population	100
No. of Families	12
Total Agricultural Area	-
Water Supply	Hand pump (100m by walking)
Firewood Supply	1km - headloading
Electricity	no
Schools	1 primary - 1 km
Health Facilities	health centre (5km by walking or scotchcart)
Vehicle Repair Facilities	0
Mills	1.5km (scotchcart)
Markets	shops - 5km main market (120km by truck)
Vehicles: Scotchcarts Bicycle	 3 1

7.3 Vehicles in operation

There is quite wide diversity of vehicles in operation in the rural areas of Zimbabwe. However the level of vehicle ownership in many areas is still low. Many of the vehicles that are in operation are old or have not been maintained properly. As a result vehicle utilisation tends to be low and their activities are not as diverse as would be expected. The most commonly operated vehicles in the rural areas of Zimbabwe are listed below:

Wheelbarrows - many households have access to wheelbarrows which are used primarily for the transport of household goods such as water, firewood and maize to and from the mills. They are also used in small scale rural industries such as brick making. They cost around Z$400 which is quite expensive for most rural households so they are only present in the more affluent areas.

Bicycles - bicycles are in operation in many rural areas but their numbers are not large and they are almost entirely used by men. Some of the problems with bicycle use is that distances to service centres in some areas can be quite long and in some areas the roads are very sandy. A 1985 National Transport Study estimated that 25% of households owned a bicycle (SWECO, 1985). However, from the surveys it was apparent that in some areas ownership was higher and in others it was far lower.

Animal carts - despite the droughts of 1992 which killed off much of the country's livestock, DAP is still the most popular form of transport and means of ploughing. When the animals are not engaged in agricultural preparation they can be harnessed to a cart, or scotchcart as they are commonly known, for transport activities. They are used for a variety of tasks including water collection, firewood collection, harvesting, marketing as well as trips to the grinding mill and markets.

The use of scotchcarts is far more widespread in the north of the country where the land is more fertile and incomes are higher. In the Chiweshe district, a predominantly maize and tobacco growing area, officials estimate that almost every household has access to a scotchcart. In contrast the dry zone in the south of the country has far fewer. The agricultural extension in Tsholosho district estimated that only 30 % of households had access to scotchcarts.

The carts are manufactured by small scale manufacturers; the wheels and axles are second-hand from cars and the body work is made from sheet steel, wood or pressed from old oil drums. In some parts of the country there is some difficulty finding second-hand axles and wheels and in response Intermediate Technology Development Group (ITDG) have implemented a training programme for manufacturers to make their own. Manufacturers vary in size producing from between 140 to 6 per year. The price also varies greatly depending on the demand and the supply of axles and wheels. In the Chiweshe District scotchcarts were being sold for as little as Z$1,600, however in the Tsholosho District the price can rise to Z$4,000.

Maintenance and repairs on the carts is minimal with the main complaint being about the replacement of wheel bearings. The frequency of bearing replacement depends largely on the quality of routine maintenance. They can last up to 8 years if well maintained. Tyres and inner tubes are the other main expenses. Bearings cost in the region of Z$120 per side, second-hand tyres cost Z$80 and new tubes cost Z$110. Some of the carts can last for 30 years but 10-15 years is more common.

The most common cart set up is for 2 oxen (cows) or 4 donkeys to provide the DAP. The load capacity is generally 500kg; however with larger carts and more animals the load can increase to one tonne. The cost of the animals varies from area to area with oxen varying in price between Z$1,500 and Z$2,500 (average is Z$1,840), cows between Z$900 and Z$1,500 (average is Z$1275) and donkeys between Z$100 and Z$450 (average is Z$246).

Tractors - tractors are used very successfully on large and small scale commercial farms. Their use in the communal lands is far more limited. In Tsholosho for example the extension officer estimated that there were only 10 in the whole district. Most of the tractors found on communal lands are those that have been bought second-hand from the larger commercial farms. In many cases these tractors are extremely old, over 20 years in many cases and require a lot of repairs to keep them going. In very fertile areas such as Chiweshe there have been tractorisation programmes to introduce subsidised tractors into the area but these projects have been largely unsuccessful.

The most successful tractor operators are the local businessmen who have the anagement skills to keep the tractor going and use them as intensively as possible. In many areas the tractor is the vehicle of choice for the bigger operators because of its ability to work the year round. The complaint about trucks is that during the main ploughing season the truck is largely idle and during the harvest season the payload of the tractor ideally suits the average farms requirements. The truck with its larger payload only visits the larger farms, which limits the market.

The exact age of the tractor fleet is difficult to determine because many of them are not registered. However, the Agri-Motor Industry estimates that there are a total of almost 24,000 tractors of which 18,000 are unregistered, 65% of this fleet being over 10 years old. These figures do not take account of the tractors in use in the small scale and communal farming areas. The Agri-Motor Industry report states that there could be as many as 30,000 tractors in this sector but because "these figures cannot be reasonably substantiated and it is likely that the tractors would be highly unreliable, no account has been taken of them" (Agri-Motor Industry, 1989).

Pickup trucks - there were some pickup trucks in operation in the rural areas but they were mainly owned by shop keepers and small rural traders. Their use was not widespread although the potential for pickup operation in the rural areas of Zimbabwe would appear to be very good. Part of the problem is the regulation in the bus market which means that all vehicles that are going to carry people must obtain a license. This is impractical for smaller vehicles and so passenger services to rural areas are poor. In fact the number of motorised trips per capita per week is only between 0.3 to 0.5 compared to 3.5 trips per week in urban areas (SWECO, 1985).

7.4 Vehicle operating costs

Figure 7.2 below demonstrates that at a demand of 500 tonnes per year the scotchcarts are the cheapest form of transport. They benefit from low purchase costs, low feed costs and low repair and maintenance costs. This clearly shows why the use of scotchcarts is so widespread in many of the rural areas of Zimbabwe. The donkey scotchcart is particularly good as a transport vehicle, as the donkey is faster than oxen, cheaper, has more stamina and needs less attention. However, the diagram does not take into account the field performance of these animals. Although both animals are used as draught animal power for agricultural preparation the performance of the oxen is far better. The status of a household would also be judged by the head of cattle they own, whereas the donkey is regarded as a stupid animal and as such the status of donkey ownership is lower. In conclusion, although the donkey scotchcart is shown to be cheaper in transport operations, the oxen scotchcart would be the preference of rural people.

As the distance at a demand of 500 tonnes per year goes beyond 20 kms the tractor and trailer becomes a cheaper option. It benefits from greater speed, a greater load capacity and is not so labour intensive. As a result the tractor is used intensively at harvest time for transport to the marketing boards from villages that are distant. The effective distance for animal transport is normally between 20-30 kms with 50 kms being an absolute maximum. The high purchase costs of the truck means that at relatively low levels of demand it would not be used instead of animal transport until about 50 kms but in practise it would be before this because of the animals' limited range. The animal scotchcarts are therefore primarily used for household tasks and the transport of inputs to fields and harvest to the village. The motorised transport is primarily used for long distance high demand work.

Figure 7.2: Vehicle operating costs at 500 tonnes per year

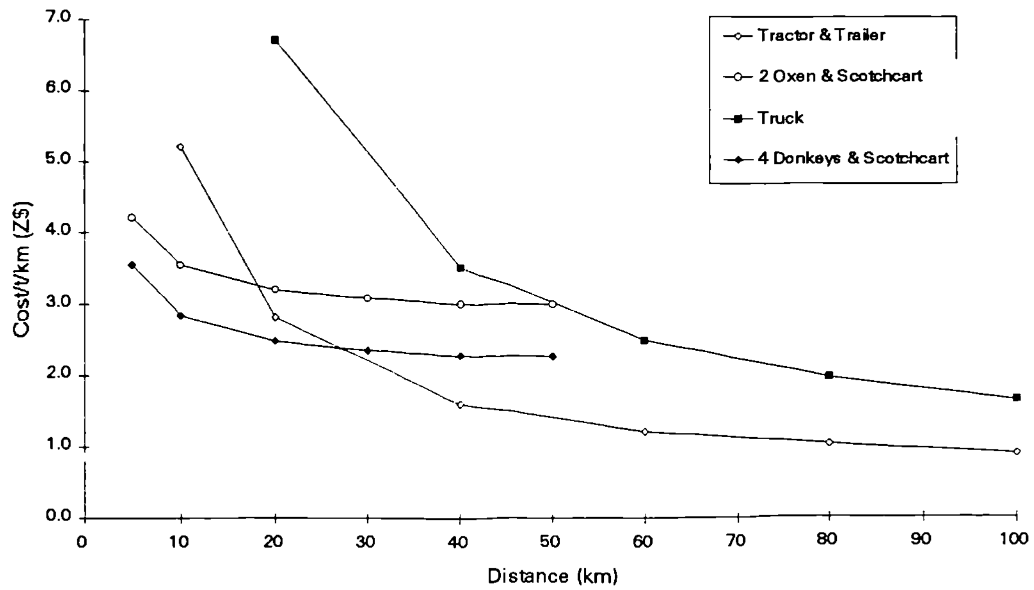
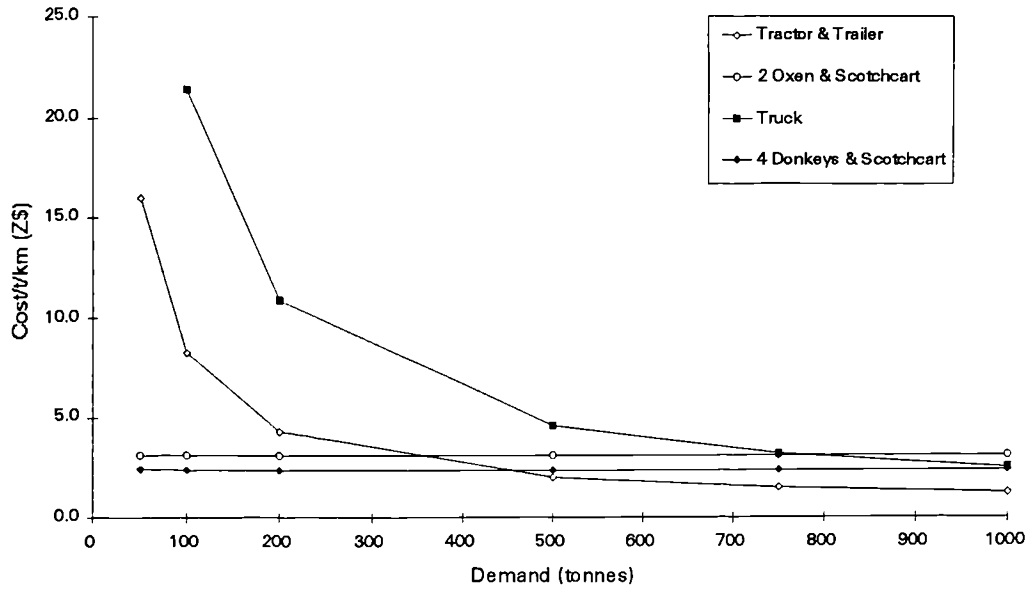


Figure 7.3 shows a very similar picture to figure 7.2. 30 kms represents a typical distance that might be expected for transport to a marketing board from the village. At low demand levels the animal transport is cheapest, while the tractor becomes cheaper t about 400 tonnes per year and the truck at 1000 tonnes per year. At 1000 tonnes per year and at a distance of 30 km the tractor is almost fully utilised but the truck is only half utilised. As demand continues to increase the truck continues to gain advantage over the tractor. In reality the tractor and truck are used according to the size of farm and therefore the quantity of harvest i.e. the tractor will take produce from the smaller farms and the truck from the bigger farms. The diagrams help to understand the reason for the preference of tractors over trucks in rural areas where demand is limited. Tractor operators can achieve year round utilisation whereas trucks operate on a more seasonal basis.

Figure 7.3: Vehicle operating costs for a 30km trip and various levels of demand

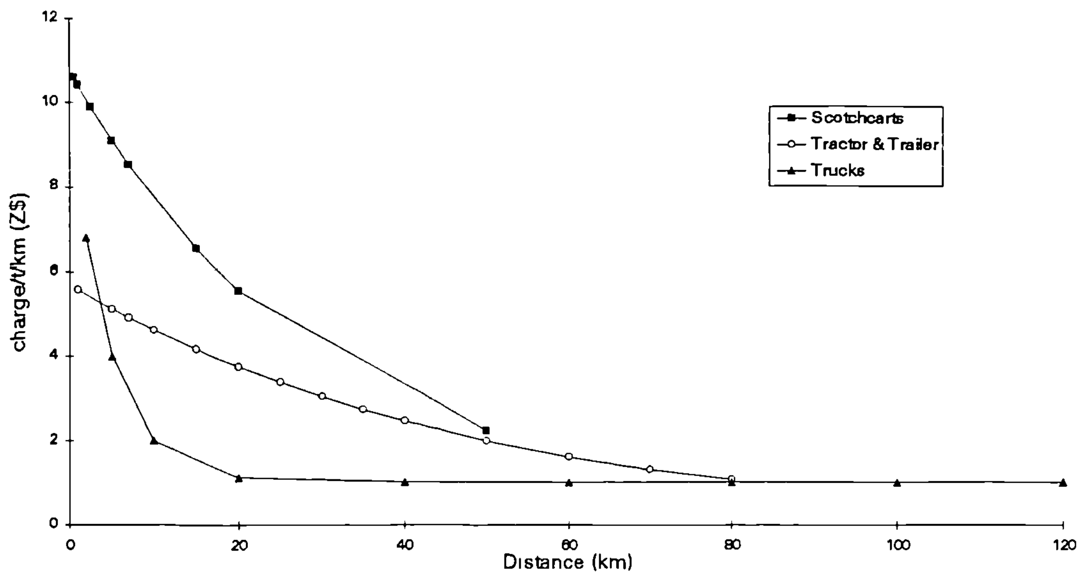


7.5 Transport charges

The transport charge curves in Zimbabwe are very much as expected as shown in figure 7.4. The scotchcarts are the most expensive form of transport, although providing an essential service in rural areas for low demand, relatively short distance routes. Likewise the tractor is more expensive than trucks for all but the shortest distances, the lower truck charges reflecting their advantage for the transport of large loads.

Unexpectedly, both the scotchcart and tractor have steeper curves than their next cheapest rival and as a result the scotchcart curve converges on the tractor curve at about 50 kms and the tractor curve converges on the truck curve at about 80 kms. Whilst part of this is due to problems in smoothing the transport charge data, it also points to some anomalies in the system. The scotchcart for example is not usually used for operations over about 20-30 kms, but in the Tsholosho district scotchcarts are used in the off-season for the transport of roofing materials, a particular kind of grass, which they have to travel up to 50 kms to collect. As the amount of activity, agricultural or other, is minimal at this time of year there is intense competition for business and so charges are below the prime time levels.

Figure 7.4: Zimbabwe transport charges



There are a number of factors which may cause the tractor's charge curve to converge on the truck's. The first reason is that on the longer routes the tractor is in direct competition with trucks for the business and so they must charge rates that are equal to or below the truck charges. The second reason is that in many areas there are subsidised tractors and it is usually these tractors which engage on the longer distance routes. As such they are not incurring the full costs of this activity. The tractor is not designed for long distance, high demand road routes. At a trip distance of 80 kms the tractor would become fully utilised after about 750 tonnes per year which is less than half the trucks capacity. It can be concluded that tractor operators are just trying to keep their vehicles as fully utilised as possible, these long distance routes fill in gaps when they are otherwise idle.

7.6 Factors affecting the provision of rural transport services

7.6.1 Infrastructure

The urban and inter-urban road network in Zimbabwe is one of the most efficient in Southern Africa and stems from colonial days when the roads were built to serve colonial interests. As a result, rural roads to communal areas had largely been neglected. However since independence the network of roads serving the communal areas has expanded and now most areas are accessible through good road links.

The District Development Fund (DDF) has undertaken an ambitious program of road building and upgrade in the communal and resettlement areas of rural Zimbabwe. This has left Zimbabwe with an impressive rural roads network both in terms of length and quality. For example, 14,000 kms of the 18,000 kms of "primary rural roads" have already been upgraded. However, the cost of this program means that DDF targets for the maximum distance of communities from primary, secondary and tertiary rural roads are unlikely to be met. Part of the problem is in the capital intensive nature of the road building, the roads being built to unnecessarily high standards, and the highly centralised nature of the organisation.

Although there is always scope for improvement in the rural infrastructure, the quality of the roads in the study areas posed no constraints to the use of either motorised or non-motorised vehicles.

7.6.2 Credit facilities

As mentioned in the introduction there was a policy in the early 1980's to expand the provision of credit to smallholder farmers in rural areas. There were many credit schemes to finance the inputs for agricultural production as well as vehicles such as tractors and scotchcarts. Part of the problem with the early credit schemes was the very poor repayment record. The Agricultural Finance Bank for example had non-epayment rates in the region of 97%. Now it is practically impossible for small scale farmers to get credit from commercial banks although some of the bigger farmers and small businessmen can get credit if they have collateral. The Cotton Marketing Board (CMB) has now taken over as the major provider of agricultural credit for small scale farmers.

Many of the small scale farmers are not prudent with their income. At harvest time the beer halls do a booming business. My assistant during the survey said that farmers could spend up to Z$1,000 in a week. This causes many problems with planning and paying for the inputs for the next season, repaying loans and providing for their families.

7.6.3 Marketing and storage facilities

Since the survey was conducted the marketing and storage operations within the country have changed significantly from state run monopolistic organisations to the now deregulated environment. During and prior to the surveys all marketing and storage was carried out by state run companies. Of particular interest here are the CMB and the Grain Marketing Board (GMB).

Although there was free entry into the production of cotton or maize, the marketing and distribution of these products was regulated which caused undesirable effects in related activities. For example, the CMB had a statutory monopoly over the purchase of cotton which adversely affected farmers who could not get transport to CMB facilities and became reliant on illegal middlemen who paid low prices. Similarly, maize producers had to sell to "approved buyers", a layer of middlemen with monopolistic power. They in turn had to sell to the GMB who dictated final prices and the margins the middlemen could make. This restricted the entry of smaller middlemen into the market.

7.6.4 Regulation in transport services

Although Zimbabwe does not have a transport union that controls the prices of transport services, there are other organisations that do a similar thing. The marketing boards for example have meetings with transport associations and other interest groups to discuss the price of transport during the harvest seasons to the marketing boards. The transport charges that are formulated have very little to do with the actual costs associated with transport and consequently the market for transport services is not allowed to operate effectively. A closer examination of the data for transport charges indicates that transport charges to marketing boards are considerably more expensive, up to double, that to other destinations.

A similar situation occurs in the bus industry where rural transport services are highly regulated. All bus operators must receive a license to operate passenger bus services and one of the conditions is that operators must provide rural services as well as the more profitable inter-urban services. The result is that operators leave the rural areas at 2 or 3 o'clock in the morning and do not return until the late evening. Rural people who do not live on the major rural routes are forced to leave their homes the previous night if they want to catch these services. This regulation also means that other vehicles such as emergency taxis and pickups are not used fully for the transport of people. These vehicles provide the majority of passenger services in many countries and are ideal for the rough rural roads and small dispersed demand.

7.6.5 Vehicle backup services

Vehicle backup services at the village level are not widespread mainly because of the low level of vehicle ownership and the relatively small size of the villages. At the service centres or growth points the backup services are adequate although they are short of much of the equipment needed. The availability of spare parts is also a problem and the cost of spares means that many farmers allow their vehicles to fall into disrepair at some stage during the vehicle's life. Where tractors had been introduced under aid schemes there was often a problem because the service network had not developed to support it. Additionally there would often be a wide variety of tractor makes and not the dealer network to support them all.

7.6.6 Routine maintenance

Routine maintenance is not conducted with as much care as should be the case. Many of the repair problems mentioned above stem from the lack of maintenance. This was particularly the case for the greasing of bearings on scotchcarts and the changing of oils etc. on motorised vehicles.

7.6 7 Local manufacture

The manufacture of scotchcarts is common in all of the study areas although the quantities produced varies considerably. In the Chiweshe district small scale manufacturers can produce up to 140 units per year whereas in the Tsholosho district this falls to only 6. Equipment needed for manufacture can often be a problem especially with regard to welding facilities. The availability of second-hand axles and wheels can also be limited particularly in less densely populated areas. As a result, ITDG have set up a programme at the Institute of Agricultural Engineering in Harare to train small scale artisans in the manufacture of axles and wheels.

7.7 Overall impressions of the provision of rural transport services

The case study in Zimbabwe has concentrated on the communal and resettlement lands where farm sizes are small and mechanisation is the exception. Unlike Ghana, rural Zimbabwe does have access to a number of small non-motorised vehicles such as wheelbarrows, bicycles and animal carts. In some of the more fertile areas ownership levels are high but in others ownership is low and the rural population remains isolated. The more isolated communities rely on motorised vehicle services from operators in the towns and other villages and also from inconveniently scheduled and infrequent rural bus services.

During the survey period the GMB and CMB dominated the marketing of most of the produce grown by farmers. As a result storage facilities and markets are distant from the population of many villages, who have no incentives to buy vehicles. Regulation also affects the supply of bus services to rural areas, because all operators must have permits and keep to timetables vehicle owners do not provide services. Vehicles such as the pickup are not used as widely as in many other countries because of this regulation.

CHAPTER 8

CASE STUDY - PAKISTAN

8.1 Introduction

Since independence in 1947 agricultural and industrial growth has been fast which has led to economic growth rates of over 6% in the late 1980's, one of the fastest in East Asia.

Despite rapid industrial growth, agriculture represents the main stay of Pakistan's economy, employing 50% of the work force and accounting for 25% of GDP and 70% of exports. Pakistan is one of the few Asian countries to be a net exporter of food. The major crops are wheat, rice, cotton and sugar cane. Despite successes in the agricultural sector Pakistan has high population growth and large income differentials between the rich and poor. For example, 90% of farmers operate on 10 hectares or less and 30% operate on 2 hectares or less.

Table 8.1: Key data for Pakistan

Characteristic	Number
Population (millions)	119.3
Area (thousands sq km)	796
Population Density (pop/sq km)	150
Rural Population (%)	66
GNP per Capita (US$)	420
Road Length (km)- Total:	111,237
National Roads	58,677
Provincial Roads	52,560
Road Density (km per million pop)	932

The Indus valley (Punjab and Sind Provinces) represents one of the largest irrigated agricultural areas in the world and has contributed to success in the agricultural sector.

The Pakistan surveys were conducted in October 1994.
The exchange rate was US$1 = Rs 31.0 and £1 = 48.5.

Despite low rainfall in the area the irrigation allows intensive farming and there has been a great influx of mechanisation.

One factor likely to prevent Pakistan's economic growth in the future is the low level of literacy in the country. In 1990, 65% of the total population and 79% of the female population were considered illiterate (The World Bank, 1995) and in rural areas up to 93% of the female population could be considered illiterate (Pakistan Statistical Yearbook, 1991). Despite these problems which have undoubtedly adversely affected increases in industrial production, the transport sector has been very strong. Operators have a better idea of their operating costs than many of their more literate neighbours.

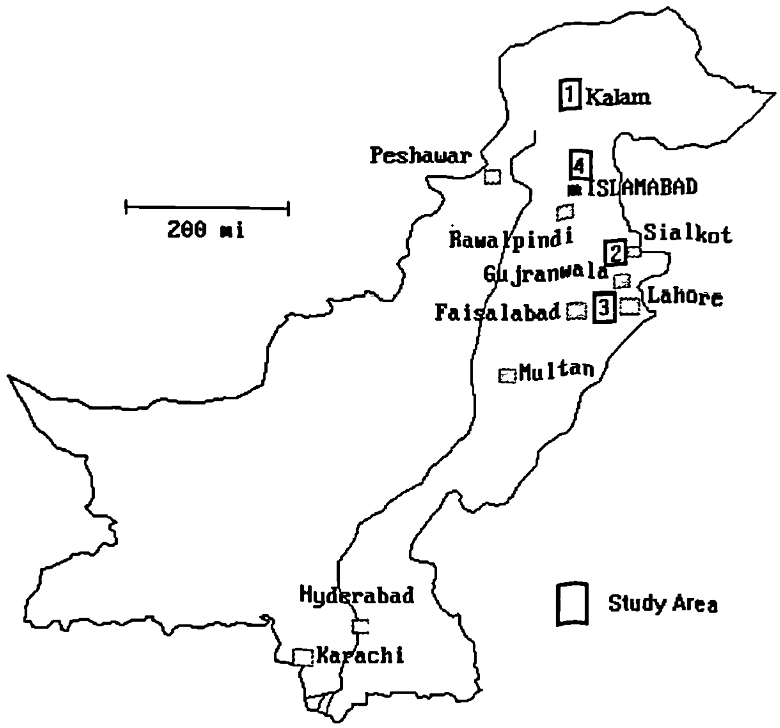
As a result, the transport sector has seen a lot of growth in the period since independence with considerable road building on both the major and rural routes. This new road construction has also been matched by the provision of transport vehicles. There have been large increases in the numbers of motorcycles, pickups. tractors and trucks. In the 20 years from 1960 to 1980 total passenger kilometres increased by over 8 times and total tonne kilometres of freight moved increased by 10 times (Qureshi, 1984).

8.2 Description of the study areas

The surveys were conducted in the North Western Frontier Province (NWFP) and the Punjab Province. Much of NWFP is in the foothills of the Himalayas and as such agricultural production is not as intensive as in other areas of Pakistan. In the main ther is only one growing season because of snow cover during the winter. However, in the lower parts of NWFP there are two growing seasons. The main crops are potatoes, vegetables, maize and fruit.

The Punjab Province is the agricultural heartland of Pakistan and has vast areas of agricultural land growing maize, wheat, sugar cane and rice. Agriculture is this area is more intensive both with regard to agricultural inputs, mechanisation and irrigation.

Figure 8.1: Map of Pakistan marked with the study areas



Study area No.1: **Gubrall Village**
Kalam Tehshl
Swat District
North Western Frontier Province

Gubrall is situated in the foothills of the Himalayas in the Swat Valley. The village is situated 25km from Kalam the main service centre in the area and 140km from Mingora, the main agricultural marketing area. As the terrain is mountainous the fields are cut in to terraces on the sides of mountains. In November the snow comes so they are restricted to one growing season from April to October. The main crops are turnips, potatoes, cabbage, tomatoes, peas, pumpkins and apples.

The villages in the area rely primarily on hired vehicles for their transport needs, and vehicle ownership is quite low in the village. This is mainly because production is quite low, and demand dispersed. Although some people keep animals it is not common because of the high feed costs during the winter period. As a result most vehicles are owned by transporters in Kalam who travel around the villages on demand in jeeps and

2 and 4 wheel drive pickups. The pickup is an ideal vehicle for this environment, coping well with rough and often steep roads and with a payload sufficient for the needs of small scale individual farmers. The pickup also provides a bus service which is again very suitable for small dispersed demand.

Table 8.2: Gubrall village statistics

Variable	Number
Population	3500
No. of Families	400
Total Agricultural Area	-
Water Supply	Taps/River
Firewood Supply	2km (foot) twice per week
Electricity	No
Schools	1 (in village)
Health Facilities	1 health centre (12km by pickup)
Vehicle Repair Facilities	0
Mills	0
Markets	1 shop (in village) 1 weekly (12 km) 1 main market - (140km by truck/pickup)
Vehicles: Truck (6 Wheel) Donkey Bicycle	 2 60 5

Trucks are also in operation during the harvest season when groups of farmers will hire a vehicle and travel hundreds of kilometres until they find the best price for their produce. Many of the fields are located well away from the main road on rough and mountainous paths. Camels are used for the transport of the harvest from the field to the roadside. They are capable of carrying 320kg, some 4 times greater than the capacity of a donkey. The camels are brought up from the lowlands and travel over 200 kms to reach the area.

During the land preparation season tractor drivers move up from the lowlands to plough the land. Mules are used for the transport of inputs and essential goods when there is a lot of snow making access difficult. The weather is the main problem for accessibility and in the middle of the winter the area can be cut off for long periods. As a result many of the villagers from Gubrall move to the lowlands with their donkeys and possessions to find work. It is estimated that nearly 50% of the people living in the valley migrate during the winter. Seasonal inaccessibility causes particular problems with health and education.

Although vehicle ownership is not high because of the difficulties of keeping vehicles, particularly animals, the availability of hired transport is very good. This is mainly due to the dynamic nature of the vehicle owners in the lowlands who will move from agro-climatic zone to the next looking for new opportunities during their off season.

Study area No.2: Kukary Village
Mingora
North Western Frontier Province

The village of Kukary is located near Mingora (6km) and about 120km south of Kalam. The village is located on the slopes of the valley and although the terrain is not as rugged as in Kalam many of the fields are still terraced. Mingora is considerably low r than Kalam and so agriculture can be conducted the year round and there is no problem with seasonal accessibility. The main crops are maize, rice and fruit crops which are cultivated mainly by tractors.

Mingora is a more prosperous area than Kalam and so personal vehicle ownership is higher. The donkey is the most commonly owned animal at the village level and is used for the transport of harvest, firewood and other household and agricultural inputs. The donkey is also used as a source of income, particularly for the transport of building materials and at harvest time. It is particularly useful for work in the narrow village streets, for travel to the hills along rocky paths and to terraced fields. For the transport of inputs to the fields and fodder and harvest from the fields, hand carts of various description are used as well as human labour, carrying the load either on their backs or heads.

The area has a number of tractors which are primarily used for agricultural preparation. Their use for transport is limited, many did not own trailers at all and the others were put off by the trailer licenses of Rs 3,500 per year. Most tractor operators said the main reason for not engaging in transport activities was the lack of demand for their services. The availability of pickups and trucks is usually good enough during most periods of the year.

Table 8.3: Kukary village statistics

Variable	Number
Population	750
No. of Families	-
Total Agricultural Area	-
Water Supply	Taps
Firewood Supply	2km by foot or donkey
Electricity	Some
Schools	1 (in village)
Health Facilities	1 hospital (6km by pickup)
Vehicle Repair Facilities	6km
Mills	6km
Markets	1 shop (in village) 1 main market (6km pickup)
Vehicles: Pickup Tractor Donkey Bicycle Motorcycle Handcarts	 2 2 40 40 10 ?

The pickups and trucks are operated in much the same way as in Kalam with the operators working out of Mingora and travelling to the villages as and when their services are required. The pickups provide most of the passenger transport, carrying up to 30 people, as well as the supply of inputs and the transport of harvest.

Study area No.3: New Gorala
Gujrat
Punjab Province

New Gorala village near Gujrat is situated in the main agricultural area of the Punjab Province. The terrain in the Punjab province is predominantly flat. Farmers mainly grow rice and wheat but supplement their incomes by the rearing of livestock and sale of milk. In addition the area has many industries such as furniture makers, chip board and small engineering companies which also help to supplement agricultural incomes.

At the village level most transport operations are undertaken with draught animal power. The most commonly used animals are donkeys, mules, oxen and horses. The donkeys are mainly used for personal transport, for movement around the village, farm and to markets. The other animals are more commonly used on a for hire basis either for agricultural produce or transporting raw materials and finished products from the many rural industries. A horse cart known as a "tanga" provides much of the passenger transport to nearby services and towns. The tanga is fast and can carry up to 8 people or can be used for marketing purposes as they can cover long distances relatively quickly, which is particularly useful for perishable goods. Oxen and mules ar usually used for high weight, low value goods where time is not an important consideration. As land use is fairly intensive in this area one of the main drawbacks of animal ownership is the high cost of fodder.

Pickups compete with animal carts for business and their obvious advantage is that they are faster, can travel longer distances and have a higher payload. Again they are used for the transport of both produce and passengers. Tractors are also commonly available for hire, particularly at harvest time. However, they are also used by industry for the movement of heavy goods over distances of up to 100 kms. Bicycles and motorcycles are also used for personal travel and marketing purposes.

Table 8.4: New Gorala village statistics

Variable	Number
Population	900
No. of Families	-
Total Agricultural Area	-
Water Supply	Handpump in house
Firewood Supply	Cow pats
Electricity	Some houses
Schools	School (2km by tanga or pickup)
Health Facilities	health centre (3km by tanga or pickup)
Vehicle Repair Facilities	1 for non-motorised 2 for motorised
Mills	1
Markets	1 shop (in village) 1 main market - (5km by tractor or cart)
Vehicles:	
Truck (6 Wheel)	1
Pickup	5
Tractor	8
Motorcycle	10
Donkey	40
Donkey Cart	20
Mule Cart	5
Tangas	3
Ox Cart	15
Bicycle	35

Overall the transport system is very competitive, with a wide range of vehicles offering slightly different services depending on the requirements of the customer. The level of vehicle ownership is very high with most households owning some form of transport, mainly animal based. There are numerous repair facilities either at the village level or along the roadsides and the operators have extremely good knowledge on maintenance and repair requirements as well as the limitations of their particular vehicle.

A survey was also conducted in the Faisalabad area of the Punjab Province which is also a very important agricultural and industrial area. The description of the rural transport given above could equally well be used to describe the rural transportation system there.

Study area No.4: Kuri
Islamabad
Punjab Province

Kuri can be regarded as a peri-urban village as it is only 30 kms from Rawalpindi and Islamabad the capital. The village is very accessible and has good road links and a wide variety of transport services. The terrain can be described as rolling. Many of the people in the area commute into Rawalpindi or Islamabad each day and so there is a ready supply of external income. The agriculture was mainly maize and wheat but there are also livestock rearing with much of the milk being sold in the cities.

One of the most noticeable additions to the rural transport fleet in this area is the small Suzuki pickup which has a load capacity of about 800kg, roughly half that of the standard pickup. Although it was to be found in some of the other survey sites it is particularly popular here because of the good roads and large demand for any transport services. The Suzuki pickups are very convenient in being able to operate in congested city streets and so can easily take produce to urban markets in Rawalpindi. The main complaint about the vehicle was that it ran on petrol instead of diesel which is more expensive. The pickup in general has a very important part to play in rural life in this area.

Village level transport is again dominated by animal transport and bicycles. The diversity of animals is not as high as in Gujrat but there are pack donkeys, donkey carts, oxen and mules. Tractor ownership is also quite high, and operators derived much of their income from the transport of building materials as well as harvest.

Table 8.5: Kuri village statistics

Variable	Number
Population	350
No. of Families	-
Total Agricultural Area	-
Water Supply	Water pumps (100m)
Firewood Supply	10 hours (donkey)
Electricity	Some
Schools	School - in village
Health Facilities	Hospital (30km by pickup)
Vehicle Repair Facilities	1 for non-motorised 1 for motorised
Mills	1 in village
Markets	1 shop (in village) 1 main market - (30km by pickup)
Vehicles:	
Pickup	1
Suzuki pickup	3
Motorcycle	5
Donkey	15
Donkey Cart	7
Ox Cart	5
Bicycle	10

8.3 Vehicles in operation

As described in the study areas above, Pakistan has a wide variety of vehicles in operation, both motorised and non-motorised. There are vehicles to suit every transport purpose from large scale movement over long distances to the movement of subsistence goods within and around the village. The vehicle operators also have very good knowledge on repairs and maintenance and take great care and pride over their vehicles. Most motorised vehicles for example have ornate wood or metal work and have brightly coloured art work. The following vehicles are those most commonly found in the rural areas of Pakistan:

Pack animals - the animals usually used for load carrying are the donkey, mule and camel. The **pack donkey** is the most popular animal for household transport because they are relatively cheap (approximately Rs2,250), can carry in the region of 70kg and need very little attention. In addition to household transport they are also hired out for the collection of firewood, movement of farm inputs and outputs and for the transport of building materials. Their diversity of use means they have year round utilisation and can operate on any sort of infrastructure.

The **pack mule** is a far more expensive animal and as such tends to be used for commercial purposes instead of for household transport. They have a load capacity of around 120kg, have enormous stamina and need very little attention but their cost is high (approximately Rs17,000). Their main uses tend to be for the transport of farm inputs and outputs and the transport of building materials.

The **pack camel** is the strongest of the pack animals and has a load capacity of around 320kg. Its high load capacity means that their services are particularly sought after in the harvest season as described in the Swat valley study area. They can move hundreds of kilometres from one agro-climatic zone to the next to follow the harvests in different parts of the country. They can operate on the mountain paths but struggle if the terrain is too rough because of their soft feet. The camel can also be used for ploughing which means that utilisation levels are high the year round. The camel's requirements are low but they are not popular throughout Pakistan because of the lack of operator knowledge and their relatively high cost (approximately Rs14,000).

Animal carts - the main animal carts operating in rural Pakistan are pulled by oxen, donkeys, mules, horses and camels. As with the pack animals the donkey cart is very much used at the household level whereas the others are used more for commercial purposes. The most sophisticated of these is the "Tanga" which is a horse drawn cart with wooden wheels, suspension and passenger seats.

In Pakistan the **donkey cart** and **mule cart** operate with the simplest carts, which consist of a wooden base attached to a second-hand set of car axles, wheels and tyres.

Consequently the bulk of repair and maintenance requirements relate to the greasing and replacement of axle bearings and replacement of tyres and inner tubes. These carts are normally assembled by rural artisans and so are relatively cheap and easy to service. The donkey can pull a load of about 300kg and the mule can pull 600kg.

As with the pack donkey, the donkey cart is very much used at the household level. The existence of many other more efficient animals means that its use for hiring purposes is limited. Its main advantages lie in its relative affordability and the ease with which it can be maintained and looked after. The mule cart is normally used for the movement of larger quantities of goods for commercial purposes.

The **camel cart** is a four wheeled cart which has a load capacity of 1.2 tonnes when pulled by one camel. The camel cart is restricted to use on good roads because of the high load capacity and problems associated with sharp surfaces on the camels soft feet. The use of camel carts is not very widespread and this is probably because of the lack of operator knowledge on looking after camels.

The **ox cart** is another popular form of animal transport which is normally pulled by two oxen. The load capacity of the cart is up to 1.4 tonnes. The design of the cart is similar to that of the donkey and mule cart but is larger. The speed of the ox cart is low but the high load capacity makes it an attractive transport vehicle for rural industry or agricultural produce where speed is not important. The oxen have the added advantage that they can be used for agricultural preparation. The big disadvantage is the cost of feed which can rise to Rs 200 per day per pair of oxen.

The **horse cart** provides a totally different service from the other animal carts in that it tries to take advantage of the speed of a horse instead of just moving large quantities of goods. As a result the design of a horse cart or "**Tanga**" is very different from the others. The Tanga has large wooden wheels,, specially made suspension and often quite intricately made chassis. The cart is therefore quite an expensive piece of equipment and can cost up to Rs 40,000. The end result is a fast and manoeuvrable vehicle ideal for marketing purposes and the transport of passengers as well as normal farm duties.

Although the horse is fast it is also expensive to buy (Rs 22,000) it does not have the same work rate as the other animals and it also needs far more attention after it has worked, both in terms of feed and rubbing down. All these factors make the horse inappropriate for heavy haulage work so its advantages lie as a specialist marketing and passenger vehicle.

Pickups - The pickup is a commonly used vehicle for rural goods and passenger movement. Its versatility allows high utilisation the year round and on a variety of infrastructure. The size and speed of the pickup makes it an ideal vehicle for servicing the transport needs of small and dispersed populations. As such it was the major form of transport for most communities in the more isolated areas of NWFP where it was relied on for the supply of inputs, transport of harvest and for passenger movement. In areas where the roads were particularly bad 4WD pickups were used but generally 2WD vehicles are adequate.

National Transport Research Centre (NTRC) transport statistics estimated that there were nearly 20,000 pickups registered in Pakistan in 1983 which was a doubling in vehicle numbers from 1980 (NTRC, 1984). If the trend in the increase in pickup numbers is similar to that of tractors over recent years then pickup numbers could now be in excess of 80,000.

Tractors - in the late 1960's agricultural production increased rapidly due to improved varieties of rice and wheat, increased use of irrigation tubewells and fertilisers. At this time the use of tractors in agriculture was quite limited, only 8% of land being cultivated by tractors compared to 90% of land being cultivated by bullocks, and the government decided that a mechanisation policy was needed to sustain growth (Finney,1972).

Since then the tractor population has soared. The NTRC estimated that in 1988 there were 232,584 tractors in operation in the country. This represents a doubling in tractor numbers in 5 years. The majority of tractors are domestically produced with Massey Ferguson, Belarus, Ford and Fiat accounting for 97% of the market, ranging in power from 48-63hp (NTRC, 1989). A similar survey conducted by the NTRC found that 29% of tractors were being used solely for transportation purposes and that 67% of tractor owners also owned a trailer. Particular note was made of the emerging industry in trailer manufacture and concern over the excessive use of tractors for transportation purposes (Qureshi, 1990).

Part of the reason for the rapid growth in tractor ownership, and particularly in the use of tractors for transport, is the government's policy on keeping import tariffs on tractors well below those for trucks for example. As part of a recent campaign by the government to make tractors more accessible in rural areas, there is now a scheme which allows the purchase of tractors totally tax free as detailed in Box 8.1.

Box 8. 1 The People's tractor scheme

The People's Tractor Scheme which has been named after Benazir Bhuttos Pakistan People's Party (PPP) started in October 1994 to enable more farmers to be able to buy tractors and stop retailers making excess profits. Tractor manufacturers were invited to forward their tractors for testing on the basis that they could supply them for Rs 150,000 and were in the 50hp bracket. Of the tractors forwarded 2 were accepted - the Belarus MTZ50 and Ursus 2812.

The tractors were offered for sale at Rs 150,000, and the government waived all duties which accounted for Rs 80-90,000 per tractor. Credit was offered through commercial banks and the Agricultural Development Bank of Pakistan. The deposit is Rs 20,000 and the rest will be paid at 30.5% over 10 years. Demand is expected to far outstrip supply.

Independent commentators feel that the PPP are supporting this scheme for political popularity. There is no evidence that there is a shortage of supply in tractor services. The feeling is that many tractors will go to people colluding with bank officials and th t repayments will stop after the initial Rs 20,000. The rest will go to people who could not normally afford a tractor and the resultant over supply of tractor services will mean they will be unable to keep up repayments. There is no need for subsidies on tractor services in Pakistan.

8.4 Vehicle operating costs

Of the five countries studied, Pakistan has probably the widest diversity of vehicles overall and certainly the largest choice of animal modes. It is also true to say that the most reliable data on operating costs and transport charges come from Pakistan.

Vehicle operators were very knowledgeable about all aspects of the operation. They could generally provide fairly detailed information on annual repair costs, routine maintenance costs, tyre costs, fuel consumption rates and annual utilisation. Immaculate care is taken over their vehicles and this is emphasised by the detail they were able to give on the amount and cost of routine maintenance. By most standards their attention to routine maintenance would be regarded as over zealous.

The high levels of vehicle ownership and diversity in rural areas has undoubtedly created a competitive market for transport services. This may account for the detailed knowledge that operators have of their vehicles and explain why utilisation levels are so high.

8.4.1 Pack animal operating costs

All operating costs that refer to animals are calculated in much the same way as for conventional motorised vehicles. The data used in the spreadsheet model is contained in appendix C. Feed costs are substituted for fuel costs and it is assumed that animals have no residual value after their working life. In other words they are not sold for slaughter. For the purposes of this analysis it is also assumed that for animal carts the trailer depreciates at the same rate as the animal.

The most commonly used pack animal is the donkey which is in widespread use in all of the study areas. In the highlands it is useful for steep rocky paths and in the plains for use on narrow paths, particularly in the villages. They are used for carrying ag 'cultural goods, fodder, produce from market, personal belongings, building materials and firewood. They are generally used at the household level as an all purpose transport vehicle. The initial investment to buy one is small, but as figures 8.2 and 8.3 demonstrate they are only the cheapest option to operate when the available load is small and the distance short.

For more commercial activities such as the transport of farm inputs, harvest and building materials on a for hire basis the pack camel and pack mule are the cheaper options. As figures 8.2 and 8.3 show the pack camel is actually the cheapest option at all times. This is because of its very large carrying capacity, 320kg compared with 80kg for the donkey and 120kg for the mule. Despite the camels absolute advantage in cost terms it does not cope with very stony ground or the cold as well as the mule. In addition the mule is more commonly available and inexperienced users of the camel are reluctant to change.

Figure 8.2: Vehicle operating costs at 25 tonnes per year for pack animals

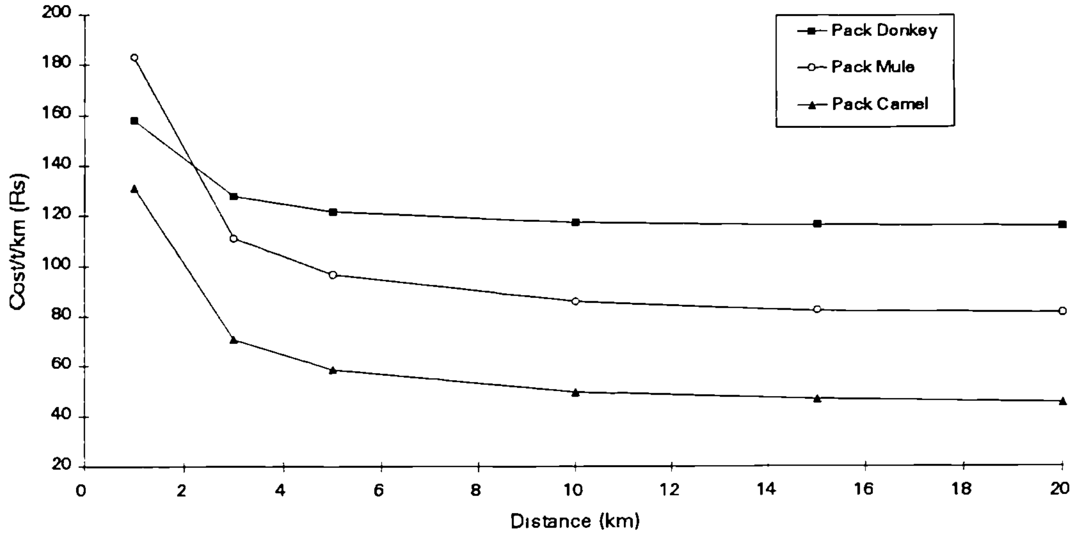
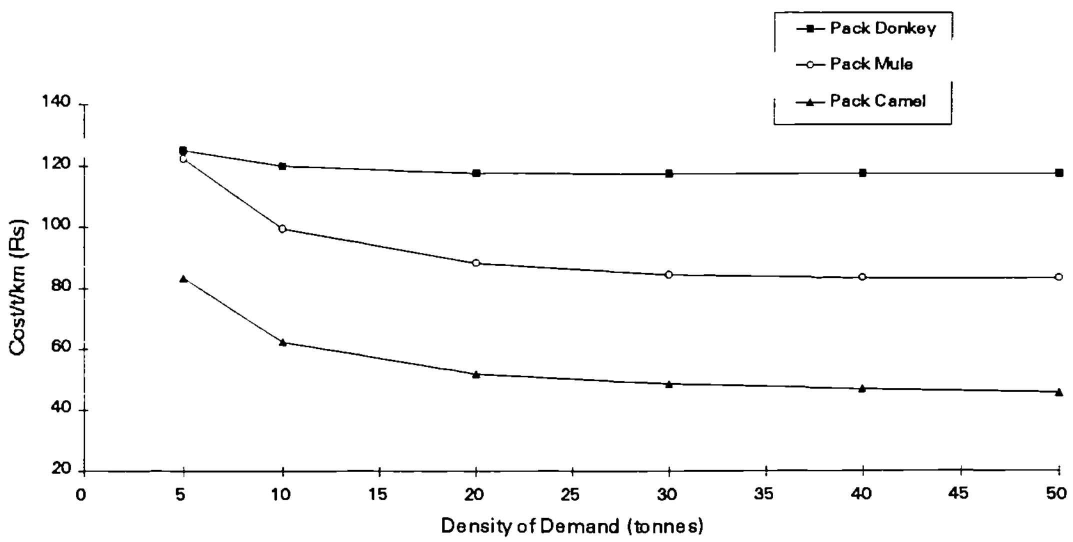


Figure 8.3: Vehicle operating costs for a 10km trip and various levels of demand for pack animals



The camels' remarkable performance as a pack animal means that they are often moved from one agro-climatic zone to another in order to help with the transport of harvest from fields to road side. This was particularly the case in Kalam.

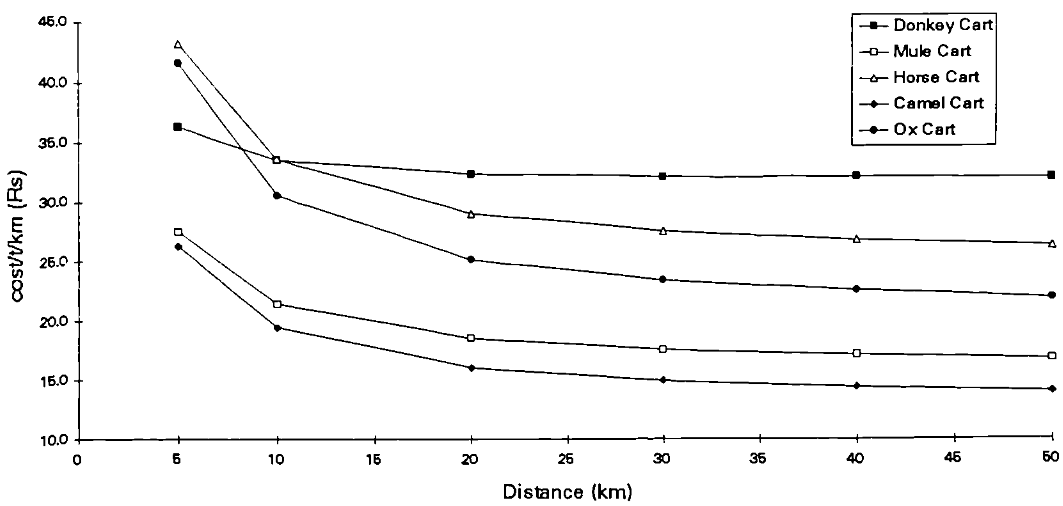
All the pack animals commonly used in Pakistan are very sturdy and need little attention. However due to fairly intensive use of agricultural land, animals are not able to graze freely and therefore feeding can be quite an expensive process.

8.4.2 Animal cart operating costs

As figures 8.4 and 8.5 demonstrate the large load capacity of the mule cart and camel cart make the cheapest to operate in all circumstances. The camel cart in particular has a very low operating cost. However, the use of the camel cart does have infrastructure restrictions which may make it unattractive for certain rural areas, for example it does not perform well on rough or slippery roads.

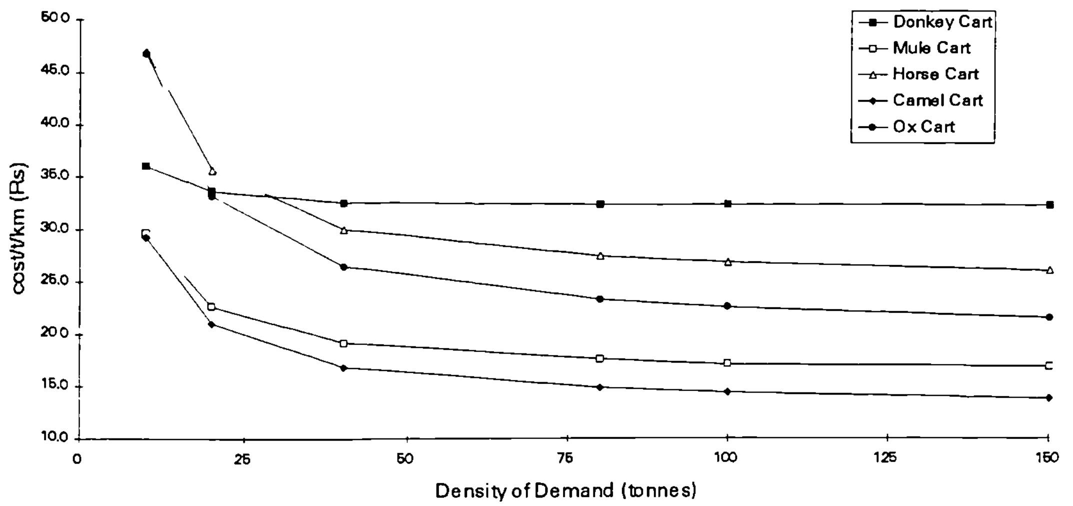
At first glance it is surprising that the mule cart out performs the ox cart particularly at higher levels of demand, this is largely due to high feed costs for oxen (Rs 200 per day for a pair of oxen compared to between Rs 25-50 for the other animals). However the oxen also serve a dual purpose that they can be used for agricultural preparation, and indeed this is probably the main reason for buying oxen.

Figure 8.4: Vehicle operating costs at 50 tonnes per year for animal carts



In figures 8.4 and 8.5 it can also be seen that the donkey cart is cheaper than the ox cart and horse cart for low demand short distance work. For even shorter and lower demand work than that shown in these diagrams the donkey cart would be cheapest vehicle altogether making it ideal for household transport. Of the larger animals the horse cart is the most expensive to operate because of the high purchase costs of the animal and cart. However, the horse cart provides a slightly different role than the other animals because its main advantage is speed and manoeuvrability. People are prepared to pay a premium for these characteristics particularly for the marketing of perishable goods and passenger movement.

Figure 8.5: Vehicle operating costs for a 20km trip and various levels of demand for animal carts



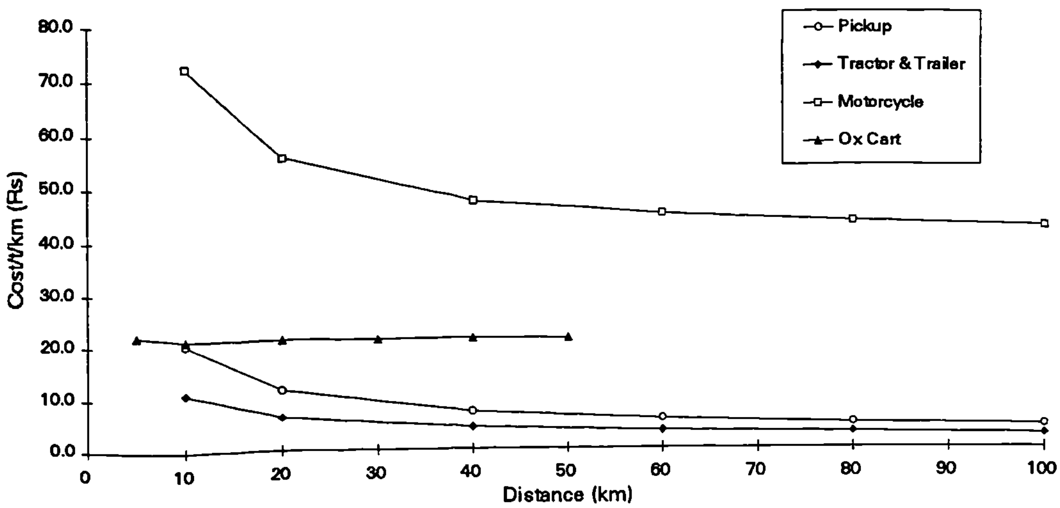
8.4.3 Motorised vehicle operating costs

Motorised transport in the rural areas of Pakistan is dominated by the use of pickup trucks and tractor and trailers. The use of motorcycles is also common for personal use and for the marketing of goods such as milk.

The tractor in particular is in very widespread use in the rural areas and they are very highly utilised, being used for ploughing and transportation purposes. Many tractor owners move regularly from one agro-climatic zone to the next to find work in the coming ploughing or harvest season. Transport activities represent a significant proportion of their time and often the majority of it. One of the reasons for this can be seen from figures 8.6 and 8.7 where it is shown that tractors represent a cheaper transport option than pickups even over relatively long distances.

The main reason for this lies in the subsidies that apply to tractors which make them far cheaper than in other countries. An example of the type of scheme is the "Peoples Tractor Program" which has offered incentives to certain tractor producers to offer their tractors for sale at Rs 150,000 and in return the government will waive all import duties which account for Rs 80-90,000. In addition to this subsidised price there is a credit scheme operating with the Agricultural Development Bank of Pakistan and other commercial banks. Independent commentators feel that the scheme is for political purposes only, that the market for agricultural and transport services is working efficiently and competitively and the introduction of this sort of scheme just imposes unwanted distortions on the market.

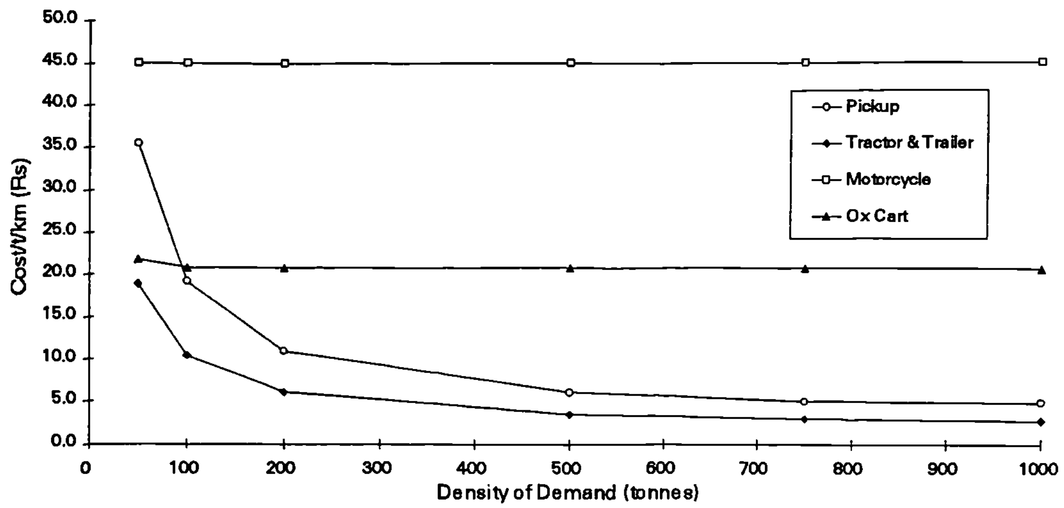
Figure 8.6: Vehicle operating costs at 500 tonnes per year for motorised vehicles



As a result tractors are involved very heavily in the transport market and on routes that are relatively long, up to 100km. They are used for the transport of harvest, produce to market, building materials and any other business that may be available. The tractors are maintained extremely well and the levels of utilisation are high, in the range of 2,000 hours per annum.

In response the pickup is used very much as the horse cart is used in the animal world. It takes advantage of its speed and is used for marketing and the passenger transport. Farmers will hire pickups after harvest and travel hundreds of kilometres around the country to find the best prices for their produce. On a day to day basis they are used to carry passengers to market, deliver farm inputs and perform other activities where time is important. The pickup is used extensively in the highlands of Kalam where they are ideal for travelling long distances between dispersed communities on poor roads to pick up relatively small loads i.e. one farmer's entire harvest.

Figure 8.7: Vehicle operating costs for a 50km trip and various levels of demand for Motorised Vehicles



A new pickup costs in the region of two to three times the amount of a new tractor, hence the unexpectedly poor performance of the pickup over longer distances. Despite the fact that in theory the tractor appears to be a cheaper vehicle over long distances its slow speed often discounts it from this type of activity. As a result the pickup dominates the business from one region to the next. The pickups normally used for rural use are second-hand and informal credit arrangements are entered into either with the previous owners or village elders. Although interest is officially not charged, the interest component will normally be added on to the value of the vehicle.

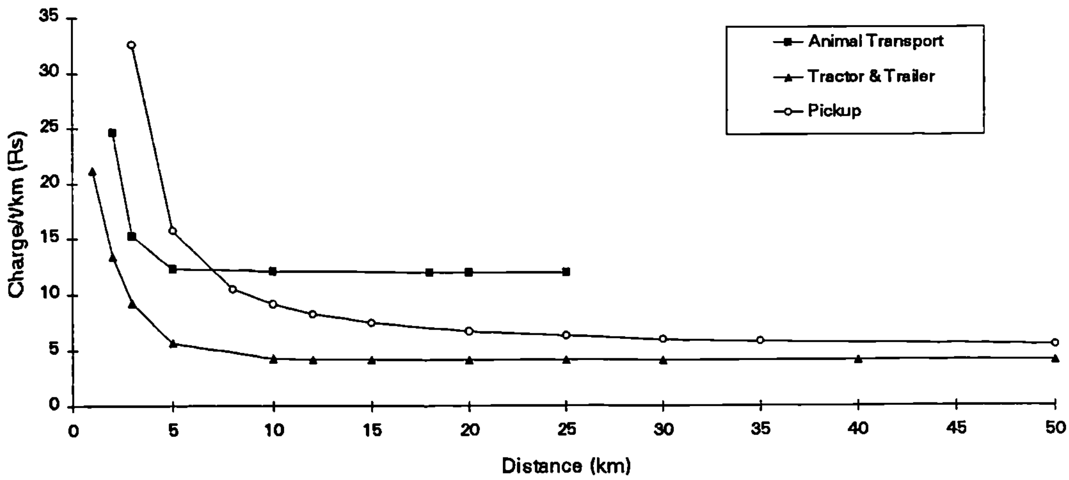
Pakistan also has a very efficient truck industry which is also used during the harvest season. This aspect of rural transport was not covered in this study but work has been done on the freight industry in Pakistan by Rizet and Hine (1993).

8.5 Transport charges

From the data collected on transport charges the results confirm that in terms of the charge per tonne per kilometre the tractor and trailer is the cheapest mode of transport as demonstrated in figure 8.8. For short distances, probably at the village level, animal transport is cheaper than pickups which is also expected. However, as distances increase the pickup becomes substantially cheaper.

The results here are derived from the regression analysis of the tariff data which relates to all areas and all road surface types. It should be noted that operators, particularly of pickups, add a 50-100% premium to prices on rough roads to cover increased repair requirements, demonstrating the effect that road roughness has on vehicle operating costs.

Figure 8.8: Pakistan transport charges



When transport charges are compared directly with the vehicle operating costs generated from the data there are a few discrepancies that need to be explained. For example at 500 tonnes demand, the tractor and pickup charges do not cover vehicle operating costs which would go against everything learnt i.e. that they are very efficient, operating in a competitive market and fully aware of all their costs. However, at a level of 500 tonnes per year both the pickup and tractor are under utilised, and if the demand is raised to 750 tonnes then at all distances operating costs are covered. The experience from the surveys suggests that utilisation levels for all vehicle types is high and therefore the second scenario seems more appropriate.

More interesting is the situation with animal transport charges which are significantly below operating costs. This could be for a number of reasons:

a) Although there is an active market in the trade of animals so that owners have a good idea of their market value, it may be possible that this is not taken into account when charges are calculated. In other words, it may be that only variable costs are being covered. This situation may arise because most animals will be born to existing stock, and owners may therefore be under the impression that they are "free", so the opportunity cost of using these animals is therefore not incorporated.

b) In the analysis of operating costs it is assumed that over their working lives the animals depreciate to zero. In practise this may not be the case. While donkeys, mules and horses will probably have no market value after their useful working life, oxen and camels can be used as meat which in some cases may mean very low depreciation levels. If this is the case then the depreciation element has been over-estimated in the analysis.

c) It is assumed that operator wages are the same as the typical agricultural workers w ges which is Rs 100 per day and Rs 12.5 per hour if an eight hour working day is assumed. In reality the opportunity cost of labour may be significantly below this level because of rural under and unemployment. As animal transport is significantly more labour intensive then motorised equivalents, so an over estimate of labour rates will exaggerate operating costs.

8.6 Factor affecting the provision of rural transport services

8.6.1 Infrastructure

Despite intensive road building since independence, the length of both high and low type roads has increased by over 4 times in this period, Pakistan has the lowest road densities of the countries studied other than Thailand. It has been estimated that only 16 % of villages are on all weather roads and about 20 % have all weather connections with wholesale markets.

Despite the relatively low density of roads the lack of infrastructure, or infrastructure being in poor condition, was not cited as a problem in the supply of transport services. In fact, Pakistan has one of the best rural transport systems studied. The emphasis has been placed more on mobility than roads access. Pack animals are extensively used where there is no vehicle access such as in North Western Frontier Province (NWFP).

8.6.2 Regulation in transport services

There is virtually no regulations regarding rural transportation in Pakistan, and charges are very much based on a supply and demand basis. The market for transportation services is very competitive and there is no shortage of transport facilities. For example, pickup truck operators conduct passenger services alongside the more conventional bus services.

8.6.3 Vehicle backup services

In the larger villages in the Punjab there are vehicle repair workshops for both motorised and non-motorised vehicles which can handle the majority of servicing. In addition the more major roads have a vast array of workshops which normally specialise in certain types of repairs for certain types of vehicle. The mechanics are sk˙ ed and efficient and can provide either reconditioned parts, new locally produced parts or new imported parts. As a result the downtime for vehicles is very low.

In the more remote regions of NWFP the villages are smaller, more remote and have less vehicle ownership. In these areas it is only the major towns, such as Kalam, which have vehicle workshops. However these are generally well equipped and provide for the majority of operators needs. In the villages, the local shop stock just the essential bicycle parts for example.

8.6.4 Routine maintenance

The vehicle operators, motorised or non-motorised, have an excellent knowledge of routine maintenance and take very good care of their vehicles. It could even be said that they are a little over zealous with these activities. Oil changes are very frequent as is the routine cleaning of filters and greasing of bearings etc. Almost every vehicle owner interviewed could give detailed information about their routine maintenance activities.

8.6.5 Local vehicle manufacture

There is a thriving industry in Pakistan producing animal carts and tractor trailers. There does not appear to be industries producing simple motorised vehicles such as in Thailand. This however, would appear to be the next logical step. The craftsmen involved in these industries are very skilled. The "Tanga", a horse drawn cart, is very intricate and can be quite expensive as it is designed for speed, manoeuvrability and comfort.

8.6.6 Marketing and storage facilities

There is a very dynamic marketing system in Pakistan where producers will hire vehicles and travel for hundreds of kilometres to find the best prices. Farmers have the choice of using local markets or larger urban markets. Freedom in the use of markets is a very important component to encouraging the use of transport services whether th y be motorised or non-motorised.

8.6 General impressions of the provision of rural transport services

Rural transport in Pakistan can be characterised by high vehicle ownership, high vehicle diversity and an efficient and competitive provision of transport services. Transport operators have a very good knowledge of their vehicle and know the importance of routine maintenance. A combination of a competitive market and efficient operators mean that vehicle utilisation is very high. This in turn has a downward pressure on prices which makes rural transport services affordable for all.

Most village level rural transport is dominated by the use of pack animals and animal drawn carts. These animals are used intensively and can travel quite long distances with heavy loads. Pickups are also an essential service, particularly for passenger transport. Tractors are used intensively for transport services and are popular for both long and short distance movement.

CHAPTER 9

ANALYSIS OF THE DATA

9.1 Introduction

In the preceding five chapters the characteristics of the supply of rural transport services have been defined for each of the five survey countries. A detailed description has been given of the transport services provided in each of the study areas. The issues covered have included vehicle numbers and diversity; typical distances and demand; vehicle characteristics; the vehicle operating costs (VOC's) and transport charges; and the factors isolated as those which have had a significant contribution to the success or failure of the rural transport system.

This chapter will attempt to draw together the relevant information from each of the case studies in order to develop a picture of the factors which successful rural transport systems have in common. The analysis will initially deal with the quantifiable differences between the transport systems studied, namely VOC's and transport charges. These differences will then be attributed to various factors such as vehicle numbers and diversity, and the ease of access to such factors as markets and storage facilities, credit facilities and extension services.

Finally, these results will be drawn together to develop a strategic model which will a empt to explain the complex relationships between transport charges and the many other factors which contribute to the efficiency of transport systems. This strategic model will then form the basis of the computer programme, an expert system, which is described in chapter 10.

9.2 Assumptions made about exchange rates and inflation

In order to analyse and make meaningful comparisons of the cost and tariff data from each of the countries, it is necessary to adjust them for inflation and exchange rate movements. For the purposes of this analysis the IMF's International Financial Statistics (1995) have been used. Consumer prices have been taken as an indicator of the movement in domestic prices and the domestic currency against the US dollar allows the subsequent conversion into dollars. In this analysis all prices are converted into October 1994 (fourth quarter 1994) prices which is the date of the last survey in Pakistan. The other survey dates were in July 1993 for Thailand, November 1993 for Sri Lanka, February 1994 for Ghana and June 1994 for Zimbabwe. As table 9.1 demonstrates, the movement of domestic prices and exchange rates has been quite pronounced in the African countries studied. By contrast there has been very little price movement in any of the Asian countries studied.

Table 9.1: Key economic data

	Relative Consumer Prices and Exchange Rates										
				1993				1994			
	1990	1991	1992	I	II	III	IV	I	II	III	IV
Price Index											
Thailand	100	106	110	112	114	115	115	117	-	123	124
Sri Lanka	100	112	125	137	137	141	144	154	154	148	149
Pakistan	100	112	122	128	131	136	141	143	148	153	159
Zimbabwe	100	123	175	209	217	228	240	252	269	281	291
Ghana	100	118	130	150	161	167	171	183	195	208	218
Exchange Rate to US$											
Thailand	25.3	25.3	25.5	25.4	25.3	25.2	25.5	25.2	25.0	25.0	25.1
Sri Lanka	40.2	42.6	46.0	47.5	48.5	49.1	49.6	49.1	49.3	49.5	50.0
Pakistan	21.9	24.7	25 7	26.7	27.2	29.9	30.1	30.5	30.6	30.7	30.8
Zimbabwe	2.6	5.1	5.5	6.5	6.5	6.5	6.9	8.0	8.1	8.3	8.4
Ghana	345	391	521	602	602	699	820	935	943	980	1053

Source: International Financial Statistics, International Monetary Fund, April 1995.

9.3 Analysis of vehicle operating costs

It should be noted from the start that collecting VOC data in rural areas is a very difficult task. Most vehicle operators have very little idea of their day to day running costs, although there are always the exceptions to this rule. The most difficult questions to get answers for are those regarding repair costs and annual utilisation. The data from Pakistan are probably the most reliable.

The questionnaire used in the survey to collect VOC's is included in appendix B. The questions were deliberately left open so that the interviewer could ask the questions in the most appropriate ways to get the best possible answers. For example, a single question worded "What are your annual repair costs?" would result in blank stares from all but the most professional operators.

The data from the surveys were initially put on to a database to ease the process of analysis. The data were entered as vehicle purchase price, credit terms, repair costs, maintenance costs, tyre costs, average utilisation in either hours or kms depending on the type of vehicle, and any other data relating to operator wages or taxes etc. The results were then fed into a VOC model which had been created on a spreadsheet. The spreadsheet model allowed an easy way to test different scenarios as well as to compare VOC's for different vehicles. The VOC charts contained in chapter's 4 to 8 were all generated using this spreadsheet model.

9.3.1 Cross country comparisons of vehicle operating costs

Comparison of VOC's for each vehicle studied is not possible because many of them were not in use in all of the study areas. For example, the domestically produced vehicles in Thailand are unique to that country, while it is also rare to find the diversity of animal transport that was found in Pakistan. The most interesting comparisons to be made are for motorised vehicles because they tend to be of a uniform type from one country to the next. It is therefore simpler to pinpoint areas where certain countries have weaknesses which may lead to unduly high VOC's.

Table 9.2 shows the vehicles for which it was possible to make cross country comparisons. The results clearly demonstrate the differences in costs between the Asian countries studied and the African countries. For example, the pickup truck in Ghana has operating costs some 4.5 times the levels in Thailand and 2.8 times those in Pakistan. Similarly the costs of truck operations are up to 10 times higher in Ghana and Zimbabwe than in Pakistan. The same is the case for agricultural vehicles. The cost of tractor operation in Ghana and Zimbabwe is 4.6 times and 2.7 times more expensive respectively than in Pakistan. The cost of power tiller operation in Ghana is around 2.8 times more expensive than in Thailand and Sri Lanka.

Table 9.2: A comparison of vehicle operating costs in October 1994 US dollars

	Thailand	Sri Lanka	Ghana	Zimbabwe	Pakistan
Motorised Transport Vehicles (cents/t/km)					
Pickup Truck	8.7		39.0[1]		13.7
Truck (8-11 tonne)			20.6[1]	21.4	2.1[2]
Agricultural Vehicles (cents/hour)					
Tractor		320	1240	740	270
Power Tiller	123	127	357		
Animal Powered Vehicles (cents/t/km)					
Ox Cart		12.0		50.7	64.2
Donkey Cart				51.1	105.5

Assumptions:
Increase in consumer prices from survey date to October 1994 :-
Thailand 8.7%, Sri Lanka 5.0%, Ghana 47.2%, Zimbabwe 21.7%
Exchange rates at October 1994 :-
US$ 1 = Thai Baht 25.1 = Sri Lankan Rupees 50.0 = Ghanaian Cedis 1053 =
Zim $ 8.4 = Pakistani Rupees 31.0

Although motorised vehicles follow the trend that would be expected, animal based transport shows up an anomaly. As would be expected ox cart transport is over 4 times more expensive in Zimbabwe than in Sri Lanka. However, animal transport in Pakistan is far more expensive than in Zimbabwe. This is probably largely due to higher feed costs and labour costs. These issues will be dealt with in the subsequent analysis.

[1] Data source from Delaquis M (1993). "Vehicle Efficiency and Agricultural Transport in Ghana", MSc Thesis, University of Manitoba.
[2] Data source from Hine J. and A.S. Chilver (1991). "Pakistan's Road Freight Industry: An Overview", TRRL Research Report No. 314, Transport Research Laboratory.

Whilst some of the differences here may be due to the quality of the infrastructure it is unlikely that this is a major factor. In Zimbabwe for example, the rural infrastructure is as good, in terms of road roughness, as in Sri Lanka and Pakistan. It is also apparent that VOC's for agricultural vehicles show the same large differences between the African countries and the Asian countries studied. Agricultural vehicles because of their robust build are unlikely to be as affected by road roughness as conventional vehicles. The key to the differences must therefore lie in the components that make up a vehicle's total operating costs.

9.4 Analysis of vehicle's component costs

In order to better understand the reasons for higher VOC's, particularly for motorised vehicles in Africa, it is necessary to split the total costs into their component parts so that specific areas may be addressed. As far as the wider objectives of this project are concerned, this analysis will also be used to determine appropriate "tags" for criteria within the expert system. For example, if repair costs are more than a certain proportion of total costs this will cause the expert system to prompt the user on factors which may cause this, such as poor routine maintenance. More information on this process is included in chapter 10.

Some clues to the likely causes of high VOC's in the African study areas can be drawn from the case studies in the previous chapter. For example, there appeared to be less attention paid to routine maintenance by operators in the African case studies compared with those in the Asian countries. This is likely to drive up repair costs, increase fuel consumption, increase down times and therefore reduce utilisation. The other major factor which came out of the case studies was the lower levels of utilisation commonly found in the African case studies. Low utilisation increases the burden of interest costs and to some extent depreciation costs as well.

Table 9.3 below sets out for each group of vehicles the percentage contribution of certain cost components. In this table motorcycle technology refers to vehicles such as motorcycles and motor tricycles, and simple motorised vehicles refer to locally manufactured vehicles such as the farm vehicle and power tiller in Thailand. There are quite large differences in the percentage contribution of certain factors, part of this being due to differences in input costs, but part is also due to the efficiency with which vehicles are operated.

Whilst it is expected that motorised VOC's are higher in the African countries studied it is not immediately obvious why animal cart operating costs are so much higher in Pakistan than the other countries. A closer examination reveals that agricultural labour rates in Pakistan are 2.1 times the rates in either Sri Lanka and Zimbabwe. When this is combined with high feed rates in Pakistan this drives up VOC's. In Pakistan labour and feed costs represent around 85% of total animal cart operating costs in comparison to 55% in Sri Lanka and 45% in Zimbabwe.

Table 9.3: Relative contribution of vehicle operating cost components for each vehicle type

	Percentage Contribution								
Cost compon't	Bicycle	Pack animal	Animal cart	Motor-cycle tech.	Simple motorised	Power Tiller	Tractor	Pickup	Truck
Fuel	0	0-57	0-66	15-62	21-31	12-39	11-37	21-46	10-30
Maint.	1		1-5	10-17	4-7	2-4	3-12	7-9	<2
Repairs	17		3-18	3-16	4-9	4-24	5-13	8-10	10-30
Tyres	17		4-12	2-17	3-4	2-3	10-20	3-12	5-15
Wages	58	36-95	14-52	6-11	7-21	4-21	1-15	5	5-50
Deprec.	3	2-6	4-14	8-33	26-29	19-33	11-33	17-24	10-40
Interest	3	0.5-4	2-20	4-25	14-15	10-18	9-26	13-19	5-20

It is apparent from the large differences in motorised operating costs between countries that there is a large gap in the performance of vehicles. To ascertain the effect that v ious factors have on total operating costs, the components of the VOC will be dealt with in turn as described below.

9.4.1 Repair costs

Of the data collected on VOC's the repairs component was one of the most difficult, as most respondents had very little idea on their total annual repair bills. However, their degree of knowledge varied from country to country with Pakistan being the best. The questionnaire was split into the main components of a vehicle that needed repair so that the interviewer could prompt the operator for particular information. In this way most of the large repair costs such as engine overhauls and transmission problems were picked up. The respondent was always asked to give the cost of repairs in present day prices but this was not always possible and some repair costs had to be adjusted for inflation. Overall it is fair to say that most operators probably underestimated their true repair costs but it would be impossible to assess the extent of this.

As expected there are large differences in the contribution made by repair costs to total costs as can be seen from table 9.3 and generally the higher values relate to the African countries. However, in the above analysis it is impossible to disentangle the effects that different input prices between countries may have on the percentage contribution of repair costs.

There is variation in the first vehicle price, fuel costs and labour rates which complicates the analysis. Therefore to confirm that repair costs did in fact represent a higher proportion of total costs in Africa compared to Asia a separate analysis was conducted where vehicle costs, labour rates and fuel costs were kept constant between countries and then all prices converted to 1994 US dollars (the analysis is included in appendix D). This analysis was conducted for the pickup truck, tractor and power tiller. According to these results, repair costs as a percentage of total costs were between 6.9 and 15.7 times higher in Ghana than for the lowest values found in the Asian countries as can be seen from table 9.4. However, the difference in the percentage contribution of repair costs between Africa and Asia may in part reflect the differences in the price of spare parts as well as in their consumption.

Table 9.4: Ratio of repair costs to the lowest value for each vehicle class

	Thailand	Sri Lanka	Pakistan	Zimbabwe	Ghana
Pickup	1.0	-	2.0	-	6.9
Tractor	-	1.0	1.2	5.6	7.9
Power Tiller	1	2.4	-	-	15.7

Although the vehicle fleet is older on average in the African countries than the Asian countries and therefore repair costs would be expected to be higher, this cannot account for all the difference. In fact the true level of repairs is masked by the higher contribution of interest and depreciation costs due to low utilisation. These differences point to serious deficiencies in vehicle backup services and routine maintenance, both of which are referred to in the case studies as weak areas in the African countries.

9.4.3 Routine maintenance

Routine maintenance is the day to day activities which must be undertaken on a vehicle to arrest the premature wearing of moving parts. These include checking or changing the engine oil; cleaning or replacing oil, air or fuel filters; greasing bearings, shock absorbers and springs; and the general day to day care of a vehicle.

The care with which operators look after their vehicles is obviously going to have a large impact on the total repair bill. This is supported by the data; in general routine maintenance accounts for a much smaller proportion of the total repair bill in the African countries studied than in the Asian countries. In fact in many of the Asian countries the proportion of routine maintenance to total costs is the same or higher as for repairs to total costs. In table 9.5 the proportion of routine maintenance in the total of repairs and routine maintenance is shown. In the analysis factor prices are kept constant as in section 9.4.2. It can be seen that in the African countries the proportion is far lower to an extreme of only 8.6% for the power tiller in Ghana.

Table 9.5: Routine maintenance as a percentage of repairs plus routine maintenance

	Thailand	Sri Lanka	Pakistan	Zimbabwe	Ghana
Pickup	46.2	-	48.1	-	-
Tractor	-	43.3	61.5	26.7	18.7
Power Tiller	50.0	22.6	-	-	8.6

The lower emphasis placed on routine maintenance by operators in the African countries is demonstrated by these results. This substantiates an impression developed during the surveys that, generally speaking, the Asian operators had far better knowledge of their vehicles and of the importance of routine maintenance in keeping down total repair bills. The section dedicated to routine maintenance in the vehicle questionnaire was particularly easy to complete in countries such as Pakistan and was almost impossible to complete in Ghana. There was also a feeling in the African countries that where operators did give information on routine maintenance it was quoted verbatim from the vehicle manual.

Although the analysis did not include the break down of repairs into different types, the surveys did produce anecdotal information to support the idea that the lack of routine maintenance has a large impact on repair costs. For example, in the tractorisation project on the Afram plains in Ghana where there was very poor routine maintenance, engine overhauls were being conducted every 2-3 years. By contrast, in Pakistan where routine maintenance is conducted a little too over-zealously, engine overhauls were only undertaken every 5-10 years.

9.4.4 Fuel consumption

Of all the cost components the fuel consumption level is easiest to compare between countries. Although the price of fuel varies greatly between one country and the next, the efficiency of a vehicle can be partly determined by the litres of diesel consumed per hour or kilometre. Table 9.6 shows the fuel consumption for the various comparable vehicles. It is clear that Ghana has fuel consumption rates that are far higher than the other countries studied. For example, the pickup and power tiller in Ghana have rates that are 4 times greater than in Thailand and the tractor has a rate that ranges from 1.6 times greater than that in Pakistan to 3.2 times greater than that in Sri Lanka.

Table 9.6: Levels of fuel consumption in either litres per kilometre or litres per hour

	Thailand	Sri Lanka	Pakistan	Zimbabwe	Ghana
Pickup Litres/km	0.09	-	0.14	-	0.39
Tractor Litres/hour	-	2.5	5	3	8
Power Tiller Litres/hour	0.6	0.6	-	-	2.5

There are a number of factors which can cause fuel consumption to increase which include steep gradients, roads with high roughness, high running speeds and old or poorly maintained engines. The gradients and running speeds are roughly equivalent in all of the study areas (Kalam in Pakistan and the Kandy district in Sri Lanka had the steepest gradients) but road roughness and the number of old or poorly maintained engines are higher in the Ghanaian study areas. Therefore high fuel consumption again points to lack of routine maintenance and operator inefficiency as well as poor infrastructure.

Table 9.3 also points to the potential importance of feed costs in the operation of animal based modes of transport. For example, in Pakistan feed costs represented the overwhelming proportion of total operating costs, 57% for pack animals and 66% for animal carts. These high feed costs point to intensive land use leading to the inability of animals to graze freely, but also to the intensive usage of animals for draught purposes and the consequent high energy requirements. In Thailand, the intensity of agricultural production has increased to such an extent that the costs associated with keeping animals outweigh the costs of mechanisation i.e. there is a substitution effect. Conversely, Zimbabwe has a fairly extensive form of agriculture where there are no land pressures and animals can graze freely. As such costs associated with feed are zero or negligible.

9.4.5 Vehicle utilisation

It is important to collect accurate vehicle utilisation data for two reasons. Firstly, information on the number of kilometres travelled or hours worked per year is necessary to calculate vehicle operating costs. The higher the level of utilisation the less will be the burden of depreciation and interest repayments. Secondly, the level of vehicle utilisation is a good indicator of the efficiency with which the vehicle is being operated and the competitiveness of the transport environment in which it operates. Where operators are actively seeking new opportunities and keeping utilisation rates high, the marginal costs of operation are kept to a minimum and this translates to lower (or the potential for lower) transport charges.

H wever, collecting accurate information on actual vehicle utilisation levels in rural areas is difficult because vehicles are often old and rarely have functional meters to record kilometres travelled or hours worked. Despite this problem, it was possible to collect information on the trips made in the average week for transport vehicles and hours worked for different seasons for agricultural vehicles.

It was very apparent from the data and field observation that the Asian countries had far higher levels of vehicle utilisation than the African countries. In the Asian countries vehicle operators would often travel hundreds of kilometres to find new opportunities. In contrast, African utilisation was lower and very seasonal particularly for the agricultural vehicles. Transport unions and marketing boards had a substantial impact on the utilisation of transport vehicles. In Sanyati for example, trucks were having to wait up to 10 days during the peak harvesting season to unload at marketing boards. Trucks have been known to wait up to 2 weeks at lorry parks in Ghana waiting for loads.

Table 9.7: Levels of utilisation for various vehicles between countries

	Thailand	Sri Lanka	Pakistan	Zimbabwe	Ghana
Pickup (kms/year)	61,308	-	44,260	-	29,000
Tractor (hours/year)	-	1,440	1,900	750	800
Power Tiller (hours/year)	500	740	-	-	400
Ox Cart (hours/year)	-	875	1,938	400	-
Donkey cart (kms/year)	-	-	4,617	1,600	-

Table 9.7 shows the levels of vehicle utilisation for various modes between countries. There is a significant difference between utilisation in Africa and Asia. For example, the survey found that pickups in Thailand were travelling on average 61,000 kilometres per year compared to 29,000 kilometres in Ghana. The same was the case for tractors. In Zimbabwe and Ghana utilisation levels were around 800 hours per year compared to 1400 hours in Sri Lanka and 1900 hours in Pakistan. There are also similar differences in animal based transport. The ox cart operates for over 4 times the number of hours in Pakistan than in Zimbabwe.

9.4.6 Wage costs

Wage costs make up a significant proportion of total costs particularly for human and animal powered vehicles, and for motorised vehicles in the higher wage economies. For example, wage costs account for 95% of total costs in pack donkey operation in Zimbabwe where the only other costs are depreciation and interest. Even in Asian countries where fodder costs are very high the wages cost still accounts for around 50% of total costs. For most motorised vehicles in low wage economies, labour costs do not represent a significant proportion of total costs.

The calculations of vehicle operating costs assumed that the labour rate used per hour of vehicle operation was equivalent to an eighth of the daily agricultural wage rate in the country concerned. There are problems using this method because the figure does not always represent the true opportunity cost of labour. For example, a women using pack donkeys in Zimbabwe to transport maize to the grinding mill has an opportunity cost of labour far below the daily agricultural wage. There is high rural under and unemployment which would preclude the women from finding work at this rate of pay. However, in the Asian countries where in many cases there may even be labour shortages, this figure may be quite representative.

Although this study has not looked in detail at the opportunity cost of labour in calculating operating costs it is obviously a factor that should be considered in examining issues of vehicle choice. It is particularly relevant for labour intensive modes of transport such as animal and human powered modes. Where the (opportunity) cost of labour is low there should be more emphasis on animal and human powered vehicles. Where labour rates are increasing and labour shortage becomes an issue, a policy to encourage the use of more sophisticated modes of transport such as the simple motorised vehicles described in Thailand may be more appropriate.

9.4.7 Tyre costs

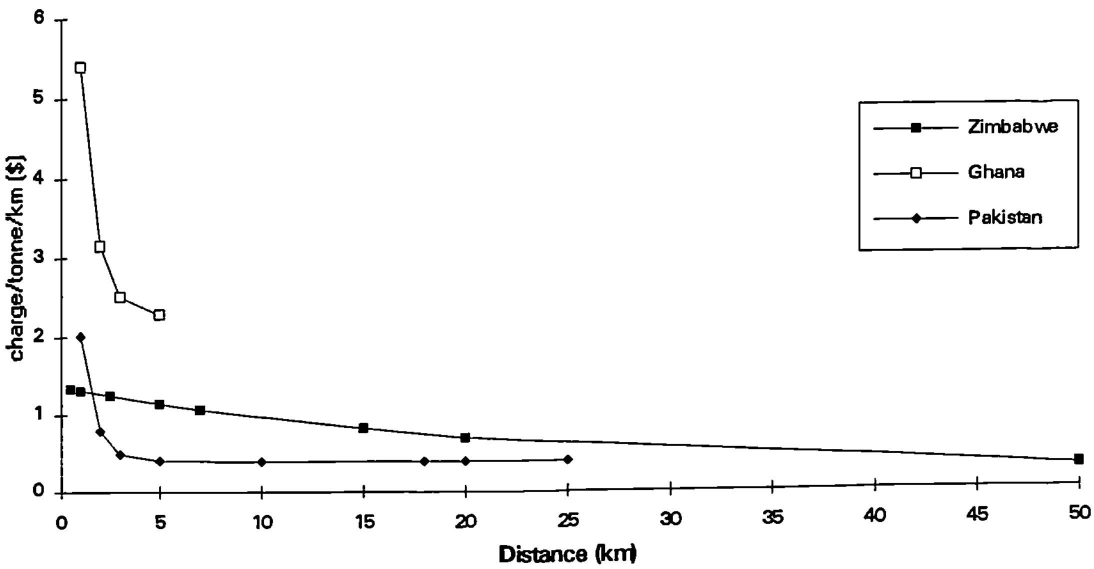
The differences in tyre costs between countries due to taxation accounts for a substantial difference in the proportion of tyre costs in total costs. Differences in operator performance probably make very little difference except where there is excessive overloading or high speed driving. Poor road conditions are likely to make more of a difference.

9.5 Rural transport charges

As discussed in chapter 2, previous research has shown that freight transport charges in many African countries are higher than those in many Asian countries. The causes for this were attributed to higher VOC's combined with, or as a result of, inefficient transport markets. The data presented here verifies these findings for the movement of goods, agricultural or subsistence, in rural areas. Transport charges for the African countries studied are significantly above those for the Asian countries.

The transport charge data collected from the five survey sites have been adjusted for inflation and exchange rate movements as described in section 9.2 and smoothed to produce the curves in figures 9.1 and 9.2. Figure 9.1 presents data from Zimbabwe, Ghana and Pakistan for various non-motorised modes of transport. The data from Zimbabwe and Pakistan are mainly animal carts where typical loads are anywhere between 500 kg and one tonne, while the data from Ghana is for headloading where loads are in the range of 20 to 40 kg. It is clear that transport charges in the African countries are substantially higher, and this is particularly the case in Ghana.

Figure 9.1: Transport charge curves for non-motorised modes of transport



Although making cross country comparisons can be difficult, it is a worthwhile exercise because the differences in transport charges are so large that it points to major deficiencies in many African transport systems. Table 9.8 presents the data where an attempt has been made to compare the relative costs of transport to rural communities between countries. Domestic transport charges have been converted to US dollars and also taken as a proportion of the transport charge per kilogram of rice at domestic prices. In order to quantify the extent of the differences in transport charges, Pakistan was taken as the base case and each country's transport charge taken as a percentage higher or lower than that.

It was decided to include the domestic transport charge as a proportion of the domestic price of rice as well as the relative transport charges in US dollar terms so as to provide another backup indicator. Rice was chosen as the product with which to make comparisons because it is the staple food in Thailand, Sri Lanka and Pakistan, and is freely available and commonly used in Ghana and Zimbabwe. The other alternative would have been maize but although this is the staple food in Ghana and Zimbabwe it is not commonly eaten in the Asian countries studied. Therefore there may be a case for arguing that this measure may make the African transport charges appear slightly more attractive.

Table 9.8 shows that in dollar terms the cost of transport (charge per tonne per kilometre) in Zimbabwe is just under three times more expensive for a 5km trip and just under twice as expensive for a 20km trip than the equivalent trip in Pakistan. However, in Ghana this difference rises to nearly six times. The transport charge as a proportion of rice is less clear cut in the Zimbabwe case falling from double the Pakistan level at 5km to only 20 per cent greater at 20km.

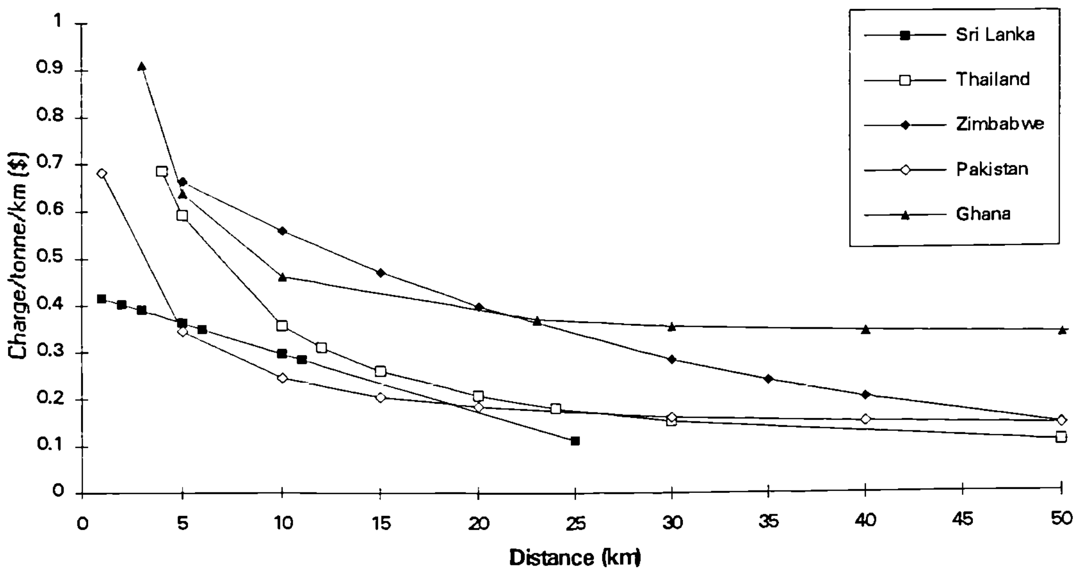
Table 9.8: The relative cost of transport for non-motorised modes of transport in US dollar terms, and as a proportion of the transport charge per kilogram of rice.

Trip Distance	5 Km		10 Km		20 Km	
	$	Rice	$	Rice	$	Rice
P kistan	100	100	100	100	100	100
Zimbabwe	280	190	240	160	180	120
Ghana	580	540	-	-	-	-

Similar trends are apparent when transport costs for motorised vehicles are compared. The African countries again have higher transport charges than in the Asian examples as can be seen in figure 9.2. The vehicles in the survey were mainly those predominantly operating in rural areas, for example tractors, power tillers, pickups and a few trucks. Typical loads for these vehicles are in the range of one to five tonnes depending on the country and road conditions. If the data are further classified into vehicle types, it is found that the larger vehicles have lower transport charges, but the general trend remains.

In table 9.9 where Pakistan is again taken as the base, the African countries have transport charges which are generally between two and two and a half times more expensive than in Pakistan in dollar terms. However as distance increases in Zimbabwe the ratios narrow. Costs as a proportion of the transport charge per kilogram of rice confirm these conclusions. Zimbabwe, as in the non-motorised case above, probably has a relatively higher price of rice than the Asian countries, leading to lower than expected difference in charges.

Figure 9.2: Transport charge curves for motorised modes of transport



Thailand which at first glance would appear to have the most efficient rural transport system has higher than expected values both in dollar terms and with respect to the price of rice. This may in part be due to the way transport charges are made in the study area. For example, there is a flat rate for the transport of paddy within the district irrespective of the distance or vehicle type, thereby making short distance trips very expensive. Thailand also has a GNP per capita of over three times that of the next richest country in the survey, possibly meaning that the labour component in total costs account for some of this difference.

The general conclusions that can be drawn from these results are that the African countries have transport charges for relatively short haul trips in rural areas of at least double those of their Asian counter parts. It is also apparent that Zimbabwe has a significant advantage over Ghana particularly when non-motorised modes of transport are considered, which is the category that most affects rural communities.

It is very difficult to identify precisely the reasons for the large discrepancies in transport charges between countries. In section 9.4 it is shown that there are large differences in VOC's which undoubtedly contribute to higher transport charges. One of the factors isolated for higher VOC's in the African countries was poor routine maintenance, but this could be due to less knowledge on vehicle operation, less competitive transport markets or purely due to cultural differences. However, analysis of the survey data has pointed to some issues that it is considered go a long way to explaining differences in transport charges. Primarily, the lack of vehicle choice leads to shortages in the supply of vehicle services and reduces competition in the transport market.

Table 9.9: The relative cost of transport for motorised modes of transport in US dollar terms, and as a proportion of the transport charge per kilogram of rice.

Trip Distance	10 Km		25 Km		50 Km	
	$	Rice	$	Rice	$	Rice
Pakistan	100	100	100	100	100	100
Sri Lanka	120	110	65	60		
Thailand	140	190	106	130	80	100
Zimbabwe	220	150	200	130	100	70
Ghana	180	170	220	190	240	220

A combination of low vehicle numbers and poor vehicle diversity in the African survey areas is the catalyst for many of the problems associated with inefficient transport markets. The following section will deal with the factors resulting from poor vehicle choice as well as those which have led to poor vehicle choice in the first place.

9.6 Evidence on vehicle choice

Two measures can be used to determine the truth of the impression gained from the case studies that there is poor vehicle choice in Africa. They are the level of vehicle diversity and the level of vehicle ownership in rural communities. The findings support the observations from the case studies. The level of vehicle diversity and ownership in the African countries studied are far below those found in the Asian countries.

9.6.1 Vehicle diversity

What was immediately obvious from the case studies was the lack of vehicle diversity in the African countries studied in comparison with the Asian countries. Apart from in Thailand where animal transport had largely been superseded by motorised modes, the other Asian countries had far greater choice with regard both to motorised and non-motorised vehicles.

In most of the Asian rural communities surveyed the population had access, whether through ownership or hire, to a wide choice of vehicles. These ranged from bicycles, pack animals, animal carts, motorcycle technology and simple motorised vehicles, to tractor based vehicles and conventional vehicles. By contrast, Ghana in particular suffered from virtually no vehicle diversity. Many villages were totally reliant on headloading for their day to day transport needs, with infrequent access to tractors and mammy wagons owned by urban based traders. The use of intermediate modes of transport was virtually non-existent. In Zimbabwe the situation was better with some households having access to wheelbarrows and animal transport. However, although some areas had access to a good diversity of vehicles there were others in exactly the same situation as in Ghana. Table 9.10 lists the different rural transport vehicles that were encountered in the field trips and for each country the vehicles are marked as to whether they are commonly available, available in only certain areas or not available at all.

Table 9.10: The degree of vehicle diversity for each survey site

Vehicle	Thailand	Sri Lanka	Ghana	Zimbabwe	Pakistan
Shoulder pole/ Back pack	XX	O	O	O	X
Hand cart/ Wheelbarrow	X	XX	X	X	XX
Bicycle	XX	XX	X	X	XX
Pack animals	X	O	O	X	XX
Animal carts	X	XX	O	XX	XX
Motorcycle technology	XX	XX	O	X	XX
Simple locally manufactured motorised vehicles	XX	O	O	O	O
Power tiller & Trailer	XX	XX	X	O	O
Tractor & Trailer	XX	XX	X	X	XX
Pickup	XX	X	X	X	XX
Trucks	XX	XX	XX	XX	XX
Diversity Measure	19	15	7	10	17

0 = Not available X = Not widely available XX = Available widely

In order to make meaningful comparisons about the degree of vehicle diversity between countries a simple measure has been developed. For each vehicle category a score is attributed - 0 = not available, 1 = not widely available and 2 = available widely. From the experience of the surveys any country with a diversity measure of below 10 has a serious problem and should examine ways of introducing new modes or making existing modes more available.

The table shows that Thailand has good availability of vehicles at all technology levels. In contrast Ghana has large gaps in vehicle availability particularly at the lower technology sector of the market. Although Zimbabwe does not have universal availability of lower technology options it is a feature that is becoming increasingly widespread. Perhaps more emphasis should now be placed on motorcycle technology and simple motorised vehicles. Locally manufactured simple motorised vehicles are unique to Thailand but would appear to provide the ideal stepping stone from non-motorised vehicles to the considerably more expensive conventional motorised vehicles. In a country such as Pakistan where intermediate modes of transport and motorcycle technology are widespread the introduction of simple motorised modes may ease the large step to conventional motorised vehicles.

9.6.2 Vehicle ownership levels

Although vehicle ownership levels vary from village to village within a country the overall trend is that ownership levels are far higher in the Asian countries studied than in the African ones. Table 9.11 shows the population per vehicle type of a representative village in each of the survey countries. It is clear that even for non-motorised vehicles the African countries lag far behind those in Asia. For example, Sri Lanka has nearly 4 times the number of non-motorised vehicles per head of population than in Zimbabwe and nearly 14 times more than in Ghana even though their income levels are broadly comparable. The situation for motorised vehicles is even more pronounced with Sri Lanka having over 5 times the number of Zimbabwe. A representative village in Ghana would have no motorised vehicles at all.

Table 9.11: Population per vehicle type for a representative village in each of the survey sites.

Vehicle Type	Thailand	Sri Lanka	Pakistan	Zimbabwe	Ghana
Non-Motorised	3.6	7.2	12.7	27.3	100
Motorised	3.0	58.3	62.5	300	-

Given the low levels of vehicle ownership and low vehicle diversity in Africa the question is whether there are any lessons to be learnt from the criteria that affect a person's choice of vehicle in Asia. It is also important to know whether low vehicle ownership and diversity affects the efficiency of rural transport in Africa.

9.7 Factors influencing vehicle choice

This section will deal with the results from the PRA surveys (as detailed in chapter 3) conducted in the five countries. It will detail the conclusions drawn from the various group exercises undertaken with the farmers together with the views of key informants and observations from the author. The two key survey techniques of interest here are the vehicle matrixes and the historical time trend analysis. In these exercises the farmers themselves identify the key criteria in vehicle choice and the basis of the decisions made in determining vehicle choice.

Vehicle matrixes - formal group sessions were conducted in Thailand and Sri Lanka to ascertain whether there were certain factors that had over-riding importance in a rural person's choice of vehicle. For each vehicle available in the study area the respondents were asked to judge which vehicle best fitted the criteria such as low cost of vehicle, load capacity and speed. These criteria were decided upon with reference to the study areas and the criteria which the respondents themselves suggested were important. In addition to judging each vehicle against a set of criteria the respondents were also asked to decide on the most important criteria. The most popular responses to this exercise are ranked below.

1) Low cost of vehicle
2) Diversity of use/ Multi-purpose
=3) Performance in the field
=3) Ease of repair and maintenance
- 5) Income generation
=5) Low cost of spares and repairs
=5) Vehicle durability
=8) Fuel costs
=8) Depreciation

These responses suggest that the cost of the vehicle is the over-riding factor which dictates the choice of vehicle. This is as expected and would explain why in poorer areas vehicle numbers and diversity is lower. The other major factors are diversity of use and performance in the field suggesting that people in rural areas who are most likely to derive their incomes from agriculture buy a vehicle primarily for it capability in the field. Its transport performance is therefore secondary but still valued highly. The other criteria that has been picked up relate to the other major cost components of the vehicle and ways that they can be reduced, such as the cost of spares and repairs, the ease of repair and maintenance and vehicle durability. As can be seen from table 9.3, fuel costs and depreciation also account for a significant proportion of total costs.

The criteria that were not regarded as important are factors such as load capacity, speed and the ability to cope with rough roads. Credit was not an issue but by the nature of the people who helped with the exercise, i.e. vehicle owners, they were the ones who managed to get credit.

Historical time trend analysis - another useful method in determining the factors which led to the introduction of certain technologies is through asking older members of the community to detail the development of the village. Of particular interest is the reasons why they changed from one vehicle mode to the next. Facts about the development of the village and the introduction of new technologies are interspersed with information about their family life. For example, in this way a respondent can say whether the introduction of a certain vehicle occurred before or after the birth of their first child.

The major factors which came out of this analysis were that the introduction in particular of motorised vehicles came at about the same time as the building of roads to and within the villages. The building of roads was a common theme that ran through all the interviews with older members of the community. They definitely linked the development of their village with the building of new roads.

Another common theme was that the purchase of vehicles was usually done with the sale of their previous mode, i.e. animals if they were converting to a power tiller, combined with the sale of their harvest and savings. In many instances the purchase of the vehicle occurred in a year when the price of rice was high.

A need for increased capacity was also noted as an important factor. In one village the respondent referred to the chopping down of the forest both by the villagers and the government to make way for new agricultural land. He said that this necessitated the purchase of a vehicle with increased capacity. A buffalo can cultivate a 1/4 of a rai per day, compared with 1/2 a rai for a cow and 4 rai for a power tiller. In another village the respondent noted that when the road was built (roughly around the same time as the trees were cut down) that rainfall started falling off. As a result he needed to pump ground water in order to irrigate his land. As draught animal power could not do this he was forced to purchase a power tiller. In finding out about the potential of new technologies most farmers relied on their neighbours. If neighbours successfully operated new technology then the rest of the village was likely to follow. Very few people are likely to take the risk themselves.

The results from these surveys together with the observations made by the author have allowed the formulation of a set of key factors which influence vehicle choice in rural areas of developing countries.

9.7.1 Density of demand

The demand for transport is a derived demand, in that if the quantity of inputs and outputs are high then transport vehicles will be needed to transport them. Table 9.12 shows the approximate yields per hectare for some of the major crop types in each of the respective countries. The yields in Asia are substantially higher than in Africa which suggests that the form of agriculture is more intensive. The cropping patterns illustrated in box 4.1 graphically demonstrates that in Thailand the agriculture is high input and high output. In Thailand there is high demand for the transport of fertilisers, sprays and harvested crops. The converse is true in Ghana and Zimbabwe where agriculture tends to be low input, low output.

Table 9.12: Typical yields for maize and paddy in tonnes per hectare

	Thailand	Sri Lanka	Ghana	Zimbabwe	Pakistan
Rice	18.6	9.2		-	8.1
Maize	7.9	-	2.5	1.8	

In addition to agricultural produce there is also the transport of building materials, and household goods such as firewood and water. In the Asian case studies there was also much more local industry which required transport services. As a result farmers hired their vehicles for this purpose, whereas in Africa rural industries were not as common.

Table 9.13 illustrates how the density of demand affects vehicle choice for typical rural trips of 10 kms. The table has been constructed by noting the density of demand at which the VOC curve for one vehicle crosses that of another (see the figures in the vehicle operating cost sections in each of the case studies). Vehicles were taken from what were regarded as representative countries and their VOC's converted to US dollars to ease comparison. The values presented enable a guideline to be generated showing the likely demands at which one vehicle will become more efficient than the next. The VOC's for each vehicle were based on 100% utilisation.

The table shows that as the density of demand increases, vehicles with higher payloads and speeds become more cost effective. For example, for all 10 km trips where there is an annual demand of less than 2 tonne kilometres headloading is always the cheapest mode of transport. In a country like Ghana where in many villages the only choice is between headloading and the use of trucks it can be seen that headloading would remain the cheapest mode of transport until about 860 tonne kilometres. This goes some way in explaining the prevalence of headloading in Ghana. The table shows that in comparison to headloading other forms of non motorised vehicles such as the bicycle or pack donkey quickly become more attractive than headloading.

Table 9.13: A table giving the tonne kilometres required to give equivalent operating costs for each paired comparison of different vehicle types

	H	B	PD	PM	PC	DC	MC	HC	CC	OC	M	MT	PT	FV	P	T	TR
Headloading (H)	~	2	9	34	21	10	31	48	37	49	60	50	75	155	410	390	860
Bicycle (B)		~			210	140	150	500	150	260		200	300	540	1750	1700	3450
Pack Donkey (PD)			~	91	45	13	49	100	58	98	90	80	100	250	720	700	2650
Pack Mule (PM)				~			19	120	40	100	50	45	80	390	1000	950	2450
Pack Camel (PC)					~	320	85		110	310		180	360	690	2150	1950	4500
Donkey Cart (DC)						~	140	2250	170	310		95	355	670	2150	1900	4400
Mule Cart (MC)							~		280	2500			570	1350	4250	3700	7800
Horse Cart (HC)								~		90	100		210	550	2050	1900	4400
Camel Cart (CC)									~		25	48	680	1500	5250	4500	9400
Ox Cart (OC)										~	90	650	350	1250	4700	4000	8600
Motorcycle (M)											~	20	150	330	970	920	2250
Motor Tricycle (MT)												~	450	1050	3450	2900	6600
Power Tiller (PT)													~	5200		12500	21500
Farm Vehicle (FV)														~			
Pickup (P)															~		15500
Tractor (T)																~	
Truck (TR)																	~

In section 9.6 the obvious gaps in the diversity of vehicles within particular countries was discussed. In table 9.10 it can be clearly seen how the non motorised vehicles which constitute the middle of the table provide the necessary stages from the simplest vehicles to the most complicated. Without the donkey cart and ox cart for example, the jump from a bicycle to even the simplest form of motorised vehicles may be insurmountable.

Looking at the other end of the scale there are some interesting findings for agricultural vehicles versus conventional motorised vehicles. At these relatively short distances, agricultural vehicles are invariably the cheapest option, as at no point does the speed advantages associated with the pickup and truck outweigh the good payloads and comparative cheapness of tractor based technology. For example, the pickup is never a cheaper option than either the tractor or power tiller and the tractor is always cheaper than both the pickup and truck. The simple technology associated with the farm vehicle is particularly effective, and at no point does the pickup, tractor or truck become a more attractive option.

9.7.2 Marketing and storage facilities

The presence of markets and storage facilities play an important role in affecting choice of vehicle. Markets and storage facilities both provide the same role of acting as a place where agricultural produce can be amalgamated. This may be for the purpose of immediate sale or for transportation to the next destination. Access to markets and storage facilities therefore affect vehicle choice in two main ways.

Firstly, the ease of access to these facilities, whether in terms of distance or ability to use the facilities, will dictate the farmer's decision on which vehicle to use. For example, if the storage facility is close he/she may decide to buy a non-motorised vehicle which would have been of no use if the facility was beyond a certain distance. Similarly, if once the farmer had reached the facility he was unable to use it either because of its expense or because of exclusionist type practises, the need for a vehicle becomes redundant, and the farmer's produce may as well be sold to the village trader. The farmer will only demand a more advanced vehicle if it is the perception that the vehicle will enable an effective increase in farm gate prices.

Secondly, where goods are amalgamated it means that the density of demand for vehicle services increases. As described in section 9.7.1 the density of demand is of vital importance in determining vehicle choice. The larger the demand the more an efficient and cost effective vehicle can be justified and hence the unitary costs of transport are reduced. The existence of markets and storage facilities are important at any level. For example, at the village level a small grain store may be able to accumulate enough demand from all the farmers to justify the use of a donkey cart for transportation to market. Without the store individual farmers may only be able to justify headloading their surplus produce to market. Similarly, at the district level a market could attract city traders who bring large trucks to transport the produce bought at the market in bulk.

The ease with which farmers and traders have access to markets and storage facilities will be reflected in their distribution costs (transport and storage). If distribution costs are low this will effectively increase farm gate prices which will give farmers the incentive to increase production. One of the factors of production in this case would be agricultural and/or transport vehicles.

Table 9.14: Characteristics of market and storage accessibility in the five survey sites

	Thailand	Sri Lanka	Ghana	Zimbabwe	Pakistan
Typical Dist. to nearest markets or storage	1-25 km's	5-10 km's	> 20 km's	10-100 km's	5-20 km's
Market access to farmers	Good.	Good.	Poor - market women have all marketing contacts.	Good - but must sell to the GMB or CMB.	Good.
Farmer ability to transport own produce	Good - except in hill country.	Good - but sometimes crop too small to justify.	Farmers have very little mobility.	Within 20km's it is good, but poor beyond this distance.	Good - will travel hundreds of kilometres.
Reliance on traders	Very little - except in hill country.	The poorer/ smaller farmers are reliant on them.	Almost complete reliance.	Technically illegal but less accessible villages rely on them.	Very little.

Table 9.14 shows the characteristics of market and storage accessibility in the five survey sites. It demonstrates that in the Asian case studies, markets and storage facilities were on average closer to villages than in the African ones. In addition farmers were more able to sell their produce at those markets. In Ghana for example,

the multitude of middlemen that are involved in the marketing process means that even if a farmer is able to get to a market he may not have the facilities or contacts needed to sell his produce at reasonable prices. The lack of storage facilities also means that farmers will take lower prices rather than risk not being able to sell their produce.

9.7.3 Alternative sources of income

Linked to the presence of industry in rural areas is the access that rural people have to alternative income sources. Thailand is a very good example of a country where easy access to income from outside farming can provide the finance for buying motorised vehicles. In the Phitsanuloke province it is very often the income from work on construction sites in the cities and from local industry that have helped to pay for their agricultural vehicles. In turn, this investment in the farm has allowed them to increase production. Additionally, incomes from outside sources are often higher and less seasonal than in agriculture. By contrast, the villages in the African study areas had very little access to alternative income sources, because rural industry is not as prevalent as in Asia.

However, even where alternative income sources are available they may not be accessible to rural people because of poor transport services. A good bus service is often essential to transport people to the main service centres where most of the employment opportunities are located. Small traders also need appropriate vehicles in order to transport their goods. The larger the load capacity and higher the speed, the wider is the range in which they can operate and therefore the higher are their possible incomes.

9.7.4 Credit facilities

In all of the countries studied the poorest people had the most difficulty in finding credit particularly from formal sources. Very often the informal sources, whilst essential, charged such high interest that many farmers would remain in eternal debt. The greatest problems are in access to credit for the purchase of non-motorised vehicles. Very often the people wanting credit for these types of vehicles are those with no bank savings, no collateral and seasonal income flows. Whilst the cost of credit to these people is important the overriding concern is with the availability.

Table 9.15 shows that the availability of credit for the purchase of vehicles in the African countries is not as good as in the Asian countries, and this is particularly the case for informal credit sources. A common theme in at least one area in each of the survey countries is the problems with providing collateral for loans from formal banks. Many of the poorer members of the community do not possess assets that will provide security for loans. In addition many people are farming land for which they do not have the deeds, in which case they cannot use the land as security for loans. Another common problem is the repayment terms that most formal institutions impose such that loans have to be repaid monthly. There was complaint that this was difficult for those on low and seasonal incomes. In some cases people preferred to take loans from traders at very high interest rates and maintain some flexibility over repayment.

Table 9.15: Characteristics of the supply of credit for the purchase of vehicles in the survey areas.

	Thailand	Sri Lanka	Ghana	Zimbabwe	Pakistan
Availability of credit	V. good - banks, BAAC, shops, and traders	Good - banks, JSP, money lenders and traders	V. poor - limited funds from banks and traders	Poor - limited funds from banks and traders	Good - banks, family, village elders and traders
Cost of credit	Low	Low except in informal area	generally n.a. in rural areas	Low except in informal area	Low
Collateral requirements	Reasonable - farmers form groups for BAAC	Unreasonable banks demand too much security	n.a.	Unreasonable banks demand too much security	Reasonable
Repayment requirements	Monthly from banks, after harvest for traders	Monthly from banks, after harvest for traders	After harvest	Monthly or after harvest for GMB	Daily, weekly, monthly or after harvest

Where even the simplest of vehicles represents a substantial proportion of a households annual income, the availability of credit on reasonable terms is essential to break the poverty cycle. The purchase of either farm machinery or specific transport vehicles allows households to increase production and widen the area from which other income earning opportunities can be sought.

9.7.5 Traders

In all the countries visited traders had a role to play in at least some communities. Their role is extremely important to these communities and although the villagers themselves complain about the low prices that they receive the most vigorous complaints come from external observers and extension officials. There are four main tasks that the traders perform and these are usually conducted in parallel:

1) Distribution (transport and storage)
2) Marketing
3) Supply of credit
4) Dissemination of information

The existence and strength of traders in rural communities obviously has a large impact on the way in which the members of the communities make choices over vehicle type. For example, where traders are powerful and control all three of the functions described above, the farmer has very little demand for vehicles for agricultural transport. Where traders operate in competition with other organisations and individuals providing the above services, the farmers can better utilise transport vehicles. If the farmer can receive a loan from a bank and transport his produce to a market where they can trade freely, the need for a trader can be totally by-passed, and the farmer can receive better returns through transporting his own produce to market.

9.7.6 Labour supply

If labour supply is plentiful then the adoption of labour saving devices and transport vehicles is likely to be a lot slower than if labour is short in supply. In many rural communities, particularly in the African countries studied, there was considerable under or unemployment of labour. In this environment there is no real incentive to move to more efficient machinery, as this would only lead to a further excess in labour supply. However, where there is a migration of labour away from the village this can very quickly lead to a situation where machinery has to be substituted for labour. It is in this case that the uptake of new transport vehicles or other labour saving devices is likely to be the quickest.

At what point rural communities will adopt new technology because of labour shortage is difficult to predict, as the Asian Institute of Technology (AIT) in Bangkok, Thailand discovered. The AIT were aware that there was a considerable shift of labour from rural areas to the cities where there were lucrative jobs in the construction sector. They predicted that this would mean a shift from the traditional form of harvesting by hand to a more mechanised approach. In the 1980's when this shift of labour started there was already common usage of power tillers and so the AIT approach was to design harvesting machinery to attach to the front of the power tiller. To their surprise there was very little uptake of this cost effective harvesting device.

The reason for this poor take up was that during the harvest season there was not actually a shortage in the supply of labour. During the traditionally festive harvest period the workers returned from the cities to help their families in the harvest. However, as the Thai economy continued to grow and increasing numbers were moving to the cities, there came a period in the 1990's when the migration back to the villages for harvest stopped. At this point the shortage of labour at harvest time was so severe that there was a direct shift from harvesting by hand to harvesting by combine harvesters. Every intermediate stage was skipped.

Although this example serves to demonstrate the problems in predicting take-up of new technology the experience from the surveys suggests that introduction of new technology before absolutely necessary may result in failure. This could explain the very poor success rate of many of the tractorisation schemes that have been attempted in Sub-Saharan Africa. At the end of the day if the provision of tractor services is unreliable there is always the fall back position of labour.

9.7.7 Multi-purpose vehicles

Most rural communities derive the majority of their income from agriculture and therefore their priorities are for agricultural implements. Consequently, vehicles that are multi-purpose are very attractive. This includes agricultural tractors and draught animal power. When thinking about the provision of transport services in rural areas this must be considered, as rural communities attach greater weight to agricultural vehicles than to transport vehicles. An agricultural vehicle can meet all of their requirements with regard to agricultural preparation and transport. As mentioned before, this suggests that more integrated agricultural and transport policy could be beneficial.

9.7.8 Extension services

The agricultural extension services that are available in the Asian countries studied were in general very good. Extension officers worked closely with rural communities advising on the latest innovations in agricultural techniques, inputs and machinery (motorised and non-motorised). In many cases extension officials actually lived in the villages so they had first hand knowledge of the problems facing the communities and were therefore in a good position to communicate these back to head office. A strong agricultural extension service enables the prompt dissemination of information both to and from the village. The accurate records that are kept on all aspects of the village also enable policy makers to determine the effects that policy has on rural communities.

In contrast, the extension services in the African countries studied were not as organised. Zimbabwe has allowed a policy to promote extension services to slip and many of the Ghanaian extension officers did not visit their villages for months at a time. If policy makers are to know the problems, and villagers to know the options, improved agricultural extension services are very important. With particular regard to the introduction of technology that rural communities have never seen before, extension officers can play an important role in the dissemination of information and training.

Th agricultural extension services would provide the ideal medium through which to promote a more integrated agricultural and transport policy. It is extension services that should provide that essential link between rural communities and policy makers and even vehicle manufacturers. Where this link is missing there is an inevitable lack of understanding of the needs of rural people.

9.7.9 Regulation in rural transport services

There was a large difference in the regulation of the transport markets between the Asian and African countries studied. In Asia transport charges were largely set through market forces whilst in Africa there was a large amount of price control. It is felt that the level of regulation in transport markets serves to discourage potential operators from entering the market. This was particularly the case in Ghana where controls were particularly stringent as described in Box 6.2. In addition the evidence from Asutsuare village in Ghana would suggest that the control imposed by the transport union contributed to the exclusion of certain smaller vehicle types such as the power tiller.

Table 9.16: Extent of regulation in rural transport services in the countries studied

	Thailand	Sri Lanka	Pakistan	Ghana	Zimbabwe
Extent of regulation	None - although near universal charge for the transport of paddy within district	None	None - totally dependant on demand and supply	GPRTU set transport charges for most rural routes. No freedom in price charged.	Marketing boards set charges but otherwise free moving.

The control imposed by the marketing boards in Zimbabwe probably had less affect on vehicle choice but nevertheless contributed to transport charges rising above the levels expected in the free market.

9.8 Consequences of poor vehicle choice

As the five case studies have described, the lack of vehicle choice because of low vehicle ownership or poor vehicle diversity leads to the inefficient supply of rural tra sport services. This results in transport services which are unreliable, infrequent and expensive. Section 9.7 above has explained the main reasons for the lack of vehicle choice. In this section it is argued that the principal consequence of poor vehicle choice and the reason for the inefficient supply of transport services is insufficient competition.

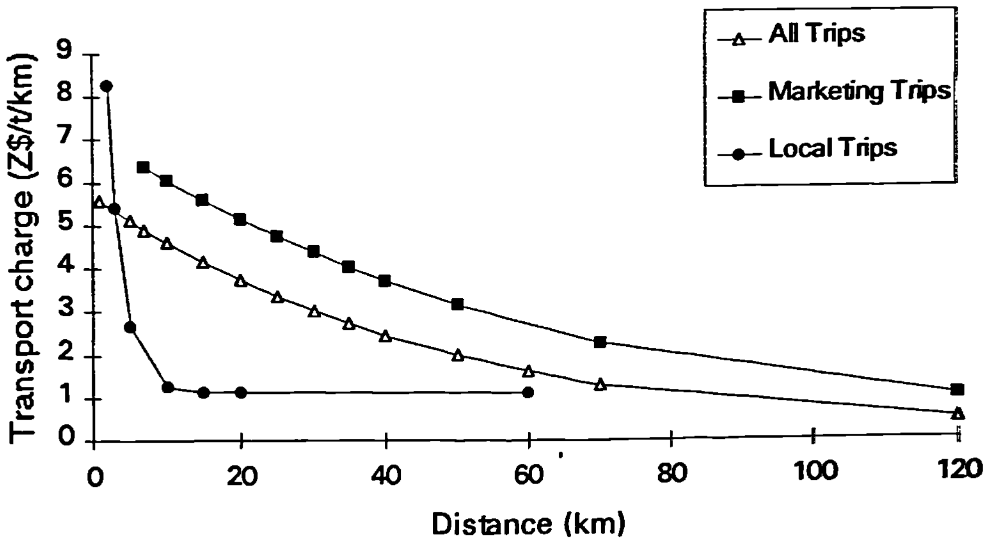
9.8.1 Competition

One of the most important factors contributing to an effective and low cost transport system is a competitive environment where operators are forced to operate efficiently, seek new opportunities and compete on price. There were a number of factors in the African transport systems that made this more difficult. In Ghana the power of the

GPRTU made it impossible for operators to seek out new opportunities or undercut the competition. All transport charges are set, permits are required for operation on all routes and there is queuing for loads. This results in a highly inefficient system where operators can under utilise their vehicles and get away with using a very aged fleet.

As with Ghana, Zimbabwe also has factors which affect competition for transport services in rural areas. The Grain Marketing Board (GMB) and Cotton Marketing Board (CMB) often set the transport charges per tonne for transport from particular villages to the main depot. Figure 9.3 demonstrates how these charges are well in excess of those found for local level transport which does not involve travel to marketing boards. The diagram shows the charge curve for all transport activities and also for local level travel and marketing board travel when the two components have been isolated. Transport to marketing boards is shown to be 4.9 times more expensive than local level transport over a distance of 10km which falls to 2.5 times more expensive as the distance travelled rises to 60km.

Figure 9.3: Tractor charge curves for Zimbabwe split up to show rates for transport to marketing boards, local transport and overall charge curve.



These very large differences can partly be accounted for by the increase in prices during the harvest period as demand reaches a peak. However, it is very unlikely that this accounts for all the difference. The setting of prices by transport associations, marketing boards and other interest groups probably only serves to push prices over the level which would have been found under market conditions.

Competition is also affected by the number and type of vehicles in operation in the area. Where vehicle number and vehicle diversity are low this will inevitably reduce competition and reduce the scope for choosing a vehicle for a specific job. For example, in Ghana rural communities have two choices; either they headload or they use a mammy wagon. However, there are many loads too big for headloading and too small to justify a mammy wagon. The result is that the people pay more for transport because they have no choice.

Vehicle choice means that rural people have alternatives in the type of vehicle they use and who is going to provide the service. When the user of transport services has choice it means that the operators have to compete for the user's custom, and this increases the efficiency with which transport services are provided. Utilisation levels must increase to keep fixed costs to a minimum which means that operators are forced to maintain their vehicles properly and to seek opportunities by under cutting the competition. This all has the effect of reducing transport charges to rural communities.

9.9 Development of a strategic model

In order to draw together the evidence collected on vehicle operating costs, transport charges and vehicle choice related to rural transport in developing countries a strategic model has been developed. The purpose of the model is to show how the various factors affecting the efficiency of rural transport covered in this chapter are related to each other. An attempt has also been made to highlight problem areas in a quantifiable way. The evidence from the case studies has been used in order to develop simple numeric relationships which when applied to case studies allows the identification of deficiencies in rural transport systems. This model forms the basis of the "Rural Transport Planner" which is described in more detail in Chapter 10.

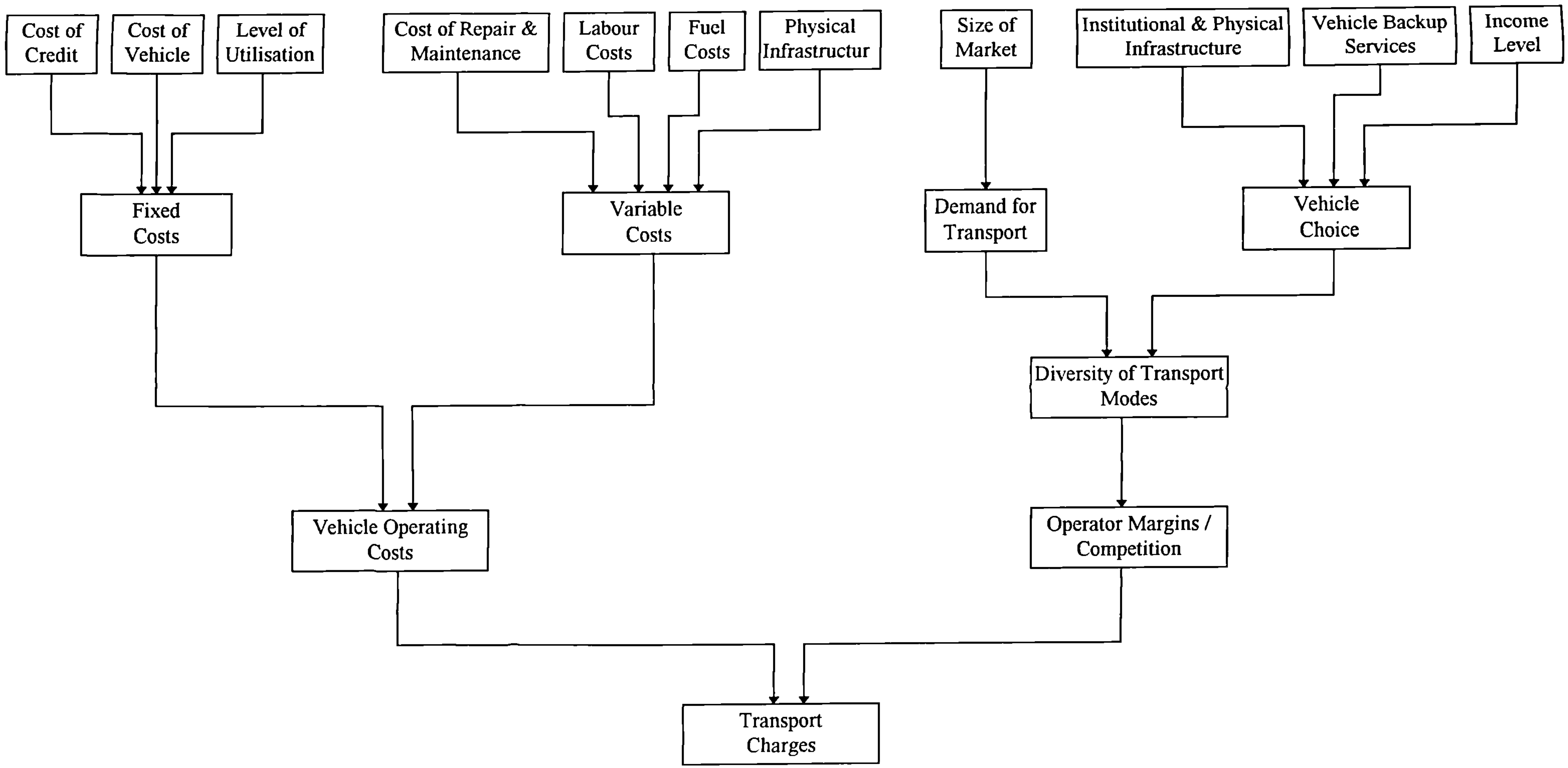


Figure 9.4: Framework to show the components of a transport charge

The philosophy behind the model is to examine ways in which transport charges can be reduced. Transport charges represent a significant component of the total costs of agricultural production, and expenditure on transport services by rural households represents a substantial percentage of their total annual income. By reducing transport charges, transport services are made available to a greater number of households. This reduces the households transport burden and introduces the possibility of increasing their margins on the sale of produce. This ultimately increases the households income.

Figure 9.4 shows that the transport charge is made up of two components, the vehicle's operating costs and the operator's margins as dictated by competition in the transport market. The vehicle's operating costs are the sum of the fixed and variable costs of operation. Variable costs include repair, maintenance, fuel and labour costs which are related to the physical infrastructure. Fixed costs relate to the standing costs of the vehicle such as its purchase price and interest repayments; the burden of these costs in total VOC's is related to vehicle utilisation.

On the other side of the diagram the level of competition is dictated by the number and diversity of transport modes and this in turn is related to the demand for transport and vehicle choice. The demand for transport is related to the size of the market. The size of the transport market is a function of factors such as the intensity of agricultural production, the population density and the presence of local industries. The factors affecting vehicle choice in rural areas include the institutional infrastructure such as credit facilities; the existence of agricultural extension services; and favourable government policy on issues such as the promotion of intermediate modes of transport an taxation. The existence of appropriate physical infrastructure such as paths, tracks and roads is important in the choice of vehicles. A person's choice of vehicle will also be affected by their ability to get it repaired; if the necessary vehicle backup services are not available people will not buy the vehicle. Ultimately the choice of vehicle is affected by income levels. Where agricultural activity is profitable or farmers have access to alternative income, their choice of vehicle will be greater.

Figure 9.4 shows the overall philosophy, the detailed frameworks used for the development of the Rural Transport Planner are contained in appendix F. Chapter 10 describes the development of the model in detail.

9.10 A summary of the analysis findings

The analysis of the VOC and transport charge data has shown that transport costs in Zimbabwe and Ghana are substantially higher than those in Pakistan, Sri Lanka and Thailand. It was found that for vehicles operating in rural areas the VOC's were up to 10 times the level in the most expensive African country compared to the cheapest Asian country. These findings are substantiated by the transport charge data which showed charges of up to 5 times greater for non-motorised transport and 2.5 times greater for motorised transport.

Detailed analysis of the case studies and PRA exercises allowed a better understanding of the factors which caused these large discrepancies. The VOC data was split down into its component parts and it was found that repair costs accounted for a disproportionately high proportion of total costs in the African countries. It is suggested that this is due to poor operator efficiency with regard to routine maintenance and the lack of adequate vehicle backup services. Utilisation levels are far lower in the African countries which forces up fixed costs.

The reason forwarded for large discrepancies in VOC's and transport charges relate to poor vehicle choice in the rural areas of the African countries studied. Low levels of vehicle ownership and poor vehicle diversity lead to an uncompetitive transport environment where operators can operate inefficiently and get away with keeping transport charges high.

The factors drawn from the case studies which it is suggested contribute to poor vehicle choice include low density of demand; poor access to credit facilities; poor access to markets and storage facilities; excess labour supply resulting in under and unemployment; regulation in transport markets; inadequate agricultural extension services; exploitive traders; and limited access to alternative sources of income. Any of these factors in isolation or in combination with others has the effect of limiting real demand for transport vehicles.

Having analysed the factors affecting vehicle choice a strategic model has been developed which links the various components to create an understanding of the important criteria in an efficient rural transport system. This model is the basis for the "Rural Transport Planner" which is described in more detail in Chapter 10.

CHAPTER 10

DEVELOPMENT OF THE RURAL TRANSPORT PLANNER

10.1 Introduction

The main objective of the PhD programme has been to create a knowledge base to aid in the selection of appropriate transport vehicles for the rural sector of developing countries, and to increase the efficiency with which interventions are made to improve rural transport systems. This knowledge base should be in the form of a practical tool to help in the analysis of rural transport systems, predicting vehicle operating costs (VOC's) and performance, understanding vehicle choice and for recommending suitable interventions. This chapter details the computer programme, the "Rural Transport Planner" (RTP), which attempts to incorporate the findings from the project in a user friendly environment.

The object of the model was to address some of the issues that have been largely ignored by the conventional transport planning models to date. The specific aim was to create a framework for the analysis of the supply of rural transport services and a way to make recommendations on suitable interventions based on the outcomes. It was decided that the best way to combine VOC modelling, vehicle databases and the knowledge generated from the field studies would be to create an expert system. Expert systems are described in more detail in section 10.3 but they basically attempt to capture the knowledge that experts have in terms of the processes they use, their experience and know-how.

10.2 Existing model approaches

The two major models that are used for transport planning at the moment are the World Banks Highway Design and Maintenance Standards Model (HDM) (Watanatada, 1987), and the Transport Research Laboratory's Road Investment Model (RTIM) (Parsley and Robinson, 1982). Both of these models are primarily concerned with the appraisal of maintenance, upgrade and new construction alternatives of infrastructure investments. The models contain relationships that predict road deterioration, the costs of various road improvements and the subsequent VOC savings. From this information Net Present Values (NPV's) and Internal Rates of Return (IRR) are calculated where the stream of costs are associated with the road improvements and the benefits from the VOC savings from improved infrastructure. These models have been generally used for the appraisal of large infrastructure projects where improving the quality of motor vehicle access is the priority. In these models all of the benefits come from the reduction of VOC's from conventional motorised vehicles.

Beenhakker et al (1987) have also developed a model for the appraisal of infrastructure. This model forwards a number of simplified procedures which are specifically aimed at the appraisal of rural access infrastructure and are therefore more easily tailored to the needs of rural transport. The VOC savings from conventional motorised vehicles can be substituted for those of commonly used rural vehicles, and the benefits from improved access to agricultural production and marketing are also included. The procedures also enable the user to appraise access through footpaths and tracks and not just conventional vehicle access.

All of the approaches taken above purely look at the appraisal of the infrastructure, in all cases there has been no account taken of the mechanisms through which vehicle services will be provided. Crossley (1982,85,86) through his development of the model PABAC (Profitability And Benefits Against Costs) has taken the physical infrastructure as purely the limiting factor on the type and performance of vehicles that ca be used. He takes a mechanistic approach, where VOC's and performance are calculated as a function of the mechanical efficiency of the vehicle and the resistance's that the vehicle experiences, such as gradient and rolling resistance for example. On this basis the performance and VOC's of any vehicle can be predicted given their mechanical characteristics. This approach is particularly useful for the prediction of VOC's for rural vehicles where there are no existing VOC relationships.

It is perceived that the role of the RTP will be to bridge the approaches taken by these various models. All the existing model approaches take either the provision of infrastructure or vehicles in isolation of the other. The RTP takes a more integrated approach to the provision of rural accessibility where infrastructure, vehicle services, spatial planning and policy interventions are taken in conjunction with each other. The expert system described in this chapter, which has been developed through the "Leonardo" expert system shell, provides the ideal interface between the user and the many factors which make up an efficient rural transport system.

The RTP model has been designed to run with market prices. For the appraisal of certain infrastructure projects it may be desirable to use economic prices. If economic prices are used then aspects of the "problem analysis" component of the model would become invalid.

10.3 What is an expert system ?

An expert system is designed to emulate the behaviour of a human expert in a particular field. Most computer programs tend to concentrate just on data or information (for example in the form of spreadsheets or databases). These programmes allow data to be manipulated and information to be extracted but they do not contain the knowledge that users need in order to perform certain actions. The expert system captures the knowledge that experts have in terms of the processes they use, their experience and know-how.

There are a number of phases in the construction and operation of an expert system. Firstly the knowledge must be entered as a number of rules which are a series of IF THEN statements. For example:

> If routine_maintenance is 'inadequate'
> Then solution is 'improve operator training'

Secondly this knowledge base will be accessed during execution so that the rules can be interrogated by the user. Thirdly the inference engine, or the mechanism by which the answers are generated, is used. The engine makes the connections through the rule base and passes out the conclusions. Finally, and possibly most importantly, it provides the interface between the user and computer. It allows the user to input information, provides help and generally creates a user friendly environment.

10.4 The functions performed within the Rural Transport Planner

The expert system mimics the processes and decisions that an expert would make given a particular study area. The user describes the study area using information that should be easily available from extension services or other government departments. The object is to calculate total distribution costs (transport and storage/marketing) for the area either at the village or district level. To do this the study area is split into two zones, the collection zone and trunking zone. At the village level transport activities in the collection zone relate to journeys from the farm to village, the trunking zone relates to transport activities from the village to district level market. At the district level the collection zone relates to journeys from village to district market, the trunking zone relates to journeys from district market to regional market.

The objective of the RTP is to minimise total distribution costs by altering the mix between storage facilities and vehicle type. The RTP contains a vehicle database of all the commonly used vehicles in the rural areas of developing countries which enables the user to alter the number of storage/marketing facilities and vehicle type to arrive at the lowest total distribution cost. On the basis of the information entered in to the system the RTP will also make recommendations on the types of interventions that may increase the efficiency of the rural transport system. The expert system contains:

1) A model to calculate total distribution costs in the area and a facility to change key variables to better understand the effects of vehicle choice and storage facilities on total distribution costs.
2) A database of commonly used vehicles in rural areas.
3) A model to predict vehicle operating costs and performance according to physical infrastructure and the density of demand in the area.
4) Advice is provided on interventions that may be appropriate in the study area based on the results from the models.

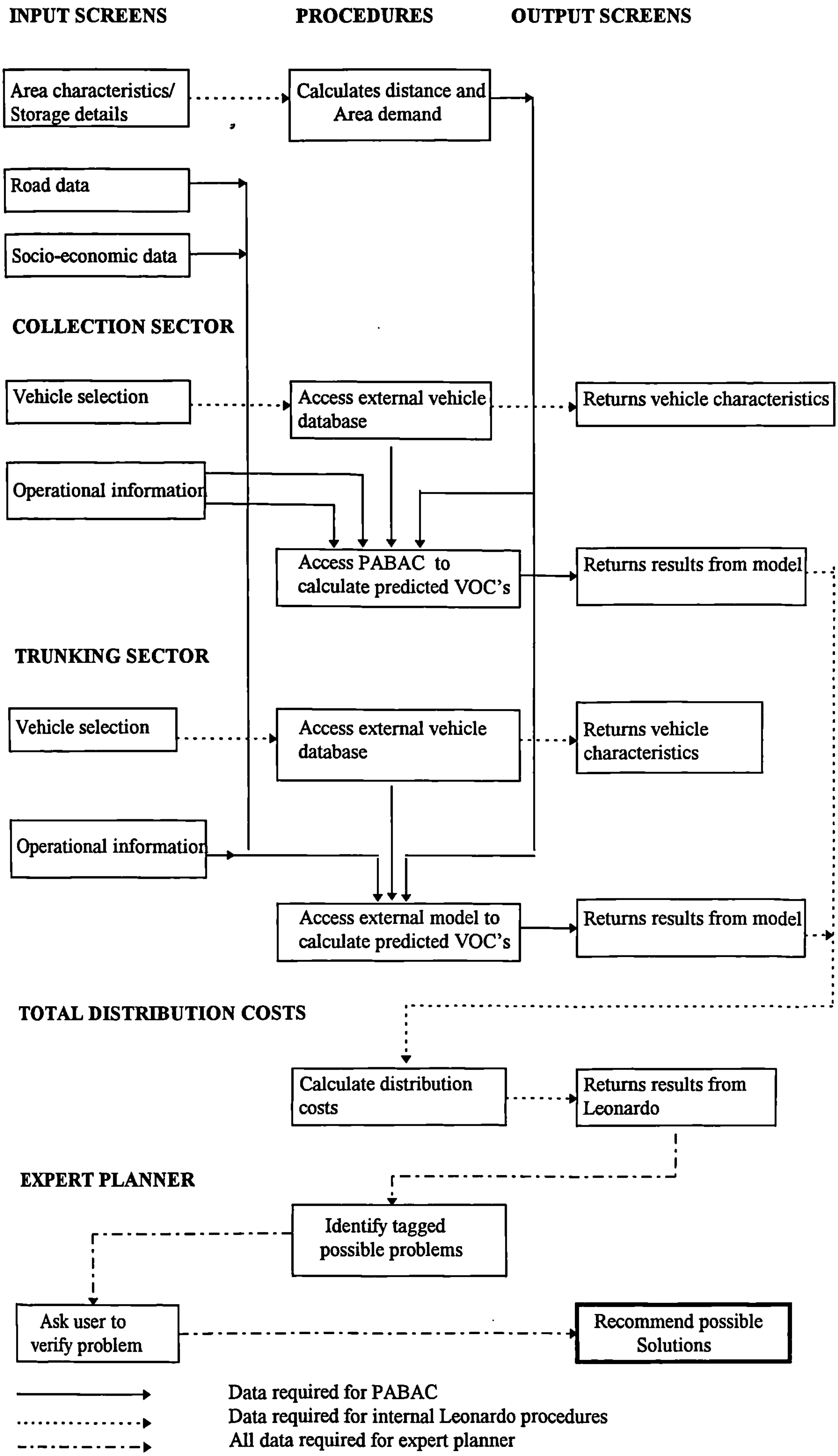


Figure 10.1: The structure of the Rural Transport Planner expert system

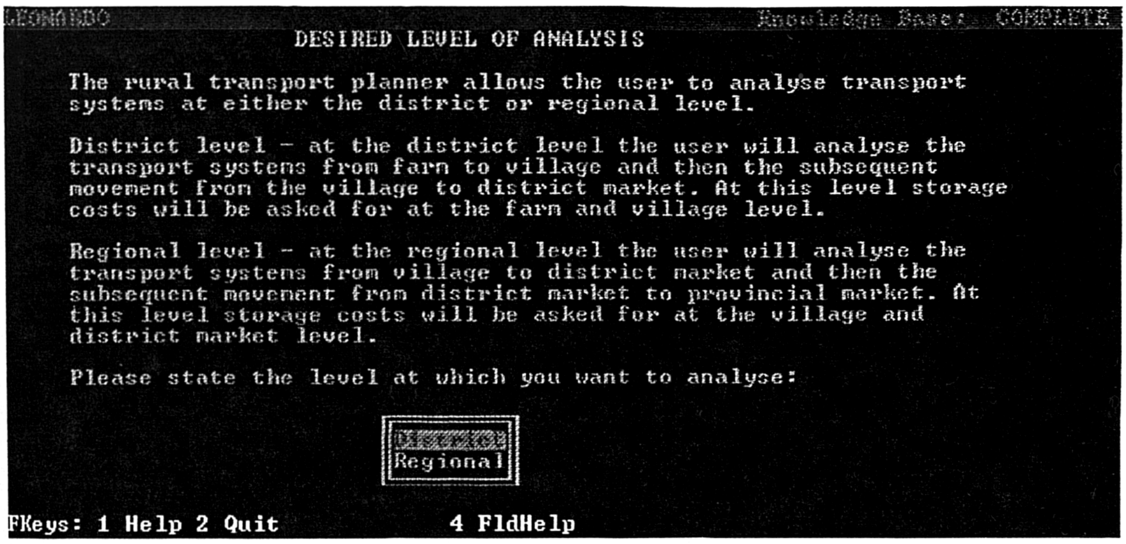
10.5 The data required by the Rural Transport Planner

In the following description of the way that the expert system operates it should be noted that the work on distribution costs has been adapted from Passmore (1989) to be more relevant to small scale farmers in developing countries. The model to predict VOC's is called PABAC and has been developed by Crossley (1982,85,86) and calibrated using the operating cost data collected during the survey visits to Thailand, Sri Lanka, Pakistan, Ghana and Zimbabwe. Figure 10.1 shows the structure of the RTP expert system, detailing the input and output screens as well as the procedures required to reach the final solutions.

Any information that could not be included in the Leonardo screens but has been thought to be useful in providing the user with a clear idea of the data required is included in help screens. These help screens are specific to each required variable and can be accessed by pressing "F4" when running the RTP.

10.5.1 Data required for the description of the study area

Figure 10.2: Leonardo screen allowing user to specify their desired level of analysis



Screen 1 (level of analysis) - the RTP is designed to conduct analysis at the district and regional level. At the district level it is concerned with the movement from farm to village and then the subsequent movement from village to district level market (or whichever market represents the first point of sale for the farmer). At the regional level it is concerned with the movement from village to district market and then the subsequent movement from district market to regional level market. Appropriate vehicles and interventions at these two levels will be very different. Figure 10.2 shows the first screen allowing the user to specify their required level of analysis.

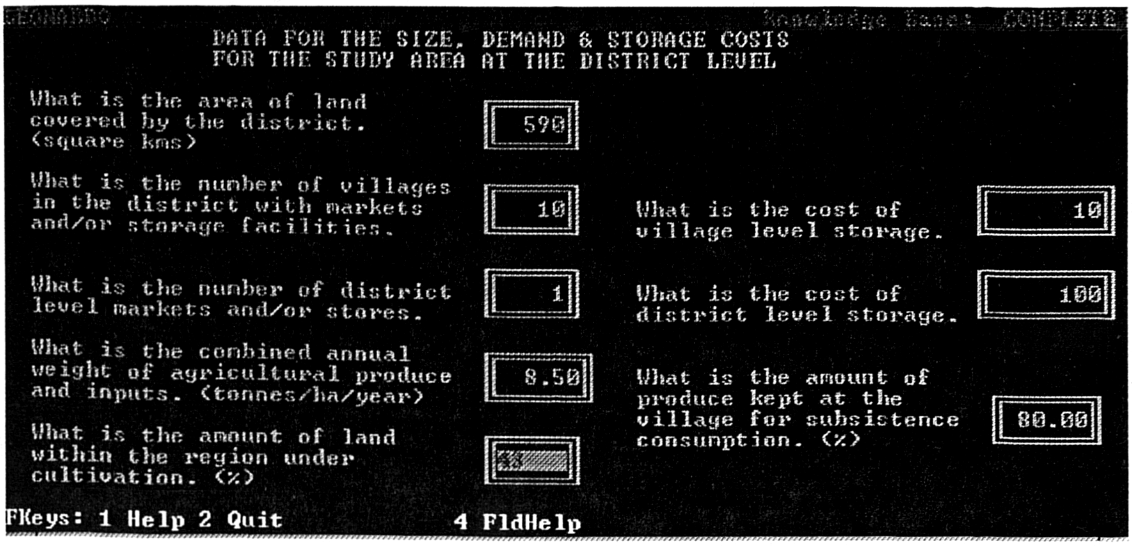
Screen 2 (characteristics of the study area) - having selected the desired level of analysis the user will be presented with the appropriate screen, district or regional level, to input information on the characteristics of the study area. This information is needed in order to calculate the distances over which produce must be transported and the demand for transport services.

In order to calculate the distances involved the following information is required: the size of the study area (STUDY_AREA); the number of first level storage facilities either at the village or district level (1ST_STORE); and the number of second level storage facilities either at the district or regional level (2ND_STORE). The cost of storage facilities is also included in order to get total distribution costs. Costs are required for first level storage facilities (FARM_STORE) and second level storage facilities (RURAL_STORE).

Another important criteria in determining vehicle choice is demand. In order to estimate the demand for transport services in the study area the following information is required: the typical agricultural yields and inputs in the study area (YIELD); the amount used for subsistence purposes or sold at district markets for local consumption (CASH_LEVEL); and the total area of land in the study area under cultivation (CROP_AREA). Figure 10.3 shows the Leonardo screen detailing the information required on the study area for the district level.

In this context it is not important to make a distinction between storage and marketing facilities because they both perform the same task of providing a place for the amalgamation of goods. What is of interest is how the amalgamation of goods affects vehicle choice. It is expected that the larger the collection points the larger and therefore more efficient vehicle can be used. However, if collection points are too dispersed then there will be no scale advantages in the collection sector.

Figure 10.3: Leonardo screen for information on study area characteristics



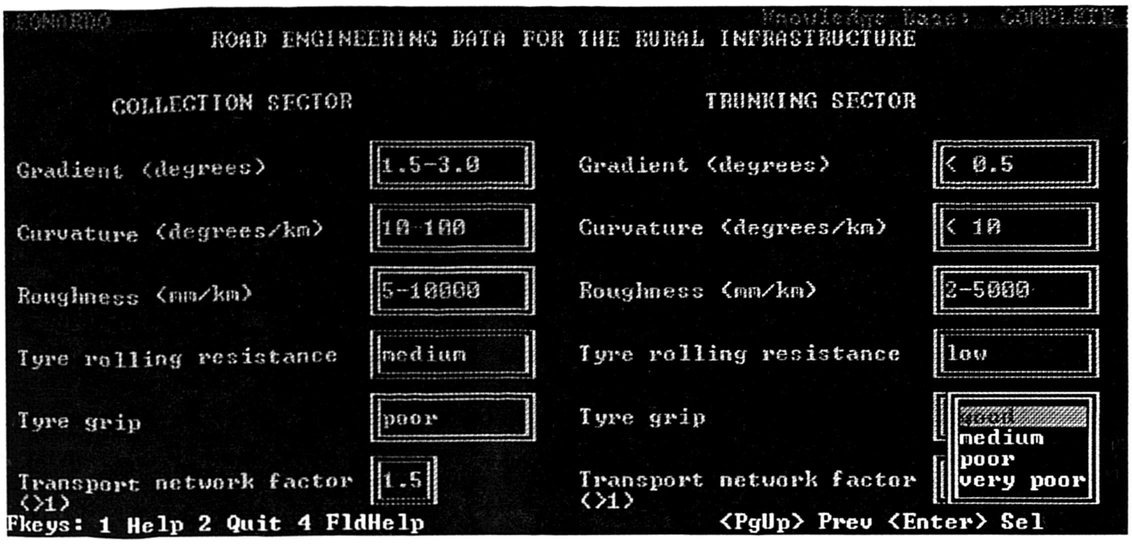
Exact storage costs either at storage facilities or markets may be difficult to find but information should be available on the costs of different storage units. For on farm storage where there may not be any formal storage facilities the costs should be related to on farm wastage through pests and damage etc.

The information required for the calculation of total demand assumes that the majority of transport demand is for the movement of agricultural related products. This is based on the premise that vehicle choice in rural areas will primarily be affected by the need for transport services that produce a financial return. However, if the user of the RTP has data on the demand for transport for subsistence purposes, or other commercial purposes, these can easily be included.

Screen 3 (road data for the collection and trunking sectors) - engineering data is required on the roads serving the collection and trunking sectors of the trip. This data includes gradient, curvature, road roughness, tyre rolling resistance, tyre grip and a road network factor (CNT for collection sector and TNT for trunking sector). The road network factor allows the user to enter a value for the road's deviation from the straight line. This is described in more detail in procedure 1.

As collecting this information can be time consuming and costly, each component is set out in categories in order to ease data collection. Tyre grip, for example, can be answered as either "good, medium, poor or very poor" as shown in figure 10.4. In addition the "F4" key within Leonardo will provide the user with help on each of the categories. These components can easily be varied to determine the effects that road conditions have on vehicle operating costs for different vehicles.

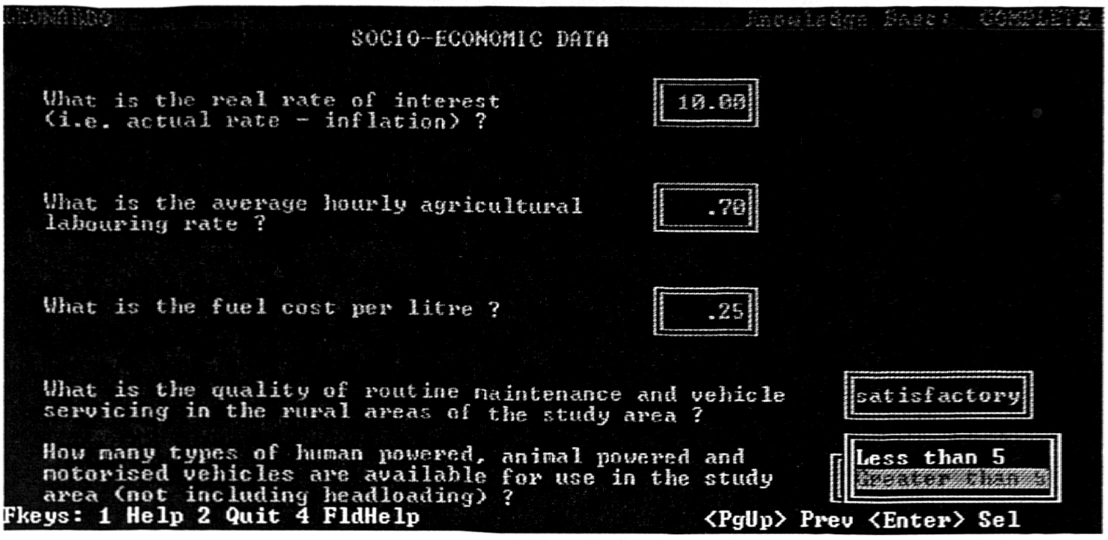
Figure 10.4: Leonardo screen for road engineering data



Screen 4 (key socio-economic data) - economic data from the study area are required in the calculation of vehicle operating costs. This includes the real rate of interest; vehicle operator wage rates; the cost of fuel; effectiveness of vehicle maintenance and servicing; and a measure of vehicle diversity (see figure 10.5). Again these components may be varied to show the effects of using actual interest rates or the opportunity cost of labour for example.

The real rate of interest is calculated as the actual rate of interest minus the country's rate of inflation. If there is a negative real rate of interest then Leonardo will take the interest rate as zero for the purposes of the calculation of VOC's. As operator wage rates may not be applicable for most rural vehicles the average hourly agricultural wage rate is asked for. This rate may be substituted for the opportunity costs of labour where more appropriate. The fuel costs per litre refer to the price of diesel unless petrol engined vehicles are being examined. Human powered vehicles will take fuel costs as being zero and a separate screen will appear if animal powered vehicles are being examined. In this case the quarterly feed costs are asked for.

Figure 10.5: Leonardo screen for key socio-economic data



It has been suggested that a major factor affecting VOC's is the quality of routine maintenance and vehicle servicing (SERFAC). The user is asked to state how efficiently these factors are undertaken. The response will affect the weighting attached to the repairs component of VOC's. It has also been suggested that the degree of vehicle diversity affects competition and efficiency in rural transport services, and the response given here will be used to "tag" certain non-cost responses at a later stage in the programme.

10.5.2 Procedures for the calculation of load and distance

Procedure 1 (calculation of distance within the collection zone) - a procedure is used within Leonardo to calculate the distance that a vehicle will have to travel within the collection zone in order to pick up produce from the farm or village and return it to the first level storage facility. For the purposes of this model it is assumed that the study area is square, as is each of the collection zones within that area. Therefore, the distance travelled by a vehicle will be from the centre of the collection zone to the average distance of each of the pickup points.

The size of each of the collection zones (CZ) is calculated by simply dividing the study area by the number of first level stores to give:

$$CZ = STUDY\_AREA / 1ST\_STORE \qquad (10.1)$$

On a grid network the distance across the collection zone is the square root of the study area ($\sqrt{CZ}$). To find the average distance from the centre of the collection zone to the farm or village this value must be halved. On a grid network therefore, the average distance (y) is given by:

$$y = \sqrt{CZ} \times 0.5 \qquad (10.2)$$

If each grid in the study area is assumed to have sides of 1 km, the distance travelled to the furthest corner of the grid is 2 kms. If however, a straight line is taken then the distance is reduced to 1.41 kms. This is a reduction in distance of 29.3% from the original journey. To adjust equation 10.2 to represent a straight line distance the constant 0.5 must be reduced by 29.3% giving a constant of 0.354. The new equation for the average straight line distance (z) is given by:

$$z = \sqrt{CZ} \times 0.354 \qquad (10.3)$$

Equation 10.3 gives the average straight line distance between the farm or village pickup point and the first level storage facility for a one way trip in the collection zone This distance must be multiplied by 2 to give the return trip distance.

This straight line distance can be made more realistic by applying a road network factor (CNT) to represent the networks deviation from the straight line. A typical road network in a developed country would need a factor of about 1.3 to represent its deviation from the straight line. In developing countries this could be substantially more, particularly in rural areas. The equation for the distance of the average return trip in the collection sector (CAD) is given by:

$$CAD = 2 \times (\sqrt{CZ} \times 0.354) \times CNT \qquad (10.4)$$

Procedure 2 (calculation of demand within the collection zone) - the next phase is to calculate the total demand for transport services (TK) in the collection sector. This is a function of the crop yield and the total area under cultivation. The crop yield (YIELD) is multiplied by 100 to convert tonnes per hectare to tonnes per square kilometre which is needed by Leonardo. This figure in turn is multiplied by the percentage area under cultivation (CROP_AREA) divided by 100. The equation to give total demand for transport services per square kilometre is given by:

$$TK = (YIELD \times 100) \times (CROP\_AREA / 100) \qquad (10.5)$$

The demand per quarter for the whole collection area (OUTLOD) is therefore expressed as:

$$OUTLOD = (TK \times CZ) / 4 \qquad (10.6)$$

Procedure 3 (calculation of distance on the trunking zone) - as with the collection sector, a procedure is needed to calculate the distance travelled along the trunking sector of the route and the demand for transport services. This distance will be from the first level storage centres to the second level storage centres at regional or national level. As in the calculation of the distance travelled in the collection zone it is assumed that the study area is square. The distance travelled on the trunking sector is the average of that from the second level storage centres to the first level storage centres.

The area of each trunking zone (AR) is calculated by dividing the total study area (STUDY_AREA) by the number of second level stores (2ND_STORE) to give:

$$AR = STUDY\_AREA / 2ND\_STORE \qquad (10.7)$$

B using the same assumptions as those used in the calculation of the average distance in the collection sector, the equation for the average distance travelled on the trunking sector (TAD) is expressed as:

$$TAD = 2 \times (\sqrt{AR} \times 0.354) \times TNT \qquad (10.8)$$

where TNT is the network factor on the trunking sector to represent the networks deviation from the straight line.

Procedure 4 (calculation of demand on the trunking zone) - the demand available on the trunking sector of the trip will be a function of the demand in each collection sector (OUTLOD) and the number of first level stores (1ST_STORE) each of the second level stores (2ND_STORE) serves. Therefore the demand available on each of the trunking sectors (OUTLODT) can be represented by:

OUTLODT = (1ST_STORE / 2ND_STORE) x OUTLOD (10.9)

This equation assumes that all of the crop yield (YIELD) will be transferred from first level stores to second level stores. In practise the total demand on the trunking sector will be reduced by subsistence consumption at the village level or through purchases at the district market level for local consumption. The amount of yield lost to the system in this way (CASH_LEVEL) must be taken out from the total demand available. The resultant equation is given by:

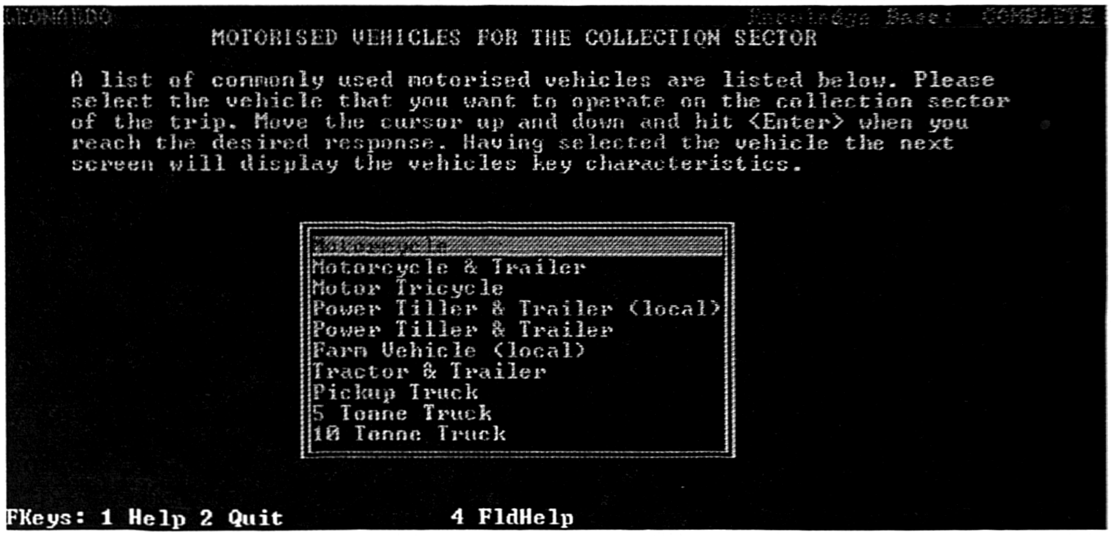
OUTLODT = ((1ST_STORE / 2ND_STORE) x OUTLOD) (10.10)
x (1 - (CASH_LEVEL / 100)

Having generated all the necessary information to determine distances and the density of demand in the various sectors of the study area it is now possible to predict vehicle operating costs. The Rural Transport Planner enables the user to select different vehicles for the collection sector and trunking sector. The type of vehicle selected will be dependent on the size of the collection areas and hence the density of demand. The larger the store the larger the vehicle that can serve it. In general the larger the vehicle the cheaper the cost in terms of tonne kilometres.

10.5.3 Data required for the collection sector

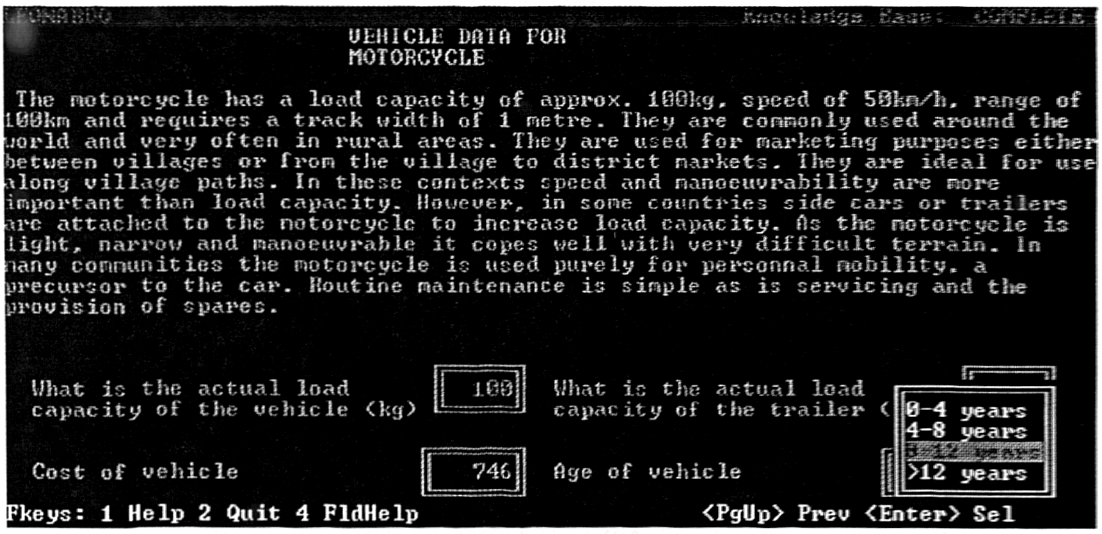
Screen 5 (vehicle selection screen for collection sector) - this screen allows users to choose a vehicle that they think would be suitable for operation on the collection sector. The user is asked to make an initial choice between human powered, animal powered, motorised or agricultural vehicles. According to the chosen category, a screen will be shown with the available database of vehicles in that category. Figure 10.6 details the screen with the database of motorised vehicles. The full list of vehicles in the database and a description of where they were found and their use characteristics is contained in appendix G.

Figure 10.6: Leonardo screen showing the motorised vehicle database



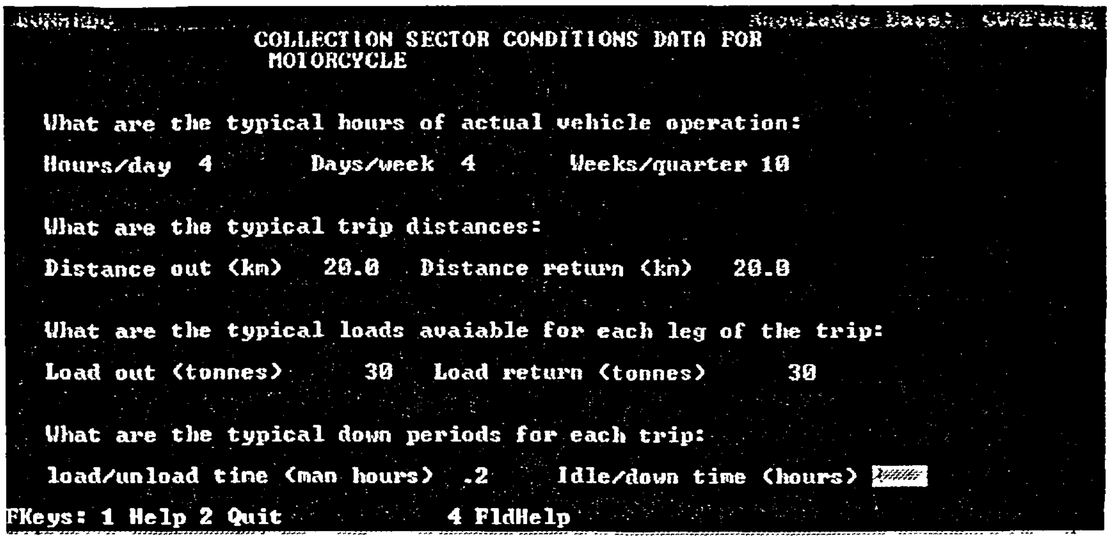
Screen 6 (characteristics of the selected vehicle) - once the vehicle has been selected from the previous screen, Leonardo accesses the vehicle database which is located in an external file. This database contains engineering, performance and descriptive information. The information of use to the user is displayed on the screen (see figure 10.7), and certain data such as vehicle payload, cost and age can be entered by the user if they have more area specific information. The information not relevant to the user is used at a later stage for inputs into the PABAC model which predicts VOC's.

Figure 10.7: Leonardo screen detailing the characteristics of the chosen vehicle



Screen 7 (vehicle's operational characteristics) - the user is asked to supply information on the vehicle's operating characteristics. These include the vehicle's actual period of operation in hours per day, days per week and weeks per year; distance of the outward (DISOUT) and return trip (DISRET), as calculated by Leonardo from data on study area and collection zone (this may be changed if the user has more detailed information); load available for the outward and return legs of the trip in tonnes per quarter year, as calculated by Leonardo (this may be changed if the user has more detailed information); the time taken to load and unload per trip; the time that the vehicle has enforced idle time either because of no available load or due to mechanical failure (see figure 10.8).

Figure 10.8: Leonardo screen for area specific conditions data



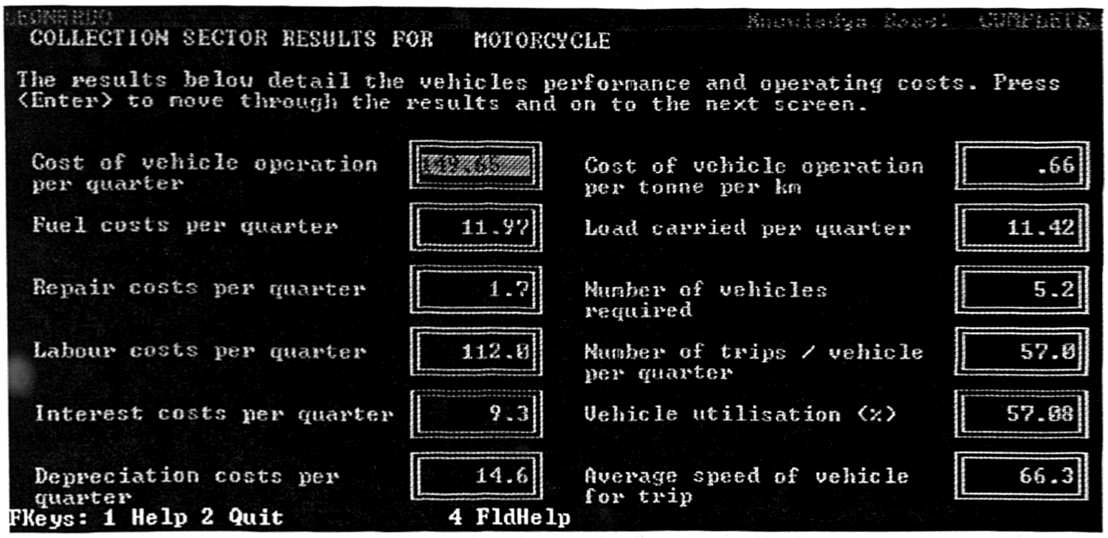
Procedure 5 (the calculation of predicted vehicle operating costs) - the information which has been entered is fed into an external FORTRAN programme to calculate predicted vehicle operating costs. This programme called "PABAC" has been developed by Crossley (1985) and takes a mechanistic approach to the calculation of operating costs. The initial programme has been calibrated using the data collected from the five survey sites. More detailed information on the construction of "PABAC" can be found in Crossley's PhD thesis.

Screen 8 (presentation of collection sector vehicle operating costs) - Once "PABAC" has calculated the results they are fed back into Leonardo and presented in a collection sector results screen. The information provided in this screen can be split up into performance data and components of the operating cost data.

The performance data includes load carried per quarter (LOADQUART); the number of vehicles required to satisfy the demand (VEHNUM); the number of trips made by each vehicle per quarter (TRIP); the level that the vehicle is utilised per quarter (%UTILISED); and the average vehicle speed per trip (AVSPEED).

The operating cost data includes total cost of vehicle operation per quarter (COSTQUART); the cost of vehicle operation per tonne per kilometre (COSTONKMQ); the cost of fuel per quarter (FUELQUART); repair costs per quarter (REPAIR); labour costs per quarter (WAGES); interest costs per quarter (AMORTQ); and depreciation costs per quarter (DEPRECIATION). The data from this screen is presented as in figure 10.9.

Figure 10.9: Leonardo screen detailing vehicle performance and cost data



10.5.4 Data required for the trunking sector

Screen 9 (vehicle selection screen for trunking sector) - this is the same as screen 5 but for the trunking sector. Normally the vehicle selected on the trunking sector will be larger than that selected for the collection sector. An exception to this may be when there are no rural collection points i.e. the collection sector is the same size as the study area.

Screen 10 (characteristics of the selected vehicle) - as with screen 6 this screen gives the vehicle characteristics for the trunking sector.

Screen 11 (vehicle's operational characteristics) - as with screen 7 this screen asks for operational information for the vehicle that has been selected for use on the trunking sector.

Procedure 6 (calculation of predicted vehicle operating costs) - the information from the vehicle chosen to operate on the trunking sector is fed into "PABAC" to calculate predicted operating costs.

Screen 12 (presentation of trunking sector vehicle operating costs) - the results from "PABAC" are fed into this screen the same as on the collection sector.

10.5.5 The calculation of total distribution costs

The next part of the programme attempts to draw the various components together in order to get an estimate of the total distribution costs in the study area described.

Procedure 7 (calculation of total distribution costs) - in order to derive total distribution costs it is necessary to find the sum of collection sector transport costs (TCTC), trunking sector transport costs (TTTC), first level storage costs (TFWSC), and second level storage costs (TRSC).

Total transport costs in the collection sector

The total costs of transport in the collection sectors of the study area are calculated by multiplying the cost of transport per kilometre (TCC) by the total number of kilometres travelled by all the vehicles in that year. The cost of transport per kilometre is calculated by dividing the total costs of vehicle operation (COSTQUART) by the number of trips (TRIP) and the total trip distance (CAD). The cost of vehicle operation and number of trips are given in quarter years from PABAC and so they are multiplied here by 4 in order to give full year values. The equation for cost of transport per kilometre is given by:

$$TCC = (COSTQUART \times 4) / ((TRIP \times 4) \times CAD) \qquad (10.11)$$

The total collection transport cost is therefore given by the cost of transport per kilometre multiplied by the total number of kilometres travelled. Total kilometres travelled is a function of the distance per trip (CAD), the number of trips (TRIP), the number of vehicles required (NUMVEH), and the number of first level stores (1ST_STORE). The equation for total collection sector transport costs (TCTC) is given by:

$$TCTC = (CAD \times TCC) \times ((TRIP \times 4) \times NUMVEH) \times (1ST\_STORE) \qquad (10.12)$$

Total transport costs on the trunking sector

The total transport costs for the trunking sectors are calculated in exactly the same way as above but using the data from the vehicles operating on these routes. The equation for the cost of transport per kilometre is given by:

$$TCT = (COSTQUARTT \times 4) / ((TRIPT \times 4) \times TAD) \qquad (10.13)$$

The equation for the total trunking transport cost (TTTC) is given by:

$$TTC = (TAD \times TCT) \times ((TRIPT \times 4) \times NUMVEHT) \times (2ND\_STORE) \qquad (10.14)$$

Total first level storage costs

The costs of first level storage costs (FARM_STORE) will be area specific. It is therefore necessary for the user to supply this information. In certain circumstances, particularly in less developed areas, there will be no formal data on first level storage costs. In this case the costs of storage should at least cover crop loss and wastage whilst at village or district market. The equation for total first level storage (TFWSC) in the study area is simply given by:

$$TFWSC = FARM\_STORE \times 1ST\_STORE \qquad (10.15)$$

Total second level storage costs

In the same way as total first level storage costs were calculated, the equation for second level storage costs (TRSC) is given by:

$$TRSC = RURAL\_STORE \times 2ND\_STORE \qquad (10.16)$$

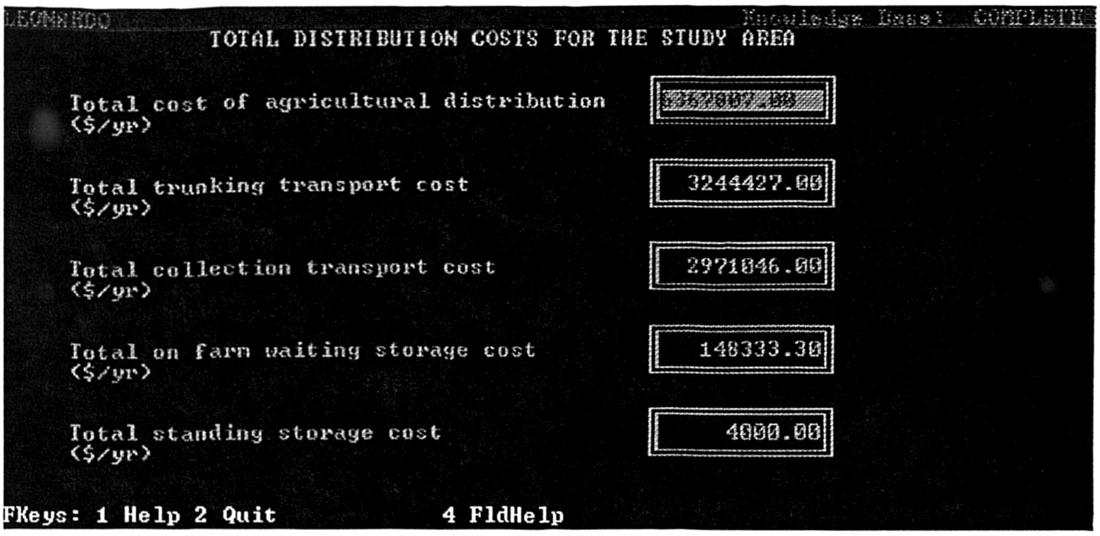
Total agricultural distribution costs

Once the four components of collection sector transport costs, trunking sector transport costs, first level storage costs, and second level storage costs have been calculated the results can be summed to give total distribution costs (AGDIST) for the study area. The equation is given by:

$$AGDIST = TCTC + TCTC + TFWSC + TRSC \qquad (10.17)$$

Screen 13 (distribution costs results screen) - This screen gives the components of total costs for distribution. They include collection sector transport costs, trunking sector transport costs, on farm storage costs, rural collection point storage costs, and total agricultural distribution costs as shown in figure 10.10.

Figure 10.10: Leonardo screen detailing total distribution costs



10.6 The expert planner

Having calculated the transport costs, storage costs and total distribution costs for the study area it is now possible to draw on the knowledge gained from the case studies and analysis of the data. The answers that were given in the previous section will be used to "tag" certain factors which may affect the cost of transport, availability of transport services or the choice of transport mode. The basis of this part of the expert system comes from the framework developed at the end of the analysis chapter which linked the various factors that affect the size of the transport charge. The full framework describing the paths taken by the RTP is contained in Appendix F.

Column 1 of table 10.1 lists the factors identified from the analysis of the survey data that may be possible causes of rural transport inefficiency. Column 2 lists the criteria that are used to "tag" them within Leonardo and column 3 describes the possible remedies. Leonardo will scan its knowledge base to see whether a factor can be successfully tagged. If a factor is successfully tagged it shows a screen such as in figure 10.11 This screen for example, has advised the user that the rural transport planner has highlighted unusually low levels of vehicle utilisation and that possible causes for this could be lack of competition or excessive regulation. The user is then asked to state whether in their opinion vehicle utilisation is "low" or "high", extra help is also given at this stage to aid in making a decision.

Figure 10.11: Leonardo screen advising the user of a possible problem

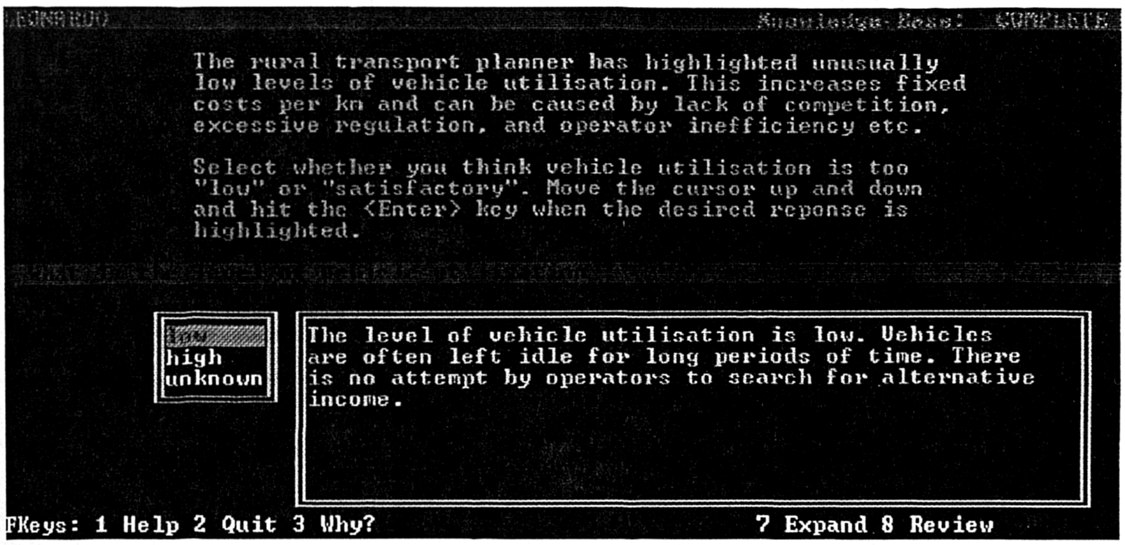
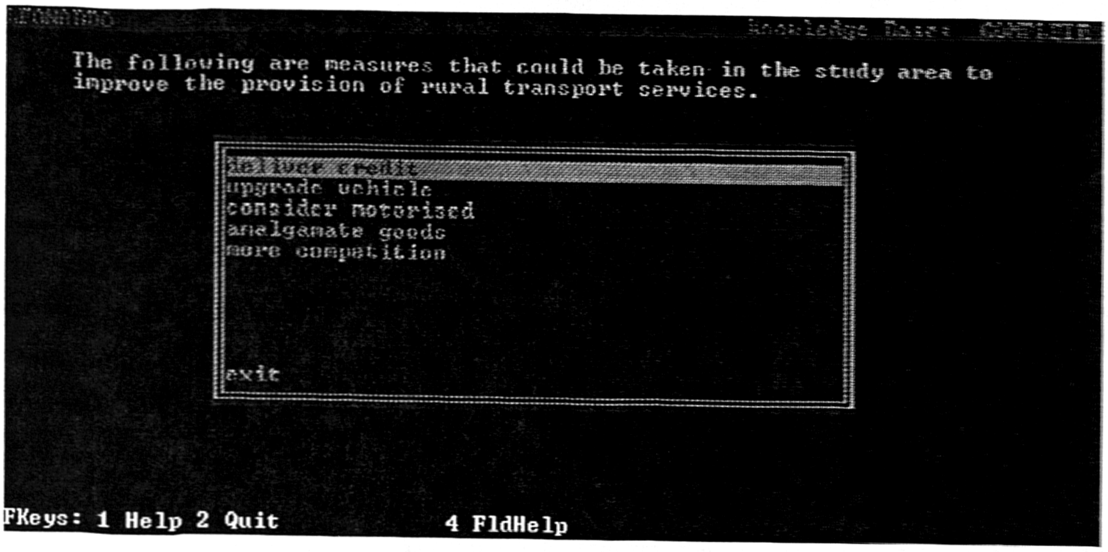


Table 10.1: Table showing problem factors, their tags and solutions

Factor	Tags	Solutions
1) High vehicle prices due to high government taxation 2) High vehicle prices due to excessive reliance on imports	depreciation > 0.05 x costquart for human & animal vehicles depreciation > 0.16 x costquart for all motorised vehicles	1) Examine government policy on vehicle taxation 2) Explore the possibility of local vehicle manufacture
1) Formal credit unavailable for vehicle purchase 2) High real interest rates 3) Unrealistically high collateral requirements 4) Inappropriate repayment terms	amortq > 0.05 x costquart for human & animal vehicles amortq > 0.10 x costquart for all motorised vehicles and/or vehicle_diversity is 'less than 5'	1) Deliver credit facilities to rural areas 2) Improve rural banks
1) Poor routine maintenance 2) Poor vehicle backup services	repair > 0.14 x costquart for human & animal vehicles repair > 0.18 x costquart for motorised vehicles and/or serfac > 1	1) Improve operator training 2) Improve service facilities and training
Poor infrastructure	repair > 0.14 x costquart for human & animal vehicles repair > 0.18 x costquart for all motorised vehicles	Upgrade roads, tracks and paths
High labour costs	wages > 0.34 x costquart for human & animal vehicles wages > 0.06 x costquart for all motorised vehicles	Upgrade vehicles to modes that are less labour intensive
1) High Fuel costs for motorised vehicles 2) High fuel costs for animal pow red vehicles	fuelquart > 0.23 x costquart for all motorised vehicles fuelquart > 0.16 x costquart for animal vehicles	1) Examine government policy on fuel taxation 2) Consider simple motorised vehicles
Low levels of vehicle utilisation	%utilised < 50 for all vehicle types	Stimulate competition through deregulation
Poor vehicle choice	vehicle_diversity is 'less than 5'	Promote new modes of transport
High levels of subsidy	tariff <= costonkmq	Place greater emphasis on market pricing
Excessive regulation of rural transport services	tariff >= 1.2 x costonkmq	Stimulate competition through deregulation
Inaccessible market and/or storage facilities	disret > 20 and vehicle_diversity is 'less than 5'	Amalgamate goods through improved provision of markets and/or stores

In this particular case if the user enters "high", then Leonardo will take no further action on this element and continue to search the knowledge base for another factor that can be successfully tagged and the process will begin again. If however, the user entered "low" then Leonardo would select the solution "more competition" which would be displayed at the end of the consultation. Figure 10.12 shows the final solutions screen which displays "more competition" as a possible solution to low vehicle utilisation levels along with the other possible solutions. At this point the user is able to highlight a possible solution and press "F4" which provides a detailed help screen on the relevant solution.

Figure 10.12: Leonardo screen advising the user of possible solutions



Screen 14 (rerun screen) - this screen allows the user to go back through the programme to change the scenarios, correct mistakes or to conduct an iteration process to minimise total distribution costs. Total distribution costs can be reduced either by altering the number of storage points in the study area or altering the size or type of vehicle. In this way the user can determine the best combination of stores and vehicles for the demand and distances involved in the study area.

10.7 Testing the model

Once the Rural Transport Planner had been constructed it was necessary to test it on a case study unrelated to the those which had been used in its development to ascertain its global applicability. This process was conducted in two stages.

The first stage involved a consultant from Silsoe Research Institute (SRI) travelling to a country with very different characteristics than those studied as part of the PhD programme. As funds were limited it was decided that they should go to the Guinope municipality, Honduras where they had existing commitments, good contacts and had visited frequently. The major town in this area is Zamarano which is also home to the "Escuela Agricola Panamericana" (EAP) (Panamerican Agricultural School). SRI were given the following terms of reference:

(i) To assess local demand for rural transport.
(ii) To assess how the supply for this demand for transport is met.
(iii) To identify typical transport activities.
(iv) To collect information on vehicle output and cost.
(v) To assess the main technical, social and economic issues, problems and constraints affecting transport from the perspective of both users and suppliers.

The second stage was to take the completed SRI report (Ellis-Jones and Sims, 1995) and determine whether the RTP predicted operating costs and interventions in the same way as the SRI consultants. Following on from this was a trip by the author to the survey site in order to determine whether local planners, policy makers and academics agreed with the outputs from the RTP.

10.7.1 Summary and conclusions from SRI report

The report was prepared in a background where the government of Honduras is implementing economic structural adjustment, and deregulation programmes. These have led to reducing import duties, free market exchange rates and a transfer of funds from the public to private sector, which has included road maintenance.

The Guniope municipality is situated 60 kms from the capital city Tegucigalpa. It is a mountainous area typical of rural Honduras, where most of the population derive their income from agriculture on farms of 3-4 manzanas (2.1-2.8 hectares). There is a wide choice of transport vehicles but the following patterns predominate:

Farm and household use:	Human and animal
Local purchases and marketing:	Animal and pickup
Journeys to Tegucigalpa:	Pickup, bus and lorry

In rural areas the use of pack animals (donkeys, mules and horses) predominates, typically carrying loads of 100kg for distances of 5-10 kms. The rugged terrain makes animal carts unsuitable in most areas. The most important form of motorised goods transport is 1-3 tonne pickups and small trucks, while 25 and 50 seat buses operate on inter-urban routes for passenger transport. Local and city based traders provide a readily available source of transport hire and also purchase agricultural produce directly from the farms.

Typical transport vehicles in rural areas are old, the average age in this survey being 13 years. Such vehicles are often unreliable and in poor condition, but are able to offer an acceptable level of service at affordable prices. Credit to buy vehicles is normally on an informal basis from family. Formal banks impose strict conditions on collateral and repayment terms. Rural transporters are either unable or unwilling to meet these terms.

Most owners of motorised vehicles undertake routine maintenance and some repairs. A plentiful supply of small workshops will undertake repairs not requiring special tools or skills. Tegucigalpa provides more advanced facilities and skills, but there are reports that skilled mechanics tend to look for higher paid work outside of Honduras.

The surveys also provided data on VOC's (indicative costs) and typical transport charges for the various modes in operation in rural areas. Table 10.2 compares the charges and costs to estimate an indicative operator margin.

Table 10.2: Typical transport charges, indicative costs and operator margins

Type of transport	Typical charge (Lps / km / qq)	Indicative cost (Lps / km / qq)	Indicative margins as a % of cost
Local from farms to Guinope			
Donkey	0.5	0.21	138%
Mule	0.5	0.32	56%
Horse	0.5	0.41	22%
Horse and cart	0.25	0.17	47%
Oxen (2) and cart	0.25	0.23	8%
1 tonne pickup	0.66	0.09	633%
Guinope to Tegucigalpa			
Bus	0.08	-	-
1 tonne pickup	0.08-0.11	0.09	-10% to 22%
3 tonne lorry	0.08-0.09	0.06	33% to 50%

The conclusions reached by the SRI study are as follows:

"The main conclusion we have reached is that there is a ready supply of transport at reasonable prices from the users' point of view. Until the more remote rural roads are improved and receive maintenance, equines and humans will remain the working transport means. Where roads are in a usable condition, motor transport especially buses, 1 and 3 tonne pickups and trucks will predominate.

"This is however dependent on a continued supply of low cost used vehicles and an ability to keep these operational. The availability of low cost second-hand parts therefore remains important.

"Particular issues that require further consideration include:

i) The shortage of skilled mechanics requires that measures be taken to ensure that local skills are upgraded and retained within Honduras. Given the low wage situation in Honduras and the proximity of better labour markets (especially in the USA) it is difficult to envisage how this might be achieved in the short term.

ii) The high cost and strict conditions applied by formal credit sources make these unavailable to rural transporters. Informal sources are therefore essential for purchases and major repairs.

iii) Problems with transport insurance require investigation and resolving.

iv) Cost-effective measures to improve the poor condition of the roads are urgently needed."

10.7.2 Use of the data from the SRI report to run the RTP

The data from the SRI report were used as input data for the RTP. The programme was run in order to determine whether the outputs from the RTP coincided with the recommendations of the SRI report. It was also used to ascertain whether the RTP would pick up possible interventions not mentioned in the SRI report. Table 10.3 details the input data used in the RTP and the output results in terms of operating costs, possible problems and the possible solutions.

10.7.3 Comparison of SRI and RTP results

Many of the conclusions that were drawn from the SRI report were also identified as possible interventions from the RTP. In particular these included the need for improved repair facilities, maintenance attention for the rural roads network and the need for improved access to formal credit. The RTP did not identify issues relating to the need for improvements in transport insurance.

The RTP differed from the SRI report in that it identified unusually high transport charges (for pickups although not for pack 'mules) and it suggested considering alternative modes of transport to meet all users needs. The RTP also made an additional suggestion that consideration should be given to improving access to markets and stores.

Table 10.3: Use of the RTP in analysing the rural transport systems of the Guinope Municipality, El Paraiso Department, Honduras

	District		Regional	
	Collection	Trunking	Collection	Trunking
Area data				
study area (sq km)	204		5000	
1st level stores	12		1	
storage costs (Lps)	90		9000	
2nd level store	1		-	
storage costs (Lps)	900		-	
yield/ha/yr (tonnes)	2.04		2.04	
local use (%)	50		50	
crop area (%)	30		30	
Road engineering data				
gradient (degrees)	> 3.0	1.5-3.0	1.5-3.0	
curvature (deg/km)	> 200	100-200	100-200	
roughness (mm/km)	10-15,000	5-10,000	2-5,000	
rolling resist.	medium	medium	low	
tyre grip	medium	medium	low	
network factor	1.8	1.8	1.5	
Socio-economic data				
interest rate (%)	10		10	
wage rate (Lps)	1.9		1.9	
fuel cost (Lps/ltr)	2		2	
feed (Lps/month)	50		-	
service factor	satisfactory		satisfactory	
diversity	> 5 vehicles		> 5 vehicles	
Vehicle data				
vehicle name	pack mule	pack mule	pickup truck	
load capacity (kg)	90	90	1000	
Vehicle cost (Lps)	1500	1500	16,000	
age of vehicle (yrs)	-	-	8-12 years	
Conditions data				
hours/day	3	3	5	
days/week	5	5	5	
weeks/quarter	10	10	10	
distance out (km)	2.6	8.9	60	
distance retrn (km)	2.6	8.9	60	
load out (kg)	260	1561	1561	
load return (kg)	0	0	0	
load time (hrs)	1	1	2	
idle time (hrs)	1	1	2	

Results				
cost/quarter (Lps)	330.6	351.5	3321 9	
fuel/quarter (Lps)	50.0	50 0	1334 1	
repair quarter (Lps)	3.8	5 1	844 3	
labour qtr (Lps)	238.5	257.3	434 4	
interest/qtr (Lps)	18 8	18 8	200 0	
deprec./qtr (Lps)	19.5	20.4	509 2	
cost/t/km (Lps)	26.3	13.7	1 3	
load/qtr (tonnes)	4.8	2.9	42 7	
no. of vehicles	53.7	541.6	36 5	
no. trips veh	53.8	32.0	42 7	
utilisation (%)	11.2	22.8	128 2	
speed (km/hr)	6.6	6.6	64 9	

Distribution costs		
total dist cost (Lps)	9,947,890	
trunking cost (Lps)	9,106,718	
collectn cost (Lps)	839,191	295,790
1st level store (Lps)	1,080	9000
2nd level store (Lps)	900	

Transport charge (Lps/km)	14.8	14.8	7	

Possible problems	User response
1) Is the supply of formal credit limited ?	Limited availability
2) Is the cost of credit high or low ?	High
3) Are loan security requirements high or low ?	High
4) Are repayment terms appropriate/inapprop. ?	Inappropriate
5) Is routine maintenance adequate/inadequate ?	Adequate
6) Are repair facilities adequate or inadequate ?	Inadequate
7) Is the road condition adequate or inadequate ?	Inadequate
8) Are labour costs increasing or static ?	Static
9) Is gov. taxation on fuel high or satisfactory ?	Satisfactory
10) Is access to stores/markets adequate/inadeq. ?	Inadequate
11) Is transport choice good or poor ?	Poor
12) Are transport charges controlled ?	Controlled
13) Is the level of vehicle subsidy high or low ?	Low
14) Is vehicle utilisation low or high ?	Low

Possible solutions
1) Improve access to rural banks and ease the loan repayment terms.
2) Improve mechanic training and access to servicing facilities.
3) Regular maintenance on rural roads will reduce roughness/seasonal impassability
4) Increase the number of stores/markets where goods can be amalgamated.
5) Examine the possibility of introducing new vehicle modes to fill gaps in supply
6) Encourage competition between operators to reduce charges and raise utilisation

10.7.4 Testing the results from the RTP

In order to test the results from the RTP for relevance the author was able to travel to Honduras in order to ask key informants their opinions on the outputs from the model. The key informants were from the fields of rural development, rural transport, agriculture and academics. The following are the people that were interviewed and the comments made on the RTP outputs:

Direccion General de Caminos (DGC) (General Directorate of roads) - Unit of Technical Assistance

The DGC has responsibility for road construction and maintenance. It was felt that the quantity of roads was not a problem and that the majority of rural communities were well connected to the formal roads network. However, the maintenance of roads is more of a problem and possibly related to the removal of this activity from the public to the private sector. Many of the food for work schemes built roads but were rarely followed up with routine maintenance.

As might be expected the DGC felt that the output from the model relating to reducing roughness on rural roads was appropriate. However, little interest was paid to the outputs relating to improving mobility in rural areas. It was felt that there was no need for the promotion of vehicles in rural areas because of the high usage of animal power anyway. Previous attempts at introducing animal traction to areas of Honduras which have not already had it have failed because of the feeling that it is a backward technology. There is no rural transport policy which deals with the supply of vehicle services; it is all roads based and there is probably a feeling that a policy is not needed either.

Consejo Nacional de Transporte (CNT) (National Transport Council)

The CNT represents the interests of transport owners to the Honduran government. The CNT has no particular interest in rural transport operators but agreed that many of the RTP suggestions would be applicable nation-wide. Particular concern was voiced over the availability of spare parts and the existence of fake parts. Repair facilities are available but only in the major cities. Rural operators must come to the city to have any major repairs carried out. It was also felt that a programme to promote routine maintenance would be a very good idea and that most rural operators had no idea of its importance.

Access to credit facilities was also highlighted as a problem, as 10 years ago there were 2 commercial banks providing credit to buy vehicles, now there are none.

Consejo Asesor Hondureno para el Desarrollo de los Recursos Humanos (CAHDER) (Honduran Council for Human Resource Development)

CAHDER were heavily involved in initiatives to promote rural development. They are particularly concerned with the provision of formal credit facilities for agricultural purposes. They are also concerned with issues relating to marketing and storage which would enable the farmers to operate with a greater degree of freedom from the traders.

As a result this organisation were particularly interested in the outputs from the model, some of which being in line with policies they are hoping to implement. They agreed with the relevance of all the outputs but were particularly interested in the issues relating to improving access to rural banks, increasing the ease of access to rural stores and markets, and the possibilities of introducing new transport modes (power tillers and farm vehicles).

CAHDER are in the process of promoting mobile markets which would meet periodically in various open spaces around Tegucigalpa. These markets would be advertised through local radio and be free for anyone to buy and sell agricultural produce (or anything else). The model highlighted that the excessive distance to market (60kms) in this case would affect vehicle choice and bias against NMT's. I suggested that these mobile markets might also be effective if it periodically met in Zamarano some 27kms from Guinope. This would allow farmers to use vehicles they already own such as donkeys, mules and tractors to transport produce to market and therefore bypassing the traders and giving farmers increased incentives to own their own vehicles. This was a suggestion they felt was worth pursuing.

The power tiller and farm vehicle that were contained in the models vehicle database and for which I showed them photographs were also well received. It was felt that the power tiller would be particularly suited to the small field sizes and sufficiently manoeuvrable for use in hilly conditions. For transport operations it would also be suited to the hilly conditions but would obviously be more useful if markets were within easier reach. The technology associated with the farm vehicle was also felt to be appropriate, but the single cylinder diesel engine may not be powerful enough for the hilly terrain.

The credit facilities that CAHDER offered were purely for agricultural preparation and livestock. They did not lend for transport vehicles. They felt that credit facilities for this purpose were needed but were outside the remit for their organisation.

Land Use and Productivity Enhancement project (LUPE)

LUPE is a project of the Ministry of Natural Resources funded by USAID that promotes rural development with particular emphasis on soil and water conservation technologies. However, it does have wider interests which include village level storage facilities and they have a number of agricultural extension officials working in the rural communities. These officers were in broad agreement with the views expressed at CAHDER but also mentioned the importance of competition between operators. They felt that new operators, particularly in the passenger transport market, faced intimidation from the established operators. It was felt that there was also undue bureaucracy from government departments to get operating licenses.

Traders (Coyotes)

Although the outputs from the model were not directly discussed with the traders it is interesting to state what was learnt during conversation with them with regard to competition between operators. There are 4 traders in Guinope operating a vehicle hire service and marketing and distribution service (acting as traders). They were quite ope in stating that prices were periodically fixed among the 4 traders i.e. they were acting as a cartel. The other point was that vehicle hire only represented 20% of their total business, the rest being accounted for by trading. It was felt that this practise was not in the best interests of the rural communities in the area.

Escuela Agricola Panamericana (EAP) Panamerican Agricultural School

The EAP which is based in Zamarano provides agricultural courses at the BSc and MSc level. The school has 8 departments which conduct research in the Agronomy, Basic Science, Agricultural Economics, Horticulture, Plant Protection, Natural Resources and Biological Conservation, Animal Science and Rural Development.

The academics here were particularly interested in the promotion of alternative vehicle types in rural areas both for agricultural and transport purposes. There was a project underway there to promote buffalo into the rural areas. It was felt that these animals had greater draught potential than the cows already being used, but also could be used for meat and milk. In their field tests they found great potential for these animals both with respect to ploughing and pulling trailers. The outputs from the RTP would not be sensitive enough to make distinctions between cows and buffalo for example, which could be a disadvantage in certain areas.

However, there was great interest in the simple motorised vehicles contained in the RTP database, namely the power tiller and farm vehicle. A number of small power tillers were actually being used by the Horticulture department at the school, but no one was actually aware that these vehicles could be used by small scale farmers and for transport purposes. Like CAHDERH is was also felt that the technology in the farm vehicle was also appropriate for the technical expertise available in the rural areas.

10.7.5 Summary of the RTP results testing exercise

The experts spoken to in this exercise gave a generally favourable response to the outputs from the RTP. All of the outputs from the model were deemed important by at least one of the organisations spoken to. However, it is impossible to say whether these officials would be willing or able to introduce any of these measures or vehicles.

These was a unanimous feeling amongst the respondents that the quality of rural roads needs improving and that this should be treated as a priority. It was felt by the author that although the roads were indeed in a bad condition they did not affect accessibility (even seasonally) and that they did not affect the level of service that could be expected on these roads. It served as another indication that even officials operating in rural areas consider rural transport problems as primarily a roads problem.

The main outputs of interest other than roads were issues of marketing and modal choice. There was interest in the idea of bringing markets closer and making them more accessible to rural people. Many of the vehicles contained in the RTP database were unknown to many of the officials, or at least the extent to which they can be used for transport activities, and considerable interest was shown in the power tiller and farm vehicle.

10.8 A summary of the model development

This chapter has described the development of the "Rural Transport Planner" which is a computer programme to aid in making interventions in rural areas designed to improve rural accessibility. The RTP has various components which include a VOC model for rural vehicles, a vehicle database, a model to calculate total distribution costs, and a set of knowledge based rules designed to recommend possible interventions to improve the efficiency of rural transport systems. The model is based on the flow diagrams contained in appendix F which show the decision making paths used by the RTP.

The model requires information on the size and estimated demand in the study area, the number of storage/marketing facilities, infrastructure and vehicle types on both the collection and trunking sectors. This allows the calculation of VOC's, storage costs and the resultant total distribution costs.

The model was tested for its validity in Honduras with the help of a report compiled by SRI and various organisations involved with rural transport in Honduras The experts felt that the outputs from the RTP were relevant for Honduran rural transport and were particularly interested in the vehicle database and the outputs relating to ma keting and storage.

CHAPTER 11

DISCUSSION AND CONCLUSIONS

11.1 Brief review of the project methodology

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

This study has attempted to address the issue of unreliable and often expensive rural transport which hinders agricultural development in the rural areas of developing countries. The aim of the project has been to examine the supply of vehicle services, with particular regard to the consequences of low vehicle numbers and diversity in rural Sub-Saharan Africa, and the effect that this may have on transport charges, competition, operator efficiency and the reliability of vehicle services.

To further our understanding of the often complex nature of the provision of rural transport services a number of data collection exercises were embarked upon. These were undertaken in Thailand, Sri Lanka, Ghana, Zimbabwe and Pakistan. Following dis ussions with experts before the survey visits, these five countries were recommended as having rural transport systems with differing characteristics.

Thailand represents the most advanced transport system with most of the rural population in the study area having access to simple motorised vehicles. Sri Lanka has high population density, easily accessible markets and high vehicle diversity. In many rural areas there is a transition from non-motorised to motorised modes of transport. Pakistan has an extremely efficient transport system with knowledgeable operators and high vehicle diversity, and in particular it was recommended as a good country from which to collect vehicle operating cost data. Zimbabwe has one of the best transport infrastructures in Southern Africa and has successfully managed to introduce animal carts. Ghana has an inefficient transport system and as a consequence the rural population is very isolated. The majority of rural transport is conducted by headloading, and vehicle numbers and diversity are very low.

Participatory Techniques of Rapid Rural Appraisal were used for the data collection exercises. This approach assumes the respondents are the experts and is sufficiently flexible to allow them to take control of the exercise. Many of the surveys involved group discussions which can dramatically improve the accuracy of the information as continuous interaction within the group crystallises the responses. The approach was particularly relevant because of the lack of prior knowledge of the factors affecting vehicle adoption and transport efficiency in rural areas.

Data were collected on vehicle operating costs (VOC's) and performance for a wide range of commonly used rural vehicles. These included non-motorised vehicles such as headloading, bicycles and animal transport, as well as motorised vehicles such as conventional trucks and pickups, agricultural tractors and simple engine-powered vehicles. This exercise has allowed the creation of a rural vehicle database which contains the main performance and use characteristics of each of the vehicles studied. This has been combined with a mechanistic model (called PABAC) developed by Crossley (1985), which predicts VOC's for the full range of vehicles in the study. The database currently contains 47 motorised and non-motorised vehicles.

In addition to the VOC information, data were also collected on the user costs of rural transport services and the factors necessary for the creation of a sound operating environment most likely to allow the successful introduction of new vehicle technology. Of particular concern were the effects that factors such as credit facilities, markets and storage facilities, competition, the regulatory environment, and government policy have on the efficiency of rural transport services.

Analysis of the data demonstrated large differences in the VOC's and transport charges for rural transport services between the generally efficient systems in the Asian countries and the inefficient ones in the African countries studied. This finding formed the foundation for the development of a framework which took the transport charge as its basis, see figure 9.4. It was felt that the transport charge could be divided into two components: the vehicle's operating costs and the operators' margins. The size of these components is dependent upon the efficiency with which transport operations are conducted which in turn is related to the operating environment. The framework therefore identifies the relationships between transport charges, VOC's, and factors relating to the operating environment.

The framework was then used to develop a knowledge based computer programme or expert system which has been named the "Rural Transport Planner" (RTP). The RTP is designed to aid in the selection of appropriate transport vehicles and to make recommendations on interventions that may improve the efficiency of rural transport systems. The relationships developed in the framework have been constructed as rules within the RTP. The rules are activated in accordance with the trigger levels that have been built into the system. The flow diagrams that form the basis for the RTP are included in appendix F.

Following the development of the RTP, a survey trip was made to Honduras to test the validity of the model. This was done in conjunction with a report prepared by Silsoe Research Institute (SRI) which formed an independent view on VOC's, transport charges and the factors affecting the efficiency of rural transport in the Guinope Municipality, Honduras. It was found that the outputs from the RTP had a useful role in determining problems and making recommendations that were in line with those of experts. The RTP also provided a way to challenge preconceived ideas on appropriate vehicles and the way to solve rural transport problems.

11.2 Main findings

1) VOC's were found to be substantially higher in the African countries studied compared with the Asian countries. The data showed that the VOC's of conventional vehicles were between 2.8 and 10 times higher in the African countries than in Asia. Similarly, agricultural vehicle VOC's were between 2.7 and 4.6 times higher in the African countries. The higher African VOC's are attributed to inadequate routine vehicle maintenance, low utilisation levels and uncompetitive transport markets which result in inefficient operator practise.

2) Where factor prices were kept constant between countries, it was found that repair costs accounted for a higher proportion of total costs in the African countries studied than in the Asian countries. For example repair costs were over 5 times higher for tractor operations in Zimbabwe compared with Sri Lanka, and repair costs ranged

from 7 to nearly 16 times higher for vehicles in Ghana than in the Asian Countries. It is suggested that these large differences can be attributed to poorer routine maintenance practice in the African countries. It was found that the total routine maintenance spend was lower, the frequency with which these activities took place was less and that the understanding of why these activities were important was also lower in the African countries.

3) Levels of vehicle utilisation in the African countries studied were far below those in the Asian countries. In many cases the utilisation in terms of kilometres per year driven or hours per year operated were less than half in Africa compared with Asia. It was suggested that these differences may have been accounted for by a less competitive operating environment and a lower density of demand in Africa.

4) Transport charges were also found to be substantially higher in the African countries than in the Asian countries, for example, between 2.8 and 5.8 times higher over a trip distance of 5 kilometres for non-motorised transport (NMT's), while motorised vehicles had transport charges that were about double of those in the Asian countries for short distance trips (10-25 kilometres). Part of this difference can be accounted for by higher VOC's but it is suggested that uncompetitive transport markets due to poor vehicle choice and excessive regulation also has a bearing.

5) Levels of vehicle ownership are higher in the Asian countries studied. For example, Sri Lanka has nearly 4 times the number of non-motorised vehicles per head of population compared with Zimbabwe, and nearly 14 times more than in Ghana even tho gh their income levels are broadly comparable. The situation for motorised vehicles is even more pronounced, with Sri Lanka having over 5 times the number of Zimbabwe. Many of the villages found in the Western Region and Affram Plains area of Ghana had no immediate access to motorised vehicles at all. In these areas motorised vehicle services are provided by traders from urban centres.

6) The vehicle diversity measure (see table 9.10) in the African countries studied is far below those in Asia. For example, the diversity measure in Ghana is less than half the value for the other Asian countries and almost a third the level of Thailand. Ghana in particular lacks diversity at the mid and low end of the vehicle range.

7) Choice of vehicles in rural communities are usually heavily biased towards their strengths in agricultural production, therefore multi-task vehicles (i.e. those that can be used for agricultural and transport purposes) are very popular. Despite the emphasis by the farmer on the agricultural capabilities of the vehicle, the surveys demonstrated that transport represented a significant component of total use. In most of the countries studied transport often accounted for up to 50% of total operations and in countries like Pakistan many tractors were used solely for transport purposes. Evidence from the Bare co-operative in Zimbabwe suggested that the transport operations were the most profitable.

8) Of the vehicles studied it was thought that the power tiller and trailer provided one of the most interesting multi-task vehicles for promotion in the rural areas of developing countries. Its uses include ploughing, threshing, harvesting, pumping water, transport activities and electricity generation. The single cylinder diesel engine is light, easy to maintain and transferable for other uses.

9) Other factors that have been found to be essential in the creation of an efficient transport system include credit facilities, access to markets, dissemination of information, access to alternative income sources and competitive transport markets.

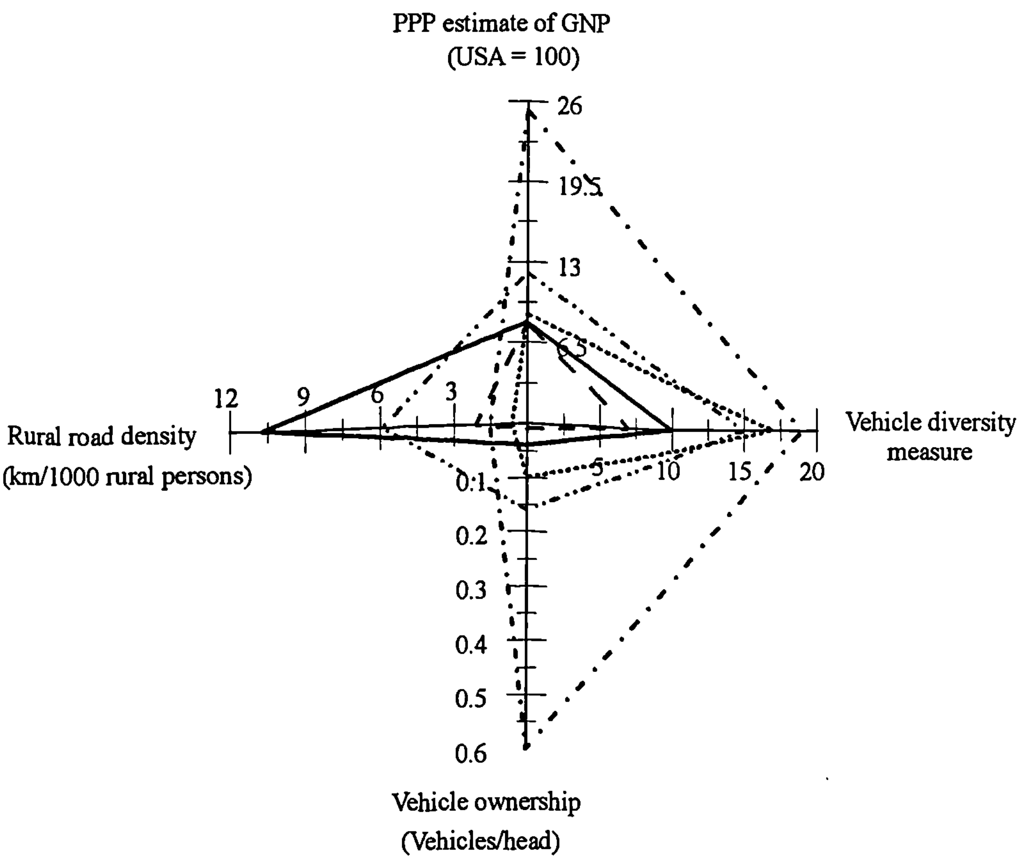
11.3 Implications of the findings

The findings from the case studies clearly point to major inadequacies in the rural transport systems of the African countries studied. These relate to the cost, availability and reliability of the provision of rural transport services. The research has shown that rural communities in the African countries studied have poor access to transport services. However, currently donor agencies and developing country governments appear to only pay lip service to improving access to vehicle services. The evidence still seems to suggest that the greatest emphasis is placed upon the construction of rural access roads. The evidence from this project points to access to vehicle services as being of greater immediate concern than the provision of physical infrastructure.

11.3.1 Under Capacity for transport services in rural areas

Figure 11.1 presents the transport "diamonds", which represent the degree of development of rural transport systems, for each of the five countries studied. The basis of the diagram is that the larger the diamond becomes, the more developed is the transport system. These "transport diamonds" have been modified from "development diamonds" which seek to show the differences in factors such as infrastructural endowment, literacy levels and economic indicators for countries at varying income levels such as those shown by Chhibber et al (1993).

Figure 11.1: Transport diamonds for the five survey countries



Thailand	Sri Lanka	Pakistan	Zimbabwe	Ghana
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In figure 11.1 there are four axis; the vehicle diversity measure (see table 9.10); the level of vehicle ownership; the Purchasing Power Parity (PPP) measure giving an indication of relative income levels between countries (USA = 100); and the rural road density (Length of rural roads divided by rural population).

The diagram graphically illustrates that Thailand, Pakistan and Sri Lanka have far higher levels of vehicle ownership and vehicle diversity than the African countries. Although Thailand has by far the highest income level, the other four countries are very similar. The most significant aspect of the diamonds is that rural road densities do not follow the same pattern as vehicle ownership and diversity. Both Ghana and Zimbabwe have higher rural road densities than either Thailand or Pakistan (although much of Pakistan is desert with few people). Zimbabwe has the highest rural road density of any of the countries studied. This suggests that there may have been an over emphasis on road building in Ghana and Zimbabwe.

The transport diamonds also give support to the original choice of countries The diamonds show large differences in the infrastructural endowment of the countries as well as the level of vehicle ownership and diversity. This meets the original objectives of finding countries with rural transport systems that show widely different characteristics.

The conclusion drawn from the findings of this study, is that transport capacity in terms of access to vehicle services in the rural areas of Ghana and Zimbabwe is low in relation to fundamental demand. Access to vehicle services, motorised or non-mo orised, is lower in the African countries studied than the Asian countries However, the African countries have as good or better access to the physical infrastructure.

The implication for policy makers in Ghana and Zimbabwe is that the use and ownership of all types of rural transport vehicles should be promoted A greater emphasis should be placed on improving access to vehicle services and less emphasis on increasing the supply of new road infrastructure. The under capacity in the transport system must be addressed. It is in the planning of how rural transport systems can be more effectively delivered that the "Rural Transport Planner", which has been developed as part of this project, has been based.

In addition to the more careful planning of rural transport interventions, there may also be a case for importing vehicles to areas where severe shortages in capacity are identified. This policy has actually been adopted by donor agencies with regard to under capacity in the freight industry. For example, large numbers of trucks have been imported into countries such as Zimbabwe, Zambia and Tanzania. The World Bank's Sub-Saharan African Transport Programme (SSATP) has also tried to implement similar schemes for NMT's. There are obvious difficulties in the implementation of such schemes but the mechanisms by which they can be addressed are discussed in section 11.3.5.

11.3.2 The efficiency with which existing rural transport services are provided

The detailed analysis of the VOC data shows that there are large differences in variable costs of vehicle operation, but also in the level of vehicle utilisation. Generally, it is the African countries which have higher variable costs and lower levels of utilisation.

Variable Costs

It has been suggested that the higher variable costs of operation in Africa can largely be attributed to poor routine maintenance practice. The result is that repair costs are high and down times long. If the efficiency of the vehicle fleets in each of these countries is to be improved, more attention has to be paid to increasing the awareness of vehicle operators to the importance of routine maintenance.

There are existing donor-assisted schemes which are trying to improve the skills and resources available to urban and rural workshops. The scheme in the Kumasi Magazine in Ghana called GRATIS, is a good example, where information is disseminated and training provided for mechanics around the country (see Box 6.1). However, this may not get to the root of the problem which often stems from poor operator practice. Perhaps more resources should be channelled into operator training, to emphasise the importance of routine maintenance and the type and frequency of maintenance to be carried out.

Training initiatives are already carried out in many of the better tractorisation schemes, but poor routine maintenance is still a major cause of high repair costs even in these.

With the size of the potential cost savings being so great, the returns to this type of intervention could be considerable, both in terms of lower operating costs and higher vehicle utilisation.

Utilisation and competition

The low levels of utilisation found in Africa have the effect of pushing up fixed costs and therefore total operating costs. This in turn leads to upward pressures on transport charges, which may explain why charges appear so much higher in the African countries. Measures aimed at increasing utilisation may also help to bring down transport charges.

Between Africa and Asia there appears to be a different culture in the way that both motorised and non-motorised vehicles are operated. In Asia the owners and/or operators actively seek alternative business opportunities, and travel sometimes hundreds of kilometres across agro-climatic zones, to find high demand areas. In this way they maintain high levels of utilisation all year round. In contrast, African operators tend to use their vehicles very intensively at certain times of the year, such as harvest, but then have long periods where they are relatively idle.

It is suggested that there are two main reasons for the lower utilisation levels in Africa. First, the density of demand in many African countries is quite low, because populations are more dispersed and agricultural production less intensive. Second, the transport market is less competitive for both passenger and goods transport. The lack of competition is heightened by low vehicle ownership and diversity in areas of rural Africa.

The density of demand in the Asian countries studied was higher than in the African countries. The higher population density increased the level of economic activity and hence the demand for transport services. As a result there was greater demand for passenger movement, transport related to rural industries and the transport of building materials. In addition, more intensive agricultural production increased the need for transport services. The quantity of inputs are higher, as are the resultant yields. The operators of rural vehicles in the Asian countries were able to keep their vehicles fully utilised throughout the year, due to the nature of the different transport activities required.

Despite the lower density of demand in Africa, the current vehicle fleet cannot meet the existing demand in many rural areas. There are obvious shortages of transport services. For example, the residents of the Bonyo village in Ghana would often not fully harvest their crop of maize because they had no way of getting it to market (section 6.2). In addition, rural populations in the African countries studied had long waits for passenger transport. In remoter communities the greatest fear was of people falling seriously ill because there are no vehicles to take them to hospital. In many cases the communities were effectively inaccessible despite having a road or track passing through the village.

The other factor which affects the utilisation of vehicles is the degree of competition in the market. In a competitive market vehicle operators have to reduce their charges as low as possible to attract customers, and they can do this by increasing the utilisation of their vehicle and reducing their margins. Where vehicles are being highly utilised they also have to be well maintained, which may account for the better routine maintenance practice in Asia.

There are a number of factors that may promote competition in a rural transport market. These include an environment which does not have restrictive legislation, high demand, a large number of vehicle operators and high vehicle diversity. It is the first of these points that policy makers may in the first instance have the most power to influence. For example Ghana has very strict regulations on almost every aspect of inter-urban and rural transport. It is likely that these regulations discourage operators from increasing utilisation by lowering fares and aggressively marketing their services. It also discourages new operators from entering the market. This creates inefficiencies in the operation of the current fleet of vehicles that would not have been sustainable in the long run had operators been subject to greater competition. The regulations also distort the supply of vehicle services. On some routes, normally urban or inter-urban, it has been reported that vehicles wait for up to two weeks for a load, despite a shortage of vehicles on rural routes.

Government has an important role in promoting competition, as well as developing appropriate policies to help develop a conducive atmosphere for the efficient provision of vehicle services. For example, many African cities that have deregulated their bus services have seen a large influx of small minibuses which are ideal for serving small pockets of demand. Similarly, a more deregulated rural transport system could well see an increase in the use of smaller vehicles for passenger and goods movement. However, a potential stumbling block could be the lack of vehicle choice to take up this challenge.

11.3.3 Vehicle choice

The range of vehicles that have been reported in this study has been wide, and includes human powered, animal powered, simple motorised, agricultural and conventional motorised vehicles. However, the majority of these vehicles are in common usage in Asia only, with the findings highlighting that vehicle ownership and diversity are far lower in the African countries studied.

Low diversity and ownership may be due to the limited density of demand in many of these areas. It is also possible that many of the rural communities in Africa are just not aware of the potential or of the existence of other modes of transport. It could also be that cultural taboos have slowed the introduction of new modes of transport. In many Asian countries for example, animals have been used for rural transport for thousands of years, where it is ingrained in the culture and the experience passed down from generation to generation.

The introduction of alternative vehicle types in rural Africa will need a considerable learning process. For example, the introduction of pack donkeys into the Makete District of Tanzania was difficult, with high mortality rates, particularly among the yo nger donkeys. However, the donkeys have become increasingly popular in the area because, for example, they enable farmers to transport greater amounts of fertiliser which has increased yields. The donkeys have also boosted the ability of households to market their produce (Sieber, 1994).

The modes of transport that have been particularly favoured are those which are multi-purpose, for use for both agricultural and transport purposes. In this regard, animals provide an excellent source of draught power. Of the animals studied all can be used for both ploughing and transport, either as a pack animal (except oxen) or for pulling a trailer. Animals like the donkey, mule, horse and camel have great advantages for transport because they are strong and can be used as pack animals and with a trailer. Oxen have greater advantages in ploughing, which is the predominant criterion in farming communities and probably the reason why they are the most common draught animal around the world. Oxen have the added advantage that in almost all communities that they have high status.

Motorised agricultural vehicles such as conventional tractors and power tillers also provide a multi-purpose role. They are considerably more expensive to operate and buy than animal power but do have transport advantages over animals when the density of demand is high enough. In general it would appear that they have few advantages over animals with regard to ploughing if income levels and the cost of keeping animals is low. Evidence suggests that substitution effects are stronger than productivity effects with regard to agricultural operations, in other words it is not until the price of labour and the cost of keeping animals exceeds a certain level that it is worth switching from animals to machinery.

The power tiller is particularly interesting because it fills the very large gap between animal power and tractor power. The technology is relatively simple and because its uses are so diverse it can be utilised all year round. For example, in the African context it could be used for transport, ploughing (soil permitting), as the power unit for grinding mills, for irrigation, threshing and for electricity. It would be the perfect vehicle for an entrepreneur to own and operate, but is probably too expensive for general purpose household use.

Thailand was the only country visited that had a thriving industry producing simple motorised vehicles such as the power tiller and farm vehicle. These vehicles are copies of conventional vehicles, but based on very simple technology appropriate for the needs and resources available in rural communities. This type of industry could be encouraged in other parts of the world, particularly in areas where there are existing workshops. This type of technology has the potential for reducing operating costs considerably, particularly for short distance trips. The local manufacture of these and other vehicles can reduce the need for acquiring expensive foreign exchange and make the vehicles more responsive to the needs of rural populations.

With regard to conventional vehicles, the use of large trucks for inter-urban freight movement has been well documented. However, the use of pickups in rural areas has not received the same attention. The surveys have shown that these vehicles can provide an extremely important role in both passenger and goods movement in rural areas.

11.3.4 The connection between agricultural and transport policy

The prime function of many of the vehicles that have been examined in these studies is for agricultural preparation. However, the evidence suggests that in many cases these vehicles can be used as much or more for transport activities. It also appears that the transport activities can be more profitable. In the light of these findings it seems sensible that agricultural and transport policy are closely linked and that when agricultural projects or tractorisation schemes are planned, that full account is taken of the transport potential of various vehicles.

It was found that some of the most successful rural transport systems were operating alongside strong agricultural extension services. These services disseminated information about new technologies, current farming techniques and marketing information. Agricultural extension services could play a vital role in promoting new vehicles and training in their use. In addition, extension officers have probably the best information on the needs of rural communities. These views could be communicated back to policy makers to ensure other interventions are more responsive to rural communities needs.

11 3.5 Mechanisms through which vehicles and other services can be promoted

There have been many attempts in the past to introduce new technologies and services into rural areas but they have proved to be unsustainable in the long term. This has been true for tractorisation projects, credit schemes, ox carts, grinding mills and a host of other technologies. There are a number of reasons for this high failure rate. One of the main reasons is that the community or the individual does not have full ownership of, or responsibility for, the technology or activity. This may come from the fact that they do not perceive the need for it, or they do not have full control over its use or returns. As a consequence maintenance is neglected, and there is default on interest payments .

The evidence from this project is that vehicles are better operated in the hands of individual entrepreneurs. They are more likely to care for their vehicles and keep them highly utilised because they have the incentives to do so. This has particular implications for the provision of credit. In the past many rural development schemes have loaned funds to co-operatives under the assumptions that there is a community need for the service and that only a group can provide the necessary collateral for the loan.

Experience from the Bank of Agriculture and Co-operatives (BAAC) in Thailand has shown that the problem of the necessary provision of security from small scale farmers can be solved by asking groups of farmers to provide the security for one loan to an individual. The group can apply great peer pressure to a member of the group if they default. In many cases the group may even repay the loan themselves to avoid prejudicing their chances of getting a loan in the future. In this way the entrepreneuring spirit can be promoted while the service is still provided and probably more efficiently and in a more sustainable manner. If individuals make excess profits then other operators will join the market, increasing competition which then places a downward pressure on prices.

The role of developing country governments and donors should be to develop the expertise to ensure that rural transport capacity can be maintained. Considerable effort should be placed on training vehicle operators, mechanics, agricultural extension officials and the financial organisations in both the formal and informal sector. It is clear that in the process of developing rural transport capacity, particularly in much of Sub-Saharan Africa, subsidy is required. However, if capacity is to be developed in a sustainable manner then the subsidy should be placed on training and not on reducing the capital costs of purchasing vehicles. Subsidising the purchase price or interest repayments on vehicles will encourage operators to join the market who are unable to meet the real costs of operation in the long term.

The experience from the five surveys in this study has demonstrated that the existence of credit facilities is far more important than the cost of those facilities. Resources are scarce in the rural areas of developing countries, and a market rate of interest increases the chances that those resources will be used by the most efficient operators.

11.4 The role of the Rural Transport Planner

The research conducted to date on the provision of rural accessibility, particularly in Sub-Saharan Africa, has demonstrated that a more integrated approach is required in the planning of rural accessibility. It has been stated by Dawson and Barwell (1993) for example, that a new integrated approach should include the provision of conventional roads, vehicle services, the improved location of essential services and the construction of paths and tracks. The approach being advocated in this thesis and the RTP is to include all of these criteria but to also stress the importance of government policy, the availability of credit and alternative income sources, operator and mechanic training and a regulatory environment which promotes competition.

The current models such as RTIM, HDM and the approach advocated by Beenhakker (1987) to the appraisal of rural access infrastructure are very much infrastructure based models. They are purely designed to appraise the relative advantages of various infrastructure alternatives. Vehicles are only relevant to these models in so far as the benefits from infrastructure improvement come from vehicle operating cost savings. The approach taken by Crossley is different in that his model (PABAC) is designed to cost various transport operations. The road in this case is merely the limiting factor on the operation of particular vehicles, the roughness of which in particular influences operating costs.

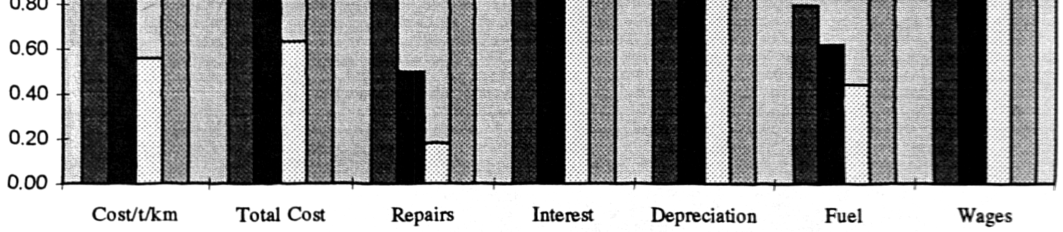
Many of the findings in this thesis have been referred to in the current literature but this is the first time that many of them have been quantified in a cross country study. Data have been collected on the components of VOC's for a wide range of vehicles in five countries. The differences in VOC's have been identified, quantified and attributed to a range of factors from poor routine maintenance to insufficient credit facilities. The framework which has developed from this (see appendix F) and the rules which have been used to determine the paths have been included within the RTP.

The RTP is effectively a user-friendly framework to aid in the planning of rural transport services. In line with a more integrated approach to rural accessibility it takes the user through all the important components of a successful rural transport system. Although this is the first step in the development of this type of system, the model provides the first attempt at actually quantifying within a rigorous structure the levels at which various interventions are appropriate. With more research these trigger levels can be refined and new ones added.

11.4.1 The validity of the RTP

The results from the five surveys have demonstrated that operating costs for various classes of vehicle are not uniform throughout the world. This makes prediction of VOC's difficult, particularly when there is such a wide range of motorised and non-motorised vehicles being used for rural transport. Figure 11.2 and 11.3 show the accuracy of RTP predictions based on the ratio of RTP values to the observed data from the field studies (RTP values come from the PABAC model). Figure 11.2 shows the comparisons for Pakistan where VOC data was easy to collect and the vehicle operators had good routine maintenance practise. Figure 11.3 shows the comparisons for Ghana where VOC data was much harder to collect and routine maintenance practise was poor. In both cases the quality of the infrastructure inputs to the programme were kept constant but for Pakistan the standard of routine maintenance was said to be "good" and in Ghana it was said to be "poor". These variables are changed in the RTP by altering the value for SERFAC (see section 10.5.1, screen3).

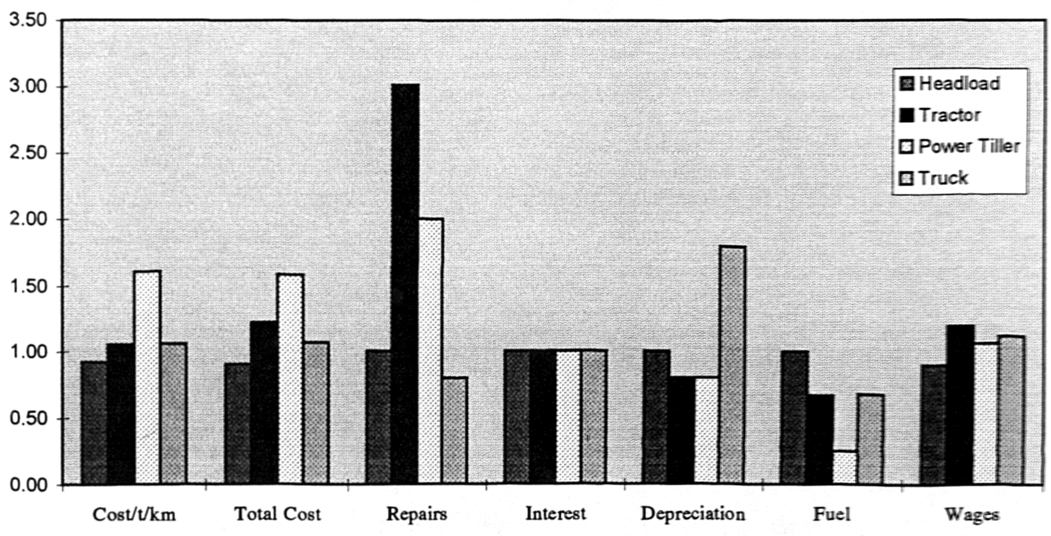
Figure 11.2: Ratio of RTP results to observed values for various vehicles in Pakistan



For both Pakistan and Ghana the cost per tonne per kilometre are similar for both the observed values and RTP values. However, the motorcycle in Pakistan and power tiller in Ghana fall outside the range that might be expected. This is probably due to a combination of the accuracy of data collection and the relationships used within the PABAC model for the way that quality of routine maintenance affects repair costs for particular vehicles. The tractor in Ghana for example shows much higher predicted repair costs than the observed data would have suggested.

The figures show that the main problem with the predictive power of the model is with estimating repair costs. In addition to road roughness, gradient and other road engineering variables, repair costs in this model are related to the quality of vehicle servicing. The inclusion of coefficients within the model to adjust for differences in servicing regimes came as a result of the large differences in operating costs that were being encountered during the five survey visits. The coefficients were based on engineering judgement and applied for all vehicle types. It is clear that more research will be needed in the future to apply these coefficients more accurately.

Figure 11.3: Ratio of RTP results to observed values for various vehicles in Ghana



The validity of the predicted VOC's was further justified in Crossley's PhD thesis (1985) where he compared VOC's from his model with those of the RTIM model for more conventional vehicles. Again predicted VOC's were within similar ranges to those shown here.

As discussed in chapter 10, the other outputs from the RTP such as the vehicle database, and intervention recommendations were tested in Honduras. The outputs were shown to various key players in rural transport planning and rural development such as academics, government ministries, agricultural extension agencies and transport associations. There was much interest in some of the outputs such as alternative vehicles, suggestions on credit, marketing facilities and competition. The suggestions were considered viable and worthy of further consideration. Access to marketing facilities was already an issue that was being looked at.

The experience in Honduras reaffirmed the need for a system such as the RTP. Most of the key players in Honduras still think about accessibility, and rural development, in terms of access to better roads. Many of the roads were in poor condition in the rural areas of Honduras but they did not cause inaccessibility. The transport problems were more a function of poor access to vehicles and high transport charges than poor access to roads. Even if the RTP is used only to encourage planners and policy makers to think about accessibility in a more integrated way, then it will have served a valuable service.

11.4.2 Uses for the RTP

This type of prediction system is likely to become increasingly useful as donors and developing country governments realise the importance of vehicle services in promoting accessibility in rural areas. Already the Road Maintenance Initiative (RMI), which is targeting nine countries in Sub-Saharan Africa to improve their maintenance systems through institutional reform and improved management practice, has included a component for promoting non-motorised modes of transport. In Tanzania there is a Village-level Travel and Transport Programme (VTTP) which is promoting an integrated rural transport approach in five districts of Tanzania. This programme has the backing of eight donor organisations including The World Bank, the Overseas Development Administration (ODA) and the Swiss Development Corporation (SDC).

With many other similar initiatives going on, particularly in Sub-Saharan Africa, the RTP could potentially provide an invaluable tool for rural transport planners. It would not only provide a database of appropriate vehicles but also a tool for planning the positioning of essential services and the types of local and national policy reforms required for the successful implementation of transport projects.

Another role for the RTP would be in the training of would-be experts, those who have a basic knowledge of the subject area but require more information on vehicle types available or the types of interventions available to them. Possibly the best use of this type of system would be as an aid to an experienced planner who needs a system to provide a checklist or a quick way of exploring various scenarios.

The RTP may also be useful in HDM IV which is currently under development. For the first time a conventional road appraisal model will have the facility to include a country's fleet of non-motorised vehicles (in the development of the current HDM IV slow moving vehicles such as tractors are categorised as non-motorised to simplify the modelling process (PADECO, 1996)). It is now considered that upgrading roads will have positive benefits for these vehicles as well as for more conventional vehicles. The RTP database of 47 vehicles is the most comprehensive available and could be used alongside HDM IV for the prediction of non conventional VOC's.

Despite these advances the main reason for including non-motorised vehicles within HDM IV is to model how these slow moving vehicles affect the speed of conventional traffic on paved roads. Economists still have great difficulty in justifying the building of low volume unpaved roads despite the desire by donors to promote rural development. On many low volume roads the quantity of non-motorised or agricultural traffic far outweighs the conventional traffic. In many cases these vehicles p obably represent the greatest majority of goods moved in terms of both tonnes and tonne kilometres.

Where conventional infrastructure cannot be justified then paths and tracks may be the next best alternative. In order to appraise this infrastructure the benefits of upgrading have to be quantified. If a footpath is to be upgraded for bicycle and motorcycle use the benefits in terms of VOC savings have to be costed. Both in the appraisal of low volume conventional access roads and paths and tracks, the RTP provides the only means by which planners can estimate VOC's for all of the most commonly used rural vehicles.

Evidence from previous studies suggests that a tool which enables planners to promote efficient rural transport services and hence reduce transport charges could have a fundamental impact on income and productivity.

Chhibber (1993) found that in Ghana an increase in crop prices of 10% would increase the production of root crops by 4% and cereals by 5%. A reduction in transport charges would have the effect of increasing farm gate prices and hence incentives to increase production. Ahmed and Hossain (1990) calculated that farmers in Africa only receive 30-50% of the final price of their products compared with 70-85% for Asian farmers, and that transport accounted for the majority of the costs. A reduction in transport charges would reduce costs and increase the price received by the farmer, so incomes would increase as a result. A survey in Kenya found that a 1% reduction in passenger fares would lead to a 0.5% increase in passenger journeys (Airey, 1990). In this case a reduction in transport charges would increase rural mobility, economic activity and quality of life.

The RTP is not designed to be a tool that will be prescriptive and give an "answer". It does not have an optimisation procedure which recommends the best vehicle, but rather encourages the user to embark on an iterative process to better understand the vehicles available. In this way the RTP acts as a model for discussion and allows the user to explore the alternatives, there are no right answers.

11.5 Limitations of the Rural Transport Planner

Evidence from the survey trips has demonstrated that within continents and even within countries, there are very different transport systems in place. What is clear is that there is a whole range of factors that may affect the efficiency with which a rural transport system operates. In most cases this cannot be narrowed down to one factor. As a result the RTP will never be able to give a definitive answer as to the factors which must be in place for the transport system to be successful, and indeed this was never the objective. What it does do however is to provide the user with a "checklist", tailored to the case being investigated, of factors which should be considered in the planning of rural accessibility. It will bring to the attention of rural infrastructure planners the importance of efficient vehicle services, without which the infrastructure is useless.

As has been discussed earlier in this chapter, evidence from the five countries is that vehicle operating costs are very different for a variety of technical, economic and cultural reasons. The RTP attempts to model these differences by asking the user whether the study area has good or bad maintenance practice, so that countries with poor maintenance practice have an adjustment in the equations to increase VOC's. HDM for example gets over this problem by having a different set of relationships for different country types. However, these large differences in VOC's between countries do mean that accurate prediction of VOC's is very difficult. This is particularly the case for the prediction of repair costs.

A feature that has been stressed through this thesis is that successful rural vehicles are truly multi-purpose in terms of their ability to transport goods, passengers and their performance in fields. The limitation of the RTP is that demand for vehicles services is expressed solely in terms of the demand in tonnes. Considerably more research would be needed to make the model complete with respect to vehicle utilisation for passenger movement and agricultural activities. However, by broadening the scope to include these activities the user would also need input data that might not be as widely available as that required at the moment. Despite this limitation the user does have a certain amount of freedom to adjust demand levels to accurately reflect the situation in the study area.

The RTP is a tool to aid in the selection of vehicle choice and to improve interventions that affect the efficiency of their operating environment. These types of interventions may impact on various social groups and on equity in different ways and this is not addressed in the RTP. For example, Women may not benefit from improved vehicle selection as men tend to "own" new technology. Similarly, the level of inequality may grow in rural communities as richer members benefit first from improved transport devices. Therefore, there are many important social considerations that will need to be taken in conjunction with the use of the RTP.

The RTP recommends various market interventions to increase competition and the efficiency of transport services. The suggestions for increased liberalisation and deregulation are in line with recent policy changes in organisations such as the World Bank and donor agencies. However, the RTP gives no guidance on why markets are as they are or the power structures at play. As such, in planning rural transport interventions attention should be paid to these points. For example, the GPRTU in

Ghana is a very powerful organisation which is involved in vehicle licensing, traffic enforcement and some road maintenance activities. Hasty legislation against such an organisation could have dangerous implications.

The surveys highlighted some monopolistic control of markets, poor routine maintenance practise and how import policy can distort the market for vehicle services. These factors have been built in to the RTP but have not been dealt with in detail. The RTP highlights cases where there could be monopoly control, poor routine maintenance or import policies that need changing and leaves it to the user to examine these issues in more detail. Wider policy issues such as vehicle safety are not covered.

It should also be noted that the RTP has been developed on the survey findings from the five case study countries. The data were collected using Participatory Techniques of Rapid Rural Appraisal (PRA) which allowed a large amount of data to be collected on a broad subject base. However, as discussed in chaper 3 there are certain limitations to the PRA technique which may lead to some bias in the results. For example, where respondents give answers that they feel may lead to their advantage rather than by giving factual answers. This was felt to be a minor problem but could however affect the relationships within the RTP.

11.6 Conclusions

1) The emphasis on planning for rural accessibility has been too focused on providing roads access. There has not been enough emphasis on the provision of rural transport services.

2) The shortage in the supply of rural vehicle services is particularly acute in Ghana and to a lesser extent Zimbabwe. The level of vehicle ownership and the diversity of vehicles available is far higher in Thailand, Sri Lanka and Pakistan. Alternative vehicle types, both motorised and non-motorised, need to be promoted in the African countries.

3) The markets for rural transport services are less competitive, less efficient and more expensive in the African countries. A less restrictive regulatory environment could promote competition, reduce costs and improve efficiency in these countries by

encouraging operators to increase utilisation and allowing new operators to enter the market.

4) The shortage in vehicle services and less competitive transport markets in the African countries studied are demonstrated by higher transport charges and VOC's. Motorised VOC's were found to be between 2.7 and 10 times higher than in the Asian countries. Similarly Africa has transport charges for motorised vehicles which are about double, and non-motorised charges that are between 2.8 and 5.8 times higher than in Asia.

5) Rural accessibility planning needs to take a more integrated approach, such that the provision of roads is considered in conjunction with vehicle services, the location of essential facilities and the construction of paths and tracks. Additionally, it needs to take account of the impact of government policy, credit facilities, extension services and marketing opportunities. The RTP provides an ideal tool for planners to address these issues.

6) If the promotion of alternative modes of transport is to be sustainable in areas such as Sub-Saharan Africa the mechanisms by which they can be introduced must be studied closely. It is suggested that rural entrepreneurs, and not co-operatives, enable the most efficient means of providing these services.

7) The ability of the RTP to predict VOC's for most vehicles is good. However, further research is required to substantiate the relationships between the quality of routine maintenance practice and repair costs.

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APPENDIX A - OBJECTIVES

ODA objectives

1) To assemble a comprehensive specification data base of vehicles used or usable for rural transport in developing countries.

2) To collect user data about actual vehicle performance and operating costs in various operating conditions in developing countries, together with information on typical operating conditions.

3) To determine the effects which various technical, infrastructural, and socio-economic factors have upon the performance and operating costs of a range of vehicles and upon the user's choice of transport mode.

4) To produce and validate a computer model/framework, incorporating the effects of factors identified in objective 3 above, which will enable the prediction of vehicle performance and operating costs as well as providing guidelines for facilitating improved rural transport mode choice through the provision or upgrading of key factors.

5) To utilise the model in a series of case studies to illustrate the benefits of effective technology transfer, infrastructural upgrading and managerial efficiency on rural tr nsport operations.

6) To produce a handbook based on outputs from the model, describing the characteristics of a range of typical vehicles from human powered to heavy commercial, and tabulating their performance and costs when operated in a wide range of conditions. This would provide an alternative (non-computer based) source of data for users.

Project structure	Indicators of achievement and value	How indicators can be quantified and assessed	Assumptions risks and conditions
Wider Objectives: 1) Unreliable and prohibitively expensive rural transport hinders agricultural development in rural areas of developing countries. A more efficient and lower cost transport system could increase agricultural output in many areas.	1.1) Improved efficiency and reliability of transport system 1.2) Increased agricultural productivity	1.1) Study other surveys for signs of increased efficiency. 1.2) Check national accounts for size of contribution from agriculture.	1) That an improvement in the overall efficiency of the rural transport system will actually aid agricultural marketing providing an incentive for increased production.
Immediate Objectives: 1) To create a knowledge base to aid in the selection of appropriate transport vehicles for the rural sector of developing countries. In so doing a tool will be created to increase the efficiency of the transport system whilst reducing the costs and burden of transport tasks to rural communities.	1.1) That donor agencies, government ministries and transport consultancies adopt the findings in order to improve the efficiency of rural transport services.	1.1) Project reports and surveys from donor agencies, government ministries and transport consultancies. This must be done in the years following the research.	1) There is enough demand in the system to justify the introduction of more efficient transport vehicles.
Outputs: 1) Vehicle operating costs.	1.1) The computer models and information needed to create a comprehensive knowledge base and framework for selection will be contained within an expert system. 1.2) A handbook will be published containing the information from the expert system for use in the field. 1.3) A Phd thesis. 1.4) The above should be up and running by January 1996. 1.5) Progress reports to ODA and various papers to, for example, The Rural Transport Forum.	1.1) The main sources of information and means of validation will come from surveys in the field, mail surveys and evidence from experts in this country. 1.2) As above 1.3) As above	1) That a satisfactory expert system can be developed incorporating all necessary variables. 2) That appropriate survey sites can be identified and sufficient data can be collected within the time limits.
2) User costs.	2.1) Same as 1.1-1.5 above.	2.1) Same as 1.1-1.3 above.	
3) Identification of factors necessary for the introduction of new technology.	3.1) Same as 1.1-1.5 above.	3.1) Same as 1.1-1.3 above.	
4) Improved framework for the selection of rural vehicles.	4.1) Same as 1.1-1.5 above.	4.1) Same as 1.1-1.3 above.	
5) Vehicle database containing information on technical specifications and costs etc.	5.1) Same as 1.1-1.5 above.	5.1) Same as 1.1-1.3 above.	
6) Suggestions for local/national level changes that could enable the introduction of more efficient vehicles.	6.1) Same as 1.1-1.5 above.	6.1) Same as 1.1-1.3 above.	

APPENDIX B - QUESTIONNAIRES

VEHICLE QUESTIONNAIRE

Village name: **Farmers name:**

Vehicle name: **Engine size:**

Vehicle make: **Age of vehicle:**

Repair Requirements

	Problem and repair requirements	Cost
Engine:		
Transmission:		
Axles:		
Electric's:		
Chassis:		
Other:		

Cost of vehicle?

Means of Payment? **Cash:** **Credit:**

If "Credit" what were the terms?

Which individual or organisation provided the credit?

Fuel Costs?

Average monthly useage? **Kms:** **Hours:**

Maintenance Requirements

	Frequency check	Frequency change	Cost
Engine:			
Check / Change the oil			
Check / Change the oil filter			
Check / Change the fuel filter			
Check / Change the air filter			
Check water			
Other			
Structure:			
Check / Change grease			
Check / Change wheel bearings			
Check / Change transmission oil			
Other			
Trailer:			
Check / Change grease			
Check / Change wheel bearings			
Other			
Tyres:			
Check tyre pressures			
Check / Change tyres			
Other			

<u>Other Data</u>

Operator wages:

Insurance/License/Tax costs:

Load/Unload time:

Is the vehicle for Hire? **Yes:** **No:**

If "yes" for what activities?

Activity	Hire Rate

Does the vehicle owner have another source of income other than farming? If so what does he do?

What does the vehicle owner consider to be the advantages and disadvantages of his vehicle?

Advantages	Disadvantages

Does the vehicle owner know of a more appropriate vehicle for his needs? If so what is it?

What stops him from buying it?

HOUSEHOLD QUESTIONNAIRE

Village Name:

Family Name:

Number of people in the household ?

What is the size of the families fields ?

How far are the fields from their house ?

Km's: **Mins:**

Does the family have access to alternative forms of income ?

Yes: **No:**

What proportion does this income represent of their total ?

None: **Less than Half:**

Half: **Most:**

What vehicle/s does the family own ?

Bicycle: **Motorcycle:** **Buffalo:**

Walking Tractor: **Tractor:** **Pickup:**

Ot er:

Are these Vehicles available for hire ? **Yes:** **No:**

Activity	Hire Rate

What are your Transport requirements ?

Activity	Rank	Trip Frequency	Trip Time	Mode of Transport	Load Carried	Responsib-ility
Water Collection						
Firewood Collection						
Travel to Grinding Mill						
Supply of Farm Inputs						
Crop Production						
Crop Harvesting						
Crop Marketing						
Travel to Market						
Travel to Health Facilities						
Travel for Education						
Travel for Religion						
Travel for Alternative Income						
Travel for Pleasure						

What proportion of the households transport requirements are satisfied with their own vehicles compared to transport services which must be hired ?

None: **Less than Half:**

Half: **Most:**

Of the transport services which they must hire what are the rates ?

Activities	Hire rate

APPENDIX C - VEHICLE OPERATING COST INFORMATION

Data from Thailand

Table 1: - Two Wheel Tractors

Cost element	Thai manufactured 8.5 hp two wheel tractor (1 tonne payload)	Japanese manufactured 8.5 hp two wheel tractor (1 tonne payload)
Replacement value		
Engine:	B 23,000	B 23,000
Chassis:	B 15,000	B 25,500
Plough:	B 1,600	B 1,600
Trailer:	B 4,000	B 4,000
Tyres:	(B 2,200)	(B 2,200)
Balance for depreciation:	B 41,400	B 51,900
Annual costs		
Depreciation:	B 4,140	B 4,325
Interest on Capital:	B 2,616 @ 12%	B 3,246 @ 12%
Tax & Insurance etc:	B 0	B 0
Variable costs (per hour)		
Fuel:	B 6.25	B 6.25
Maintenance:	B 1.24	B 1.24
Repairs:	B 1.24	B 1.24
Tyres:	B 0.88	B 0.88
Wages:	B 6.25	B 6.25
Operating information		
Economic life (Yrs):	10	12
Av. hours per annum:	500	500
Payload (Kg):	1000	1000
Utilisation (%):	50	50
Speed (km/h):	15	15
Costs of operation		
Cost per annum:	B 14,686	B 15,501
Cost per hour:	B 29.37	B 31.00
Cost per tonne per km:	B 3.9	B 4.1

Notes:

1) Interest is calculated on half the vehicle value.
2) Cost per tonne per km is calculated on the basis that the average speed is 15 km/h and that it is running 50% empty.

Table 2: - Transport vehicles

Cost element	E-Tan two tonne payload	Pickup two tonne payload	Motor Tricycle 250 kg payload
Replacement value			
Vehicle:	B 60,000	B 300,000	B 15,500
Tyres:	(B 2,800)	(B 6,600)	(B 2,000)
Balance for deprec:	B 57,200	B 293,400	B 13,500
Annual costs			
Depreciation:	B 5,720	B 20,000	B 1,350
Interest on capital:	B 3,600	B 18,000	B 1,860
Tax / Registration:	B 0	B 900	B 0
Variable cost (km)			
Fuel:	B 0.83	B 0.91	B 0.33
Maintenance:	B 0.2	B 0.14	B 0.12
Repairs:	B 0.25	B 0.16	B 0.19
Tyres:	B 0.12	B 0.06	B 0.2
Wages:	B 0.2	B 0.1	B 0.13
Operating info.			
Economic life (yrs):	10	15	10
Av. kms per annum:	8,160	61,308	10,080
Payload (kg):	2000	2000	250
Utilisation (%):	50	50	50
Av. Speed (km/h):	30	60	50
Costs of operation			
Cost per annum:	B 22,376	B 122,892	B 12,987
Cost per km:	B 2.7	B 2.0	B 1.3
Cost per tonne km:	B 2.7	B 2.0	B 10.4

Table 3: Vehicle operating costs for a density of demand of 1000 tonnes and various distances

Distance (km)	5	10	20	30	40	50
Power Tiller	12.6	8.1	5.8	5.1	4.7	4.5
Truck	18.0	9.2	4.9	3.4	2.7	2.2
Farm Vehicle	8.6	5.2	3.5	3.0	2.7	2.6
Pickup	15.0	8.2	4.9	3.9	3.4	3.1
Motor Tricycle	36.9	22.6	15.4	13.0	11.8	11.1

Table 4: Vehicle operating costs for a trip distance of 25 km and various levels of demand

Demand (tonnes)	100	200	500	700	1000	1500
Power Tiller	6.9	5.8	5.4	5.4	5.4	5.4
Truck	31.8	16.4	7.1	5.3	4.0	3.0
Farm Vehicle	7.3	5.0	3.6	3.3	3.2	3.2
Pickup	20.4	11.4	6.0	5.0	4.3	4.3
Motor Tricycle	14.2	14.0	14.0	14.0	14.0	14.0

Table 5: Predicted transport charges from regression analysis

Distance (km)	5	10	20	30	40	50
Power Tiller	18.9	10.5	5.1	3.0	-	-
Truck	-	-	-	3.3	2.5	2.0
Farm Vehicle	17.2	9.7	5.2	3.6	2.6	2.3
Pickup	20.0	9.7	5.1	3.7	2.9	2.5

Data from Sri Lanka

Table 6: Agricultural vehicles

Cost element	Tractor & Trailer 4 tonne payload	Power Tiller & Trailer - 1 tonne	Ox Cart - 2 Oxen 1 tonne payload
Replacement value			
Vehicle (Oxen):	Rs 800,000	Rs 195,900	(Rs 16,000)
Trailer (Cart):	Rs 85,000	Rs 30,000	Rs 25,000
Plough:	Rs	Rs	Rs 3,500
Tyres:	(Rs 63,000)	Rs (4,200)	Rs
Balance for deprec:	Rs 822,000	Rs 221,700	Rs 28,500
Annual costs			
Depreciation:	Rs 54,800	Rs 14,780	Rs 1,425
Interest on capital:	Rs 44,250	Rs 11,295	Rs 2,225
Tax / Registration:	Rs 0	Rs 0	Rs 0
Variable cost (Hr)			
Fuel:	Rs 30.8	Rs 7.2	Rs 0.7
Maintenance:	Rs 6.0	Rs 1.8	Rs 0.5
Repairs:	Rs 8.0	Rs 6.2	Rs 0.8
Tyres:	Rs 30	Rs 1.2	Rs 2.1
Wages:	Rs 8.8	Rs 8.8	Rs 8.8
Operating info.			
Economic life (yrs):	15	15	20
Av. hrs per annum:	1,440	740	875
Payload (kg):	4,000	1,000	1,000
Utilisation (%):	50	50	50
Av. Speed (km/h):	20	15	3
Costs of operation			
Cost per annum:	Rs 219,434	Rs 44,723	Rs 14,939
Cost per hour:	Rs 152.4	Rs 60.4	Rs 17.1
Cost per tonne km:	Rs 1.9	Rs 4.0	Rs 5.7

Table 7: Transport vehicles

Cost element	Motorcyle 90cc (Recon.) 100 kg payload	Bicycle 60 kg payload
Replacement value		
Vehicle:	Rs 34,000	Rs 2,950
Tyres:	(Rs 1,400)	(Rs 300)
Balance for depreciation:	Rs 32,600	Rs 2,650
Annual costs		
Depreciation:	Rs 3,260	Rs 133
Interest on Capital:	Rs 1,700	Rs 148
Tax & Insurance etc:	Rs 0	Rs 0
Variable costs (per km)		
Fuel:	Rs 1.3	Rs 0
Maintenance:	Rs 0.2	Rs 0.01
Repairs:	Rs 0.07	Rs 0.2
Tyres:	Rs 0.03	Rs 0.2
Wages:	Rs 0.2	Rs 0.7
Operating information		
Economic life (Yrs):	10	20
Av. kms per annum:	19,000	4,000
Payload (Kg):	100	60
Utilisation (%):	50	50
Av. Speed (km/h):	50	12
Costs of operation		
Cost per annum:	Rs 39,160	Rs 4,721
Cost per km:	Rs 2.1	Rs 1.2
Cost per tonne per km:	Rs 20.6	Rs 19.7

Table 8: Vehicle operating costs for a density of demand of 500 tonnes and various distances

Distance (km)	5	10	20	30	40	50
Power Tiller	21.1	13.0	9.4	8.2	7.6	7.3
Tractor	42.1	22.1	12.2	8.9	7.2	6.2
Ox Cart	16.1	15.0	14.5	14.3	14.2	14.1
Motorcycle	103.9	71.7	55.6	50.2	47.5	45.9
Bicycle	58.6	54.5	53.2	52.5	51.8	51.3

Table 9: Vehicle operating costs for a trip distance of 10 km and various levels of demand

Demand (tonnes)	50	100	200	500	750	1000
Power Tiller	60.8	37.9	20.5	13.0	13.0	13.0
Tractor	190.1	96.8	50.1	22.1	15.9	12.8
Ox Cart	22.0	17.2	15.0	15.0	15.0	15.0
Motorcycle	74.8	71.7	71.7	71.7	71.7	71.7
Bicycle	54.5	54.5	54.5	54.5	54.5	54.5

Table 10: Predicted transport charges from regression analysis

Distance (km)	0.5	1	2	5	10	12
Power Tiller	50.1	43.2	34.8	24.5	19.0	17.9
Ox Cart	50.9	37.8	26.6	19.8	14.8	12.8

Data from Ghana

Table 11: Transport vehicles

Cost element	Headloading 30 kg payload	Mammy Wagon 5 tonne payload
Replacement value		
Vehicle:		C 19,000,000
Tyres:		(C 780,000)
Balance for depreciation:		C 18,220,000
Annual costs		
Depreciation:		C 911,000
Interest on Capital:		C 950,000
Tax & Insurance etc:		
Variable costs (per km)		
Fuel:	C 3.3	C 160
Maintenance:		C 0
Repairs:		C 39.0
Tyres:		C 19.0
Wages:	C 20	C 2.0
Operating information		
Economic life (Yrs):		20
Av. kms per annum:	2,600	19,000
Payload (Kg):	30	5000
Utilisation (%):	50	50
Av. Speed (km/h):	5	50
Costs of operation		
Cost per annum:	C 60,580	C 6,041,000
Cost per km:	C 23.3	C 318
Cost per tonne per km:	C 777	C 63.6

Table 12: Agricultural vehicles

Cost element	Power Tiller & Trailer 1 tonne payload	Tractor & Trailer 4 tonne payload
Replacement value		
Vehicle:	C 2,000,000	C 15,180,000
Trailer:		C 4,000,000
Plough:		
Tyres:	(C 83,000)	(C 1,020,000)
Balance for depreciation:	C 1,917,000	C 18,160,000
Annual costs		
Depreciation:	C 191,700	C 1,816,000
Interest on Capital:	C 100,000	C 959,000
Tax & Insurance etc:	C 0	C 0
Variable costs (per hr)		
Fuel:	C 1,000	C 3,200
Maintenance:	C 60	C 224
Repairs:	C 610	C 967
Tyres:	C 50	C 932
Wages:	C 100	C 100
Operating information		
Economic life (Yrs):	10	10
Av. hours per annum:	400	800
Payload (Kg):	1,000	4,000
Utilisation (%):	50	50
Av. Speed (km/h):	15	20
Costs of operation		
Cost per annum:	C 1,019,700	C 7,113,400
Cost per hour:	C 2,550	C 8,892
Cost per tonne per km:	C 170	C 111

Table 13: Vehicle operating costs for a density of demand of 100 tonnes and various distances

Distance (km)	5	10	20	30	40	50
Power Tiller	895	569	406	351	324	308
Tractor	5910	3023	1579	1098	857	713
Mammy Wagon	3912	2000	1044	725	566	470
Headloading	1557	-	-	-	-	-
Headloading of 0.5 x WR	670	668	668	667	667	667

Table 14: Vehicle operating costs for a trip distance of 15 km and various levels of demand

Demand (tonnes)	25	50	100	200	500	1000
Power Tiller	1060	660	460	360	311	311
Tractor	7814	3978	2060	1101	526	334
Mammy Wagon	5163	2629	1363	729	349	223
Headloading	1555	1555	1555	1555	1555	1555

Table 15: Predicted transport charges from regression analysis

Distance (km)	5	10	20	40	60	100
Mammy Wagon	847	736	564	354	249	169
Tractor	446	410	346	250	184	108
Headloading	2126	-	-	-	-	-

Table 8: Vehicle operating costs for a density of demand of 500 tonnes and various distances

Distance (km)	5	10	20	30	40	50
Power Tiller	21.1	13.0	9.4	8.2	7.6	7.3
Tractor	42.1	22.1	12.2	8.9	7.2	6.2
Ox Cart	16.1	15.0	14.5	14.3	14.2	14.1
Motorcycle	103.9	71.7	55.6	50.2	47.5	45.9
Bicycle	58.6	54.5	53.2	52.5	51.8	51.3

Table 9: Vehicle operating costs for a trip distance of 10 km and various levels of demand

Demand (tonnes)	50	100	200	500	750	1000
Power Tiller	60.8	37.9	20.5	13.0	13.0	13.0
Tractor	190.1	96.8	50.1	22.1	15.9	12.8
Ox Cart	22.0	17.2	15.0	15.0	15.0	15.0
Motorcycle	74.8	71.7	71.7	71.7	71.7	71.7
Bicvcle	54.5	54.5	54.5	54.5	54.5	54.5

Table 10: Predicted transport charges from regression analysis

Distance (km)	0.5	1	2	5	10	12
Power Tiller	50.1	43.2	34.8	24.5	19.0	17.9
Ox Cart	50.9	37.8	26.6	19.8	14.8	12.8

Data from Ghana

Table 11: Transport vehicles

Cost element	Headloading 30 kg payload	Mammy Wagon 5 tonne payload
Replacement value		
Vehicle:		C 19,000,000
Tyres:		(C 780,000)
Balance for depreciation:		C 18,220,000
Annual costs		
Depreciation:		C 911,000
Interest on Capital:		C 950,000
Tax & Insurance etc:		
Variable costs (per km)		
Fuel:	C 3.3	C 160
Maintenance:		C 0
Repairs:		C 39.0
Tyres:		C 19.0
Wages:	C 20	C 2.0
Operating information		
Economic life (Yrs):		20
Av. kms per annum:	2,600	19,000
Payload (Kg):	30	5000
Utilisation (%):	50	50
Av. Speed (km/h):	5	50
Costs of operation		
Cost per annum:	C 60,580	C 6,041,000
Cost per km:	C 23.3	C 318
Cost per tonne per km:	C 777	C 63.6

Table 12: Agricultural vehicles

Cost element	Power Tiller & Trailer 1 tonne payload	Tractor & Trailer 4 tonne payload
Replacement value		
Vehicle:	C 2,000,000	C 15,180,000
Trailer:		C 4,000,000
Plough:		
Tyres:	(C 83,000)	(C 1,020,000)
Balance for depreciation:	C 1,917,000	C 18,160,000
Annual costs		
Depreciation:	C 191,700	C 1,816,000
Interest on Capital:	C 100,000	C 959,000
Tax & Insurance etc:	C 0	C 0
Variable costs (per hr)		
Fuel:	C 1,000	C 3,200
Maintenance:	C 60	C 224
Repairs:	C 610	C 967
Tyres:	C 50	C 932
Wages:	C 100	C 100
Operating information		
Economic life (Yrs):	10	10
Av. hours per annum:	400	800
Payload (Kg):	1,000	4,000
Utilisation (%):	50	50
Av. Speed (km/h):	15	20
Costs of operation		
Cost per annum:	C 1,019,700	C 7,113,400
Cost per hour:	C 2,550	C 8,892
Cost per tonne per km:	C 170	C 111

Table 13: Vehicle operating costs for a density of demand of 100 tonnes and various distances

Distance (km)	5	10	20	30	40	50
Power Tiller	895	569	406	351	324	308
Tractor	5910	3023	1579	1098	857	713
Mammy Wagon	3912	2000	1044	725	566	470
Headloading	1557	-	-	-	-	-
Headloading of 0.5 x WR	670	668	668	667	667	667

Table 14: Vehicle operating costs for a trip distance of 15 km and various levels of demand

Demand (tonnes)	25	50	100	200	500	1000
Power Tiller	1060	660	460	360	311	311
Tractor	7814	3978	2060	1101	526	334
Mammy Wagon	5163	2629	1363	729	349	223
Headloading	1555	1555	1555	1555	1555	1555

Table 15: Predicted transport charges from regression analysis

Distance (km)	5	10	20	40	60	100
Mammy Wagon	847	736	564	354	249	169
Tractor	446	410	346	250	184	108
Headloading	2126	-	-	-	-	-

Data from Zimbabwe

Table 16: Transport vehicles

Cost element	Scotchcart & 4 Donkeys 500kg payload	Truck 8 tonne payload
Replacement value		
Vehicle (animals):	Z$ 1,000	Z$ 540,000
Trailer (cart):	Z$ 2,000	
Tyres:	(Z$ 120)	(Z$ 10,200)
Balance for depreciation:	Z$ 2,880	Z$ 529,800
Annual costs		
Depreciation:	Z$ 192	Z$ 35,320
Interest on Capital:	Z$ 150	Z$ 27,000
Tax & Insurance etc:	Z$ 0	Z$ 3,500
Variable costs (per km)		
Fuel:	Z$ 0	Z$ 0.47
Maintenance:	Z$ 0.008	Z$ 0.11
Repairs:	Z$ 0.15	Z$ 0.62
Tyres:	Z$ 0.09	Z$ 0.24
Wages:	Z$ 0.38	Z$ 0.03
Operating information		
Economic life (Yrs):	15	15
Av. kms per annum:	1,600	14,733
Payload (Kg):	500	8,000
Utilisation (%):	50	50
Av. Speed (km/h):	4	60
Costs of operation		
Cost per annum:	Z$ 1,347	Z$ 87,478
Cost per km:	Z$ 0.84	Z$ 5.9
Cost per tonne per km:	Z$ 3.36	Z$ 1.48

Table 17: Agricultural vehicles

Cost element	Scotchcart & 2 Oxen 500kg payload	Tractor & Trailer 5 tonne payload
Replacement value		
Vehicle (animals):	(Z$ 3,680)	Z$ 160,000
Trailer (cart):	Z$ 2,000	Z$ 22,600
Plough:		Z$ 14,600
Tyres:	(Z$ 120)	Z$ (6,600)
Balance for depreciation:	Z$ 1,880	Z$ 190,600
Annual costs		
Depreciation:	Z$ 125	Z$ 12,707
Interest on Capital:	Z$ 284	Z$ 9,860
Tax & Insurance etc:	Z$ 0	Z$ 0
Variable costs (per hr)		
Fuel:	Z$ 0	Z$ 5.9
Maintenance:	Z$ 0.032	Z$ 2.4
Repairs:	Z$ 0.6	Z$ 6.6
Tyres:	Z$ 0.36	Z$ 4.8
Wages:	Z$ 1.5	Z$ 1.5
Operating information		
Economic life (Yrs):	15	15
Av. hours per annum:	400	750
Payload (Kg):	500	5,000
Utilisation (%):	50	50
Av. Speed (km/h):	4	20
Costs of operation		
Cost per annum:	Z$ 1,406	Z$ 38,467
Cost per hour:	Z$ 3.5	Z$ 51.3
Cost per tonne per km:	Z$ 3.5	Z$ 1.0

Table 18: Vehicle operating costs for a density of demand of 500 tonnes and various distances

Distance(km)	5	10	20	30	40	50
2 Oxen Cart	4.2	3.5	3.2	3.1	3.0	3.0
4 Donkey Cart	3.6	2.8	2.5	2.4	2.3	2.3
Tractor	10.0	5.2	2.8	2.0	1.6	1.4
Truck	25.7	13.0	6.7	4.6	3.5	2.9

Table 19: Vehicle operating costs for a trip distance of 30 km and various levels of demand

Demand (tonnes)	50	100	200	500	750	1000
2 Oxen Cart	3.1	3.1	3.1	3.1	3.1	3.1
4 Donkey Cart	2.4	2.4	2.4	2.4	2.4	2.4
Tractor	16.0	8.2	4.3	2.0	1.5	1.2
Truck	42.4	21.4	10.9	4.6	3.2	2.5

Table 20: Predicted transport charges from regression analysis

Distance (km)	5	10	20	50	80	120
Trucks	6.8	2.0	1.1	1.02	1.02	1.02
Tractors	5.1	4.6	3.7	2.01	1.07	-
Scotchcarts	9.1	7.7	5.6	2.2	-	-

Data from Pakistan

Table 21: Pack animals

Cost element	Pack Donkey 80kg payload	Pack Mule 120kg payload	Pack Camel 320kg payload
Replacement value			
Animal:	Rs 2,250	Rs 17,000	Rs 14,000
Balance for deprec:	Rs 2,250	Rs 17,000	Rs 14,000
Annual costs			
Depreciation:	Rs 375	Rs 1,417	Rs 1,400
Interest on capital:	Rs 113	Rs 850	Rs 700
Tax / Registration:	Rs 0	Rs 0	Rs 0
Variable cost (km)			
Fuel:	Rs 2.0	Rs 2.0	Rs 4.0
Wages:	Rs 2.5	Rs 2.5	Rs 2.5
Operating info.			
Economic life (yrs):	6	12	10
Av. kms per annum:	4,500	4,500	4,500
Payload (kg):	80	120	320
Utilisation (%):	50	50	50
Av. Speed (km/h):	5	5	5
Costs of operation			
Cost per annum:	Rs 20,738	Rs 22,517	Rs 31,350
Cost per km:	Rs 4.61	Rs 5.0	Rs 6.97
Cost per tonne km:	Rs 115.2	Rs 83.4	Rs 43.5

Table 22: Animals carts

Cost element	Donkey Cart 300kg cap.	Mule Cart 600kg cap.	Horse Cart 520kg cap.	Camel Cart 320kg cap.
Replacement value				
Animal:	Rs 2,250	Rs 17,000	Rs 20,000	Rs 14,000
Cart:	Rs 4,000	Rs, 4,000	Rs 20,000	Rs 8,000
Tyres:	(Rs 1,200)	(Rs 1,200)	(Rs 3,000)	(Rs 2,400)
Balance for deprec:	Rs 5,050	Rs 19,800	Rs 37,000	Rs 19,600
Annual costs				
Depreciation:	Rs 842	Rs 1,650	Rs 3,700	Rs 1,960
Interest on capital:	Rs 313	Rs 1,050	Rs 2,000	Rs 2,200
Tax / Registration:	Rs 0	Rs 0	Rs 0	Rs 0
Variable cost (km)				
Fuel:	Rs 2.0	Rs 2.0	Rs 4.0	Rs 3.4
Maintenance:	Rs 0.11	Rs 0.11	Rs 0.39	Rs 0.39
Repairs:	Rs 0.15	Rs 0.15	Rs 0.22	Rs 0.22
Tyres:	Rs 0.29	Rs 0.29	Rs 0.39	Rs 0.44
Wages:	Rs 2.1	Rs 1.6	Rs 1.04	Rs 2.5
Operating info.				
Economic life (yrs):	6	12	10	10
Av. kms per annum:	4,617	4,617	4,320	5,400
Payload (kg):	300	600	500	1,200
Utilisation (%):	50	50	50	50
Av. Speed (km/h):	6	8	12	5
Costs of operation				
Cost per annum:	Rs 22,625	Rs 21,861	Rs 31,793	Rs 41,690
Cost per km:	Rs 4.9	Rs 4.7	Rs 7.4	Rs 7.7
Cost per tonne km:	Rs 32.7	Rs 15.8	Rs 29.6	Rs 12.8

Table 23: Transport vehicles

Cost element	Motorcyle 125cc 100 kg payload	Pickup 2 tonne payload
Replacement value		
Vehicle:	Rs 58,300	Rs 700,500
Tyres:	(Rs 1,000)	(Rs 10,000)
Balance for depreciation:	Rs 57,300	Rs 690,500
Annual costs		
Depreciation:	Rs 3,820	Rs 46,033
Interest on Capital:	Rs 2,915	Rs 35,025
Tax & Insurance etc:	Rs 0	Rs 900
Variable costs (per km)		
Fuel:	Rs 0.65	Rs 0.89
Maintenance:	Rs 0.74	Rs 0.39
Repairs:	Rs 0.11	Rs 0.42
Tyres:	Rs 0.08	Rs 0.50
Wages:	Rs 0.25	Rs 0.21
Operating information		
Economic life (Yrs):	15	15
Av. kms per annum:	2,640	44,260
Payload (Kg):	100	2,000
Utilisation (%):	50	50
Av. Speed (km/h):	50	60
Costs of operation		
Cost per annum:	Rs 11,566	Rs 188,624
Cost per km:	Rs 4.38	Rs 4.26
Cost per tonne per km:	Rs 87.6	Rs 4.26

Table 24: Agricultural vehicles

Cost element	2 Oxen & Cart 1.4 tonne payload	Tractor & Trailer 4 tonne payload
Replacement value		
Vehicle (animal):	Rs 24,000	Rs 252,100
Trailer (cart):	Rs 12,000	Rs 21,500
Plough:	Rs	Rs 9,500
Tyres:	(Rs 2,000)	(Rs 18,000)
Balance for depreciation:	Rs 34,000	Rs 265,100
Annual costs		
Depreciation:	Rs 3,400	Rs 17,673
Interest on Capital:	Rs 1,800	Rs 14,155
Tax & Insurance etc:	Rs 0	Rs 0
Variable costs (per hr)		
Fuel:	Rs 37.6	Rs 31.3
Maintenance:	Rs 0.84	Rs 10.05
Repairs:	Rs 1.28	Rs 6.18
Tyres:	Rs 2.16	Rs 7.91
Wages:	Rs 12.5	Rs 12.5
Operating information		
Economic life (Yrs):	10	15
Av. hrs per annum:	1,938	1,900
Payload (Kg):	1,400	4,000
Utilisation (%):	50	50
Av. Speed (km/h):	4	20
Costs of operation		
Cost per annum:	Rs 110,395	Rs 160,914
Cost per hr:	Rs 57.0	Rs 84.7
Cost per tonne per km:	Rs 20.3	Rs 2.1

Table 25: Vehicle operating costs for a density of demand of 25 tonnes and various distances for pack animals

Distance (km)	1	3	5	10	15	20
Pack Donkey	158.3	127.8	121.7	117.2	116.1	115.5
Pack Mule	183.2	111.1	96.6	85.8	82.2	81.2
Pack Camel	131.5	70.9	58.8	49.7	46.7	45.2

Table 26: Vehicle operating costs for a trip distance of 10km and various levels of demand for pack animals

Demand (tonnes)	5	10	20	30	40	50
Pack Donkey	124.9	120.0	117.6	117.2	117.2	117.2
Pack Mule	122.1	99.4	88.1	84.3	83.2	83.2
Pack Camel	83.3	62.3	51.8	48.3	46.6	45.5

Table 27: Vehicle operating costs for a density of demand of 50 tonnes and various distances for animal carts

Distance (km)	5	10	20	30	40	50
Donkey Cart	36.3	33.6	32.2	31.9	31.8	31.7
Mule Cart	27.5	21.5	18.5	17.5	16.9	16.6
Horse Cart	43.2	33.7	28.9	27.3	26.5	26.1
Camel Cart	26.3	19.4	16.0	14.9	14.3	14.0
Ox Cart	41.6	30.6	25.1	23.2	22.3	21.8

Table 28: Vehicle operating costs for a trip distance of 20km and various levels of demand for animal carts

Demand (tonnes)	10	20	40	80	100	150
Donkey Cart	36.0	33.6	32.5	32.1	32.1	32.1
Mule Cart	29.7	22.7	19.2	17.4	17.1	16.8
Horse Cart	46.9	35.7	30.0	27.2	26.7	25.9
Camel Cart	29.2	21.0	16.8	14.8	14.4	13.8
Ox Cart	46.7	33.2	26.4	23.0	22.4	21.5

Table 29: Vehicle operating costs for a density of demand of 500 tonnes and various distances for motorised vehicles

Distance (km)	10	20	40	60	80	100
Pickup	20.6	11.5	7.0	5.5	4.7	4.3
Tractor	11.1	6.4	4.1	3.3	2.9	2.6
Motorcycle	72.3	55.2	46.7	43.8	42.4	41.5
Ox Cart	22.4	21.5	21.1	-	-	-

Table 30: Vehicle operating costs for a trip distance of 50km and various levels of demand for motorised vehicles

Demand (tonnes)	50	100	200	500	750	1000
Pickup	35.5	19.1	11.0	6.1	5.0	4.9
Tractor	18.8	10.4	6.1	3.6	3.0	2.8
Motorcycle	44.9	44.9	44.9	44.9	44.9	44.9
Ox Cart	21.8	20.8	20.8	20.8	20.8	20.8

Table 31: Predicted transport charges from regression analysis

Distance (km)	5	10	20	30	40	50
Pickup	15.8	9.2	6.8	6.1	5.8	5.6
Tractor	5.7	4.2	4.2	5.3	4.2	4.2
Animal Transport	12.4	12.2	12.2	-	-	-

APPENDIX D - COMPONENT COSTS

Table 1: Vehicles from Thailand and their component costs as a percentage of total vehicle operating costs.

	Cost as a precentage of total vehicle operating costs									
	Fuel	Main	Repair	Tyre	Wage	Deprec.	Interest	Tax	Var. Costs	Fixed Costs
Power Tiller (local)	21.3	4.2	4.2	3.0	21.3	29.1	15.3	0	54	44.5
Power Tiller	20.9	4.1	4.1	2.9	20.9	28.9	18.1	0	53	47
E-Tan	30.7	7.4	9.3	4.4	7.4	26.3	13.8	0	59.2	40.1
Pickup	45.5	7.0	8.0	3.0	5.0	16.7	12.5	0.8	68.5	30
Motor Tricycle	27.5	10.0	15.8	16.7	10.8	11.3	6.5	0	80.8	17.8

Table 2: Vehicles from Sri Lanka and their component costs as a percentage of total vehicle operating costs.

	Cost as a precentage of total vehicle operating costs									
	Fuel	Main.	Repair	Tyres	Wage	Deprec.	Interest	Tax	Var. Costs	Fixed Costs
Bicycle	0	0.8	5.2	19.7	5.8	2.8	3.1	0	92.5	5.9
Ox Cart	4.1	2.9	4.7	12.3	51.5	9.5	14.9	0	75.5	24.4
Motor-cycle	61.9	9.5	3.3	1.4	9.5	8.3	4.3	0	85.6	12.6
Power Tiller	11.9	3.0	10.3	2.0	14.6	33.0	25.3	0	41.8	58.3
Tractor	20.2	4.0	5.2	19.7	5.8	25.0	20.2	0	54.9	45.2

Table 3: Vehicles from Ghana and their component costs as a percentage of total vehicle operating costs.

	Cost as a precentage of total vehicle operating costs									
	Fuel	Main.	Repair	Tyres	Wage	Deprec.	Interest	Tax	Var. Costs	Fixed Costs
Power Tiller	39.2	2.4	23.9	2.0	3.9	18.8	9.8	0	71.4	28.6
Tractor	36.0	2.5	10.9	10.5	1.1	25.5	13.5	0	61	39
Truck	50.3	12.3		6.0	0.6	15.1	15.7	0	69.2	30.8

Table 4: Vehicles from Zimbabwe and their component costs as a percentage of total vehicle operating costs.

	Cost as a precentage of total vehicle operating costs									
	Fuel	Main.	Repair	Tyres	Wage	Deprec.	Interest	Tax	Var. Costs	Fixed Costs
Donkey Cart	0	1.0	17.9	10.7	45.2	14.3	11.1	0	74.8	25.4
Ox Cart	0	0.9	17.1	10.3	42.9	8.9	20.2	0	71.2	29.1
Truck	8.0	1.9	10.5	4.1	0.5	40.4	30.9	4.0	65.4	34.9
Tractor	11.5	4.7	12.9	9.4	2.9	33.0	25.6	0	41.4	58.6

Table 5: Vehicles from Pakistan and their component costs as a percentage of total vehicle operating costs.

	Cost as a precentage of total vehicle operating costs									
	Fuel	Main.	Repair	Tyres	Wage	Deprec.	Interest	Tax	Var. Costs	Fixed Costs
Pack Donkey	43.4				54.2	1.8	0.5	0	97.6	2.3
Pack Mule	40.0				50.0	6.3	3.8	0	90	10.1
Pack Camel	57.4				35.9	4.5	2.2	0	93.3	6.7
Donkey Cart	40.8	2.2	3.1	5.9	42.9	3.7	1.4	0	94.9	5.1
Mule Cart	42.6	2.3	3.2	6.2	34.0	7.5	4.8	0	88.3	12.3
Horse Cart	54.1	5.3	3.0	5.3	14.1	11.6	6.3	0	81.8	17.9
Camel Cart	44.2	5.1	2.9	5.7	32.5	4.7	5.3	0	90.4	10
Ox Cart	66.0	1.5	2.2	3.8	21.9	3.1	1.6	0	95.4	4.7
Motor-cycle	14.8	16.9	2.5	1.8	5.7	33.0	25.2	0	41.7	58.2
Pickup	20.9	9.2	9.9	11.7	4.9	24.4	18.6	0.5	56.6	43
Tractor	37.0	11.9	7.3	9.3	14.8	11.0	8.8	0	80.3	19.8

Table 6: Data for the pickup truck using Thailand factor costs for vehicle cost, labour rates and fuel costs at 1994 US Dollar prices.

	Fuel	Main.	Repair	Tyres	Wages	Dep.	Int.	Tax	Var. Cost	Fixed Cost
Thai	46.4	7.1	8.3	3.6	4.8	16.4	12.6	0.8	70.2	29.8
Pak	35.4	10.0	10.8	12.3	3.1	15.0	11.5	0.7	71.6	27.2
Ghana	53.1	18.5		6.5	1.5	11.3	8.7	0.5	79.6	20.5

Table 7: Data for the tractor using Pakistan factor costs for vehicle cost, labour rates and fuel costs at 1994 US Dollar prices.

	Fuel	Main.	Repair	Tyres	Wages	Dep.	Int.	Tax	Var. Cost	Fixed Cost
Ghana	25.6	5.0	21.6	20.8	6.4	11.4	9.1	0	79.4	20.5
Pak	37.0	11.7	7.3	9.5	14.7	11.0	8.8	0	80.2	19.8
Sri	19.7	5.1	6.7	24.8	15.7	15.6	12.5	0	72.0	28.1
Zim	13.7	8.0	21.9	16.0	9.1	17.4	13.9	0	68.7	31.3

Table 8: Data for the power tiller using Thailand factor costs for vehicle cost, labour rates and fuel costs at 1994 US Dollar prices.

	Fuel	Main.	Repair	Tyres	Wages	Dep.	Int.	Tax	Var. Cost	Fixed Cost
Thai	20.8	4.2	4.2	2.9	20.8	28.8	18.0	0	52.9	46.8
Sri	12.0	3.8	13.0	2.5	27.1	25.4	15.9	0	58.4	41.3
Ghana	34.2	2.5	26.9	0.6	8.6	17.8	9.3	0	72.8	27.1

APPENDIX E - MODEL INSTRUCTIONS

Instructions for the use of the Rural Transport Planner

The Rural Transport Planner (RTP) has been developed in an expert system shell called Leonardo. As the programme stands at the moment it is necessary to have Leonardo installed on the users computer before being able to use the RTP. The instructions that follow assume that the user has the Leonardo shell already installed.

From the enclosed computer disk it is necessary to be transfer the files to the directory from which Leonardo is being run. The files to be transferred are:

vehrtp2.dat
tra231.exe
rtp3.pkb
$$leoinp.dat
cartest5.dat
optest5.dat
input.dat
op.dat
output.dat
tariff.dat

Once these files have been transferred to the Leonardo operating directory then you are in a position to use the programme. From the operating directory type:

leonardo

then press the **<Enter>** key. This starts the Leonardo system.

The first screen is the "Welcome to Leonardo" screen which gives some basic instructions on the operation of Leonardo. To start the RTP programme move the highlight by hitting the **<Cursor Right>** key until the **Files** option is highlighted. Press the <**Enter**> key . A submenu of the **Files** command will appear which will include the filename "RTP3" - this is the knowledge base file for the RTP.

To run the RTP programme press the <**Enter**> key when it highlights the **Load** command. You are now presented with the list of knowledge bases available in the directory. The "RTP3" knowledge base can be selected either by typing in the name followed by <**Enter**>, or by using the <**Cursor Up**> and <**Cursor Dn**> keys to highlight the "RTP3" file followed by the <**Enter**> key.

You are now ready to use the RTP, just follow the instructions on the screens as you proceed through the programme.

The Leonardo rule base for the Rural Transport Planner

```
control common

SEEK recommendation

CONTROL TRACE Off

control forbidunknown on

if start is yes
then desired_response is yes;
use screen_level;
level is chosen

if level is chosen
and desired_level is District
then use screen_area;
choice is made

if level is chosen
and desired_level is Regional
then use screen_area1;
choice is made

if choice is made
then use screen_road;
/* use screen_store;
use screen_socio;
questions are answered

if questions are answered
then run log_cad(study_area,1st_store,cnt,yield,crop_area,cad,disout,
                 disret,outlod);
run log_tad(study_area,2nd_store,tnt,1st_store,outlod,cash_level,tad,
            disoutt,disrett,outlodt);
use screen_vehicle;
inputs are done

if inputs are done
and vehicle_type is 'Human Powered Vehicles'
then use screen_human;
outputs are done

if inputs are done
and vehicle_type is 'Animal Powered Vehicles'
then use screen_animal;
outputs are done

if inputs are done
and vehicle_type is 'Motorised Vehicles'
then use screen_motorised;
outputs are done

if inputs are done
and vehicle_type is 'Agricultural Vehicles'
```

```
then use screen_agricultural;
outputs are done

if outputs are done
and grade_num is known
and curve_num is known
and rough_num is known
and coner_num is known
and conet_num is known
and gradet_num is known
and curvet_num is known
and rought_num is known
and conert_num is known
and conett_num is known
and serfac_num is known
and vehicle_number is known
then data is complete

if data is complete
then RUN READ_VEHFILE (rec_num, CAPACV, CAPACT, WEIGHT, TWEIGH, POWER, SPEED,
rtfuel,HLIFE,age,FNUM,RNUM,TNUM,FRODIA,READIA,TRADIA,FWIDTH,RWIDTH,
twidth,XFRONT,XREAR,XTRAIL,FDRIVE,RDRIVE,TDRIVE,TRANEF,THIGH,TRABAL,
xtrack,HMMASS,DMMASS,WHEELB,HOMLOD,DOMLOD,WIDTH,HEIGHT,AIRFAC,CVEH,
amort,name,descrip1,descrip2,descrip3,descrip4,descrip5,descrip6,
descrip7,descrip8,descrip9,descrip10,descrip11,descrip12,buffer0);
use screen_cartest;
data is got

if start is yes
then DUMMY is 22;
facsur = 1;
facsurt = 1

if data is got
and vehicle_type is 'Animal Powered Vehicles'
then use screen_feed;
food is done

if data is got
and vehicle_type is 'Human Powered Vehicles'
then food is done

if data is got
and vehicle_type is 'Motorised Vehicles'
then food is done

if data is got
and vehicle_type is 'Agricultural Vehicles'
then food is done

if food is done
and amort_fig is known
and fuel_cost is known
and age_num is known
then use screen_operations;
operations are done
```

```
if operations are done
then RUN PACK_DATA(BUFFER1);
RUN WRITE_VEHFILE(BUFFER1);
RUN PACK_CON(BUFFER2);
RUN WRITE_CONFILE(BUFFER2);
RUN TEST2(DUMMY);
RUN READ_DATA(COSTQUART,FUELQUART,LOADQUART,COSTONKMQ,%UTILISED,
             vehnum,trip,avspeed,repair,amortq,depreciation,wages,
             buffer3);
use screen_results;
procedures are done

if procedures are done
then use screen_vehiclet;
screen is done

if screen is done
and vehiclet_type is 'Human Powered Vehicles'
then use screen_humant;
type is known

if screen is done
and vehiclet_type is 'Animal Powered Vehicles'
then use screen_animalt;
type is known

if screen is done
and vehiclet_type is 'Motorised Vehicles'
then use screen_motorisedt;
type is known

if screen is done
and vehiclet_type is 'Agricultural Vehicles'
then use screen_agriculturalt;
type is known

if type is known
and vehiclet_number is known
then RUN READ_VEHFILEt(rec_numt,CAPACVt,CAPACTt,WEIGHTt,TWEIGHt,POWERt,
speedt,rtfuelt,HLIFEt,aget,FNUMt,RNUMt,TNUMt,FRODIAt,READIAt,TRADIAt,
fwidtht,rwidtht,twidtht,XFRONTt,XREARt,XTRAILt,FDRIVEt,RDRIVEt,TDRIVEt,
traneft,thight,trabalt,xtrackt,HMMASSt,DMMASSt,WHEELBt,HOMLODt,DOMLODt,
widtht,heightt,airfact,cveht,amort,namet,descrip1t,descrip2t,
descrip3t,descrip4t,descrip5t,descrip6t,descrip7t,descrip8t,descrip9t,
descrip10t,descrip11t,descrip12t,buffer0t);
use screen_cartestt;
trunk_vehicle is done

if trunk_vehicle is done
and vehiclet_type is 'Animal Powered Vehicles'
then use screen_feedt;
foodt is done

if trunk_vehicle is done
and vehiclet_type is 'Human Powered Vehicles'
then foodt is done
```

```
if trunk_vehicle is done
and vehiclet_type is 'Motorised Vehicles'
then foodt is done

if trunk_vehicle is done
and vehiclet_type is 'Agricultural Vehicles'
then foodt is done

if foodt is done
and fuelt_cost is known
and aget_num is known
then use screen_operationst;
operationst are done

if operationst are done
then RUN PACK_DATAt(BUFFER1t);
RUN WRITE_VEHFILEt(BUFFER1t);
RUN PACK_CONt(BUFFER2t);
RUN WRITE_CONFILEt(BUFFER2t);
RUN TEST2t(DUMMY);
RUN READ_DATAt(COSTQUARTt,FUELQUARTt,LOADQUARTt,COSTONKMQt,%UTILISEDt,
         vehnumt,tript,avspeedt,repairt,amortqt,depreciationt,wagest,
             buffer3t);
use screen_resultst;
trunk_procedures are done

if trunk_procedures are done
and number_of_vehicle is known
and number_of_vehiclet is known
then run log_mod(costquartt,tript,disrett,disoutt,tad,numveht,
        1st_store,costquart,trip,disret,disout,cad,numveh,
      farm_store,rural_store,2nd_store,tttc,tctc,tfwsc,trsc,agdist);
use screen2;
results are known

/* if results are known
/* and restart is yes
/* then cycle_mode is autocycle;
/* declarations are done

/* if results are known
/* and restart is no
/* then cycle_mode is stop;
/* declarations are done

if results are known
then use screen_tariff;
declares are done

for all solutions
if declares are done
and desired_response is answer: of solutions
and check_vehicle is done
and check_manufac is done
and check_formal is done
and check_interest is done
and check_collaterol is done
```

```
and check_repayment is done
and check_routine_maintenance is done
and check_repair_and_maintenance is done
and check_infrastructure is done
then check_possible_solutions includes name: of solutions;
scan1 is done

for all solutions
if scan1 is done
and desired_response is answer: of solutions
and check_labour is done
and check_fuel is done
and check_feed is done
and check_market is done
and check_choice is done
and check_utilisation is done
and check_tariff is done
and check_subsidy is done
then check_possible_solutions includes name: of solutions;
scan is done

if scan is done
then run proc_unpack(number,possible_solutions);
unpack is done

if unpack is done
and number > 0
then use screen1;
recommendation is completed

if unpack is done
and number = 0
then use screen3;
recommendation is completed

if recommendation is completed
and restart is yes
then cycle_mode is autocycle;
declarations are done

if recommendation is completed
and restart is no
then cycle_mode is stop;
declarations are done
```

APPENDIX F - RTP FRAMEWORK DIAGRAMS

Figure 1: Factors relating to fixed costs in the rural transport planner

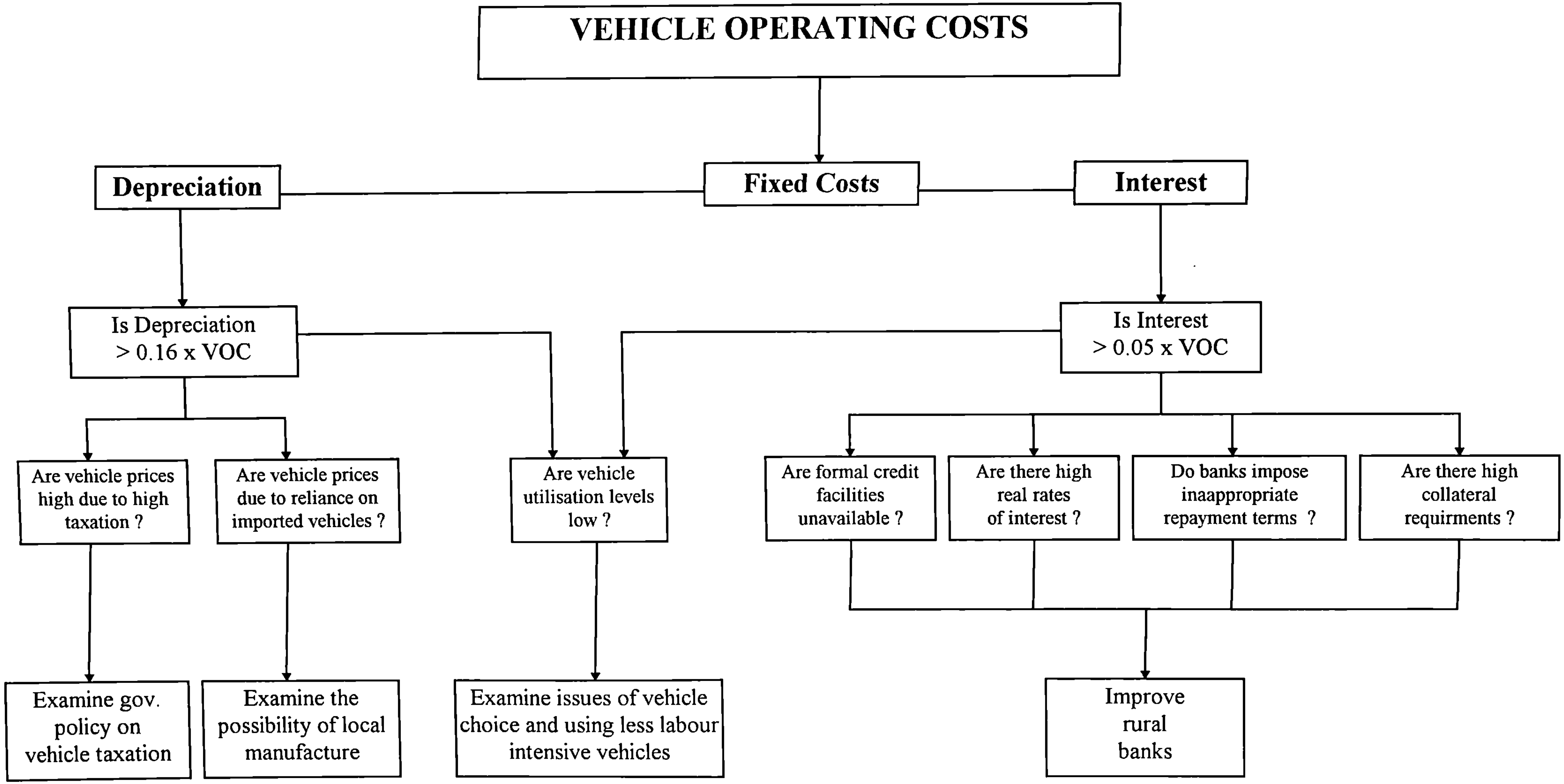


Figure 2: Factors relating to variable costs in the rural transport planner

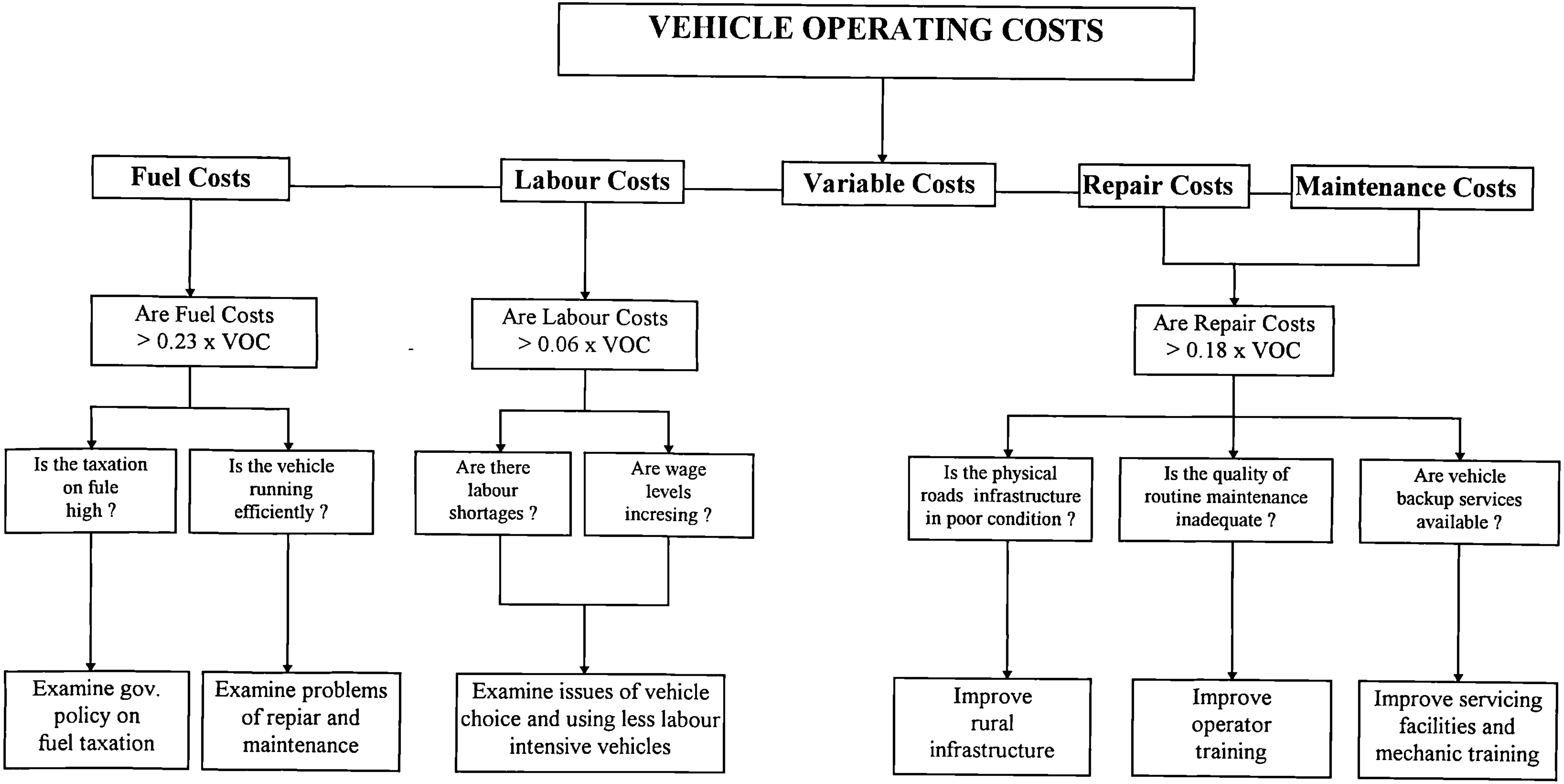
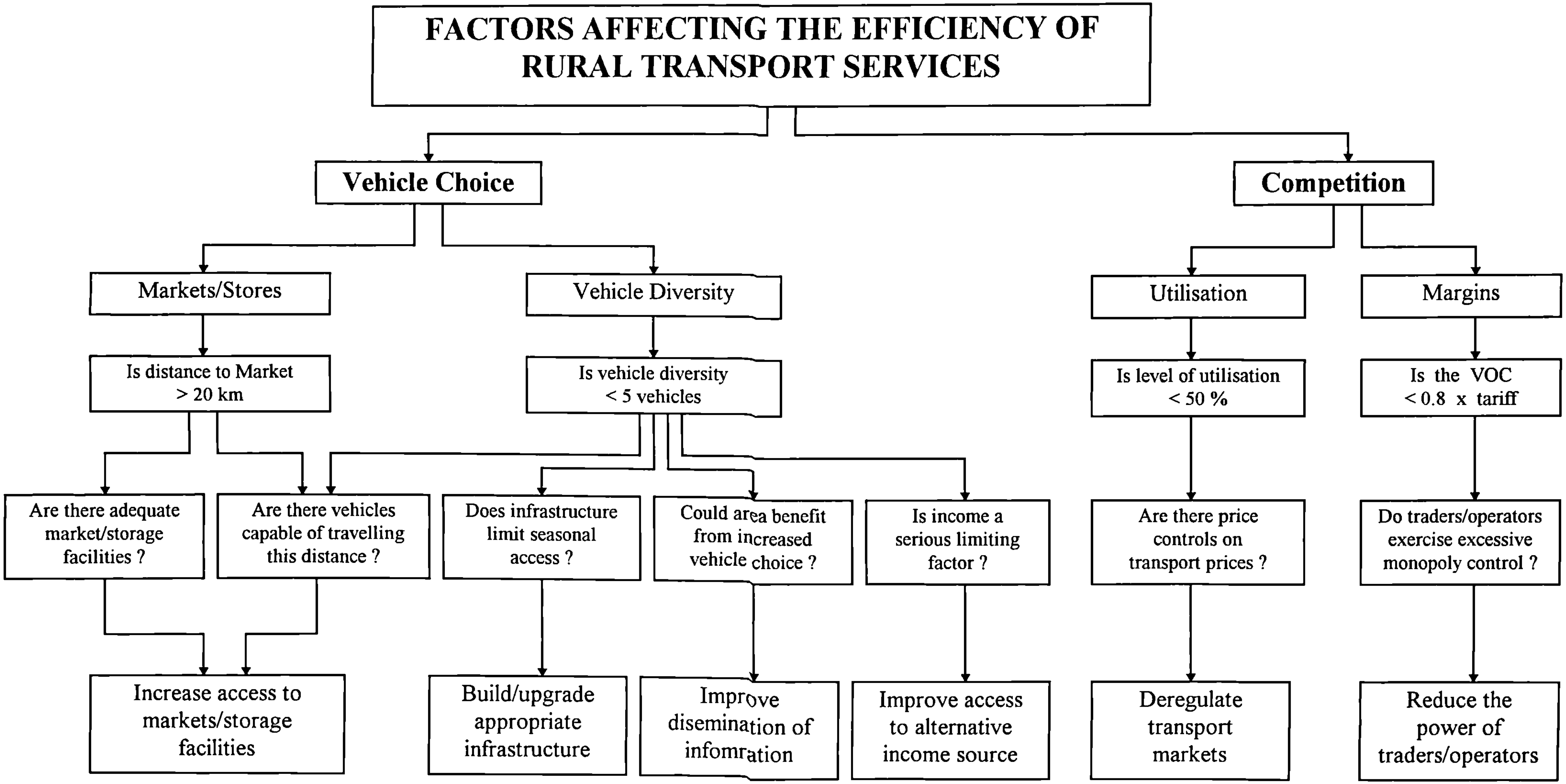


Figure 3: Factors relating to efficiency in the rural transport planner



APPENDIX G - CHARACTERISTICS OF VEHICLES STUDIED

Table 1: 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		up to 70% of body-weight	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		**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. **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. **Pakistan** - *similar to those in Sri Lanka they are used for household tasks and the transport* of fodder and agricultural produce and inputs.
Bicycle	60	70	10	50	0.88	**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. **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.
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.

Table 2: 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 families 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. Where they are used for transport 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.
Pack Mule	550	120	5	30	1.38	**Pakistan** - mules are usually used for hire purposes, there load capacity is greater than horses and donkeys as well as there 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 there stamina and load capacity is less than 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 yard to 10 km's. There load capacity is high and there 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 has reduced their marketability. In some areas there is also an unfamiliarity with these animals.

Table 3: Characteristics of motorised vehicles

Vehicle Type	Approx. Cost (US$)	Load Capacity (Kg)	Speed (Km/h)	Range (Km)	Cost/t/km ($) (10km Trip Distance)	Vehicle Characteristics
Motorcycle 50cc	450	100	50	100	0.39	**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. **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.
Power Tiller	1,500 4,650	1,000 1,500	15 15	50 50	0.15 0.13	**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. **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. **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.
Farm Vehicle	3,010	2,500	40	100	0.12	**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.

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 50hp	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.
Same 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 fully 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.

Table 4: Characteristics of conventional transport vehicles

Vehicle Type	Approx. Cost (US$)	Load Capacity (Kg)	Speed (Km/h)	Range (Km)	Cost/t/km ($) (10km Trip Distance)	Vehicle Characteristics
Pickup	12,000	2,500	70	500	0.2	**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. **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 areas and rural areas with good roads micro pickups are used for the same purposes. **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.
Truck	20,300	9,000	60	500		**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. **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. **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.
Buses						**Pakistan** - The bus industry is very competitive with 70 seaters plying the interurban routes and into the rural areas, sometimes on quite bad roads. **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.

APPENDIX H - PHOTO GUIDE

Plate 1: Headloading in Sri Lanka

Plate 2: Hand cart in Honduras

Plate 3: Bicycle in Sri Lanka

Plate 4: Tricycle being used for urban transport in Thailand

Plate 5: Pack donkey in Pakistan

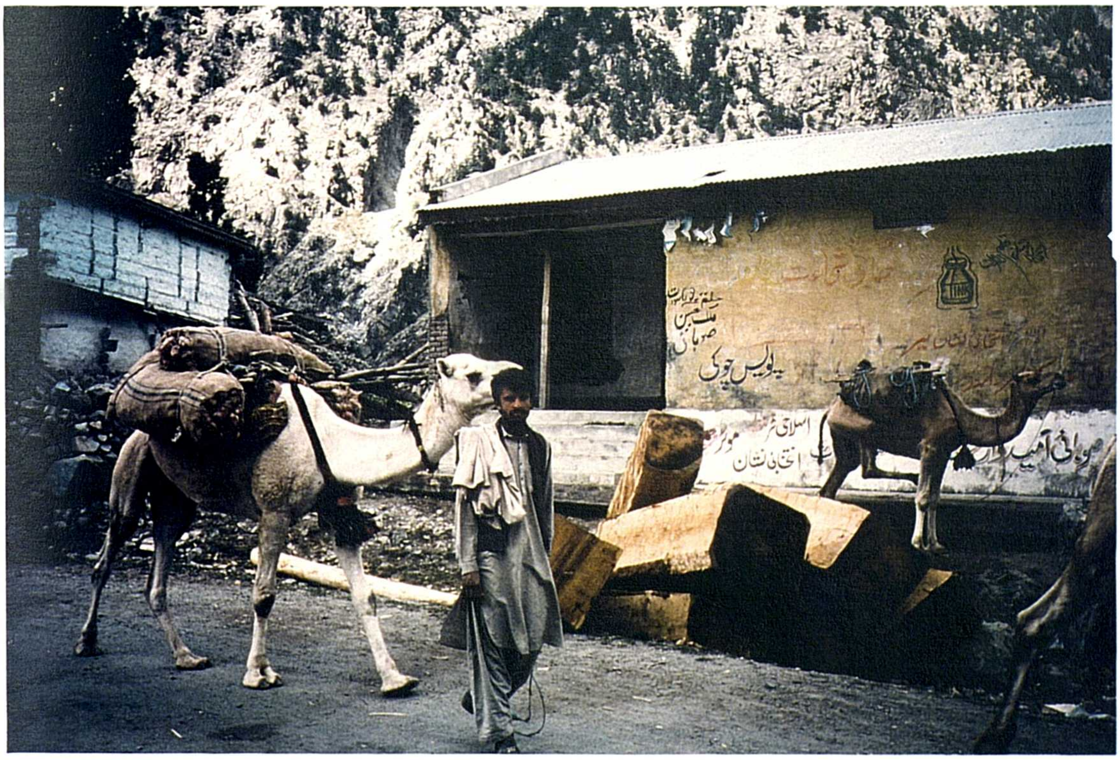


Plate 6: Pack camel in Pakistan

Plate 7: Donkey cart (scotchcart) in Zimbabwe

Plate 8: Mule cart in Pakistan

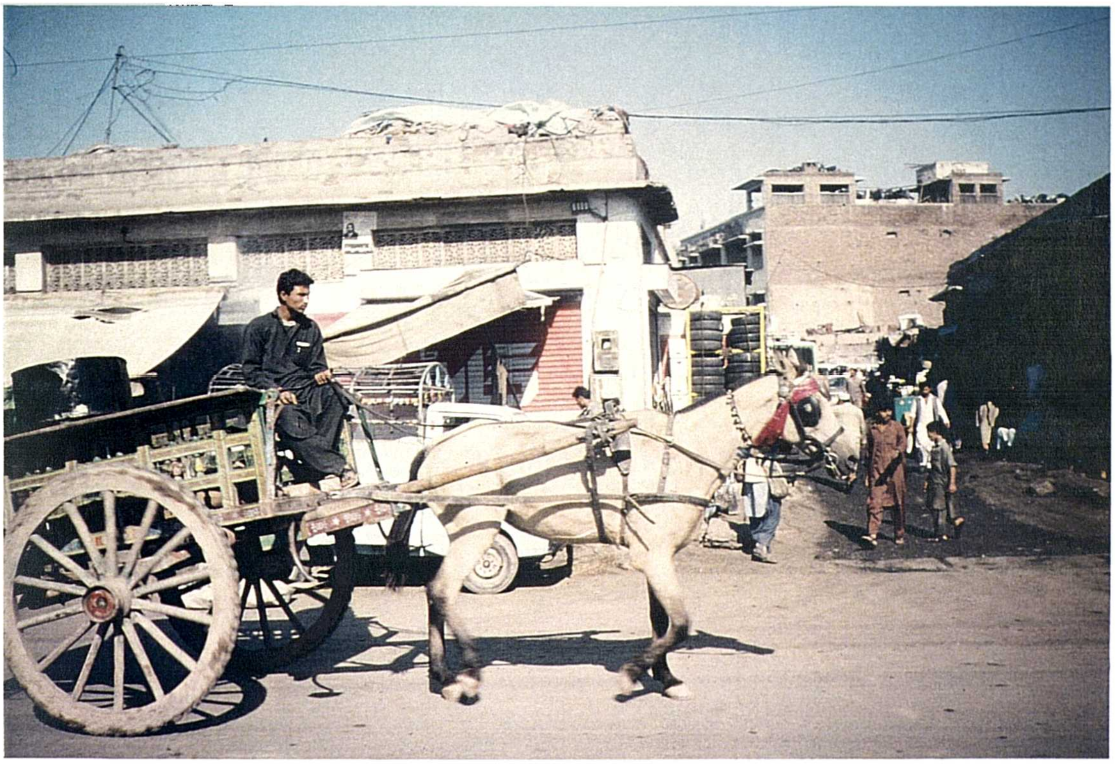


Plate 9: Horse cart in Pakistan

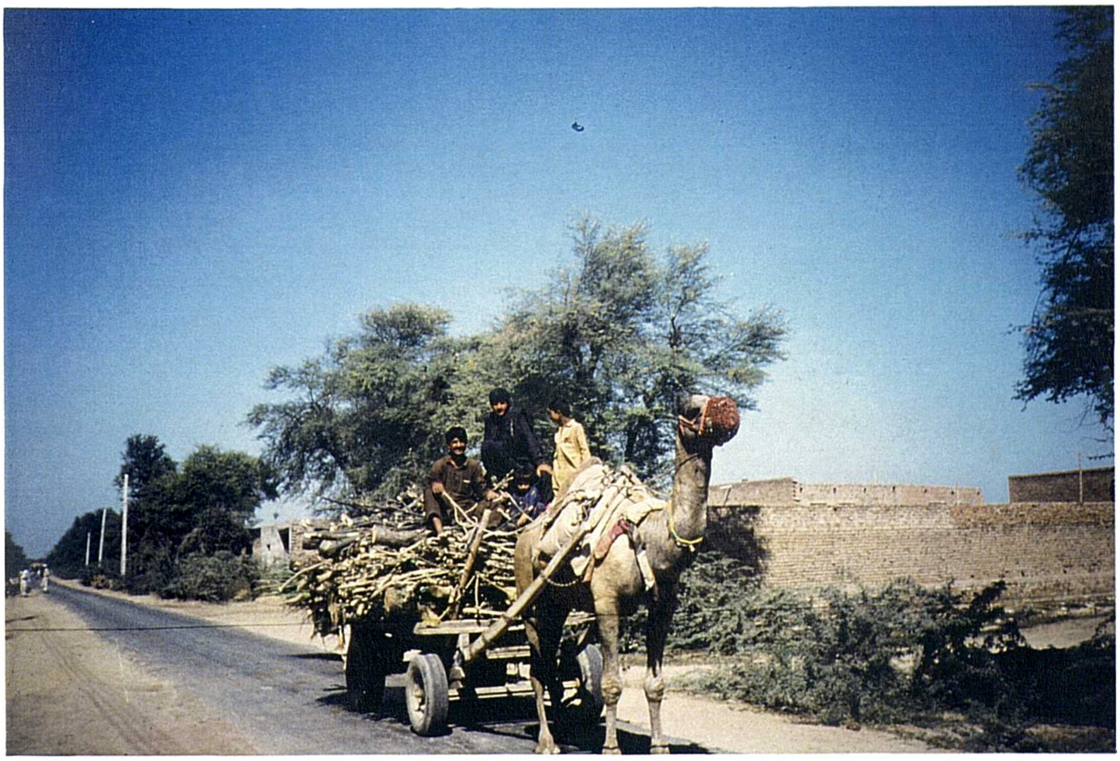


Plate 10: Camel cart in Pakistan

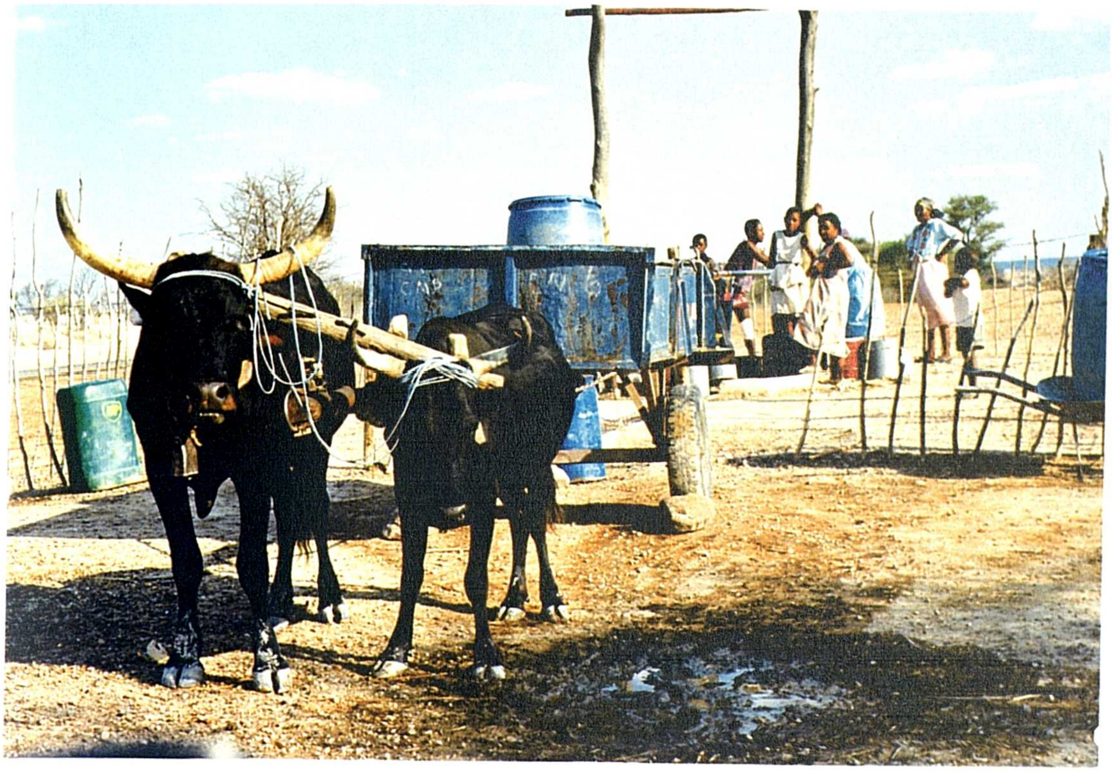


Plate 11: Ox cart (scotchcart) in Zimbabwe

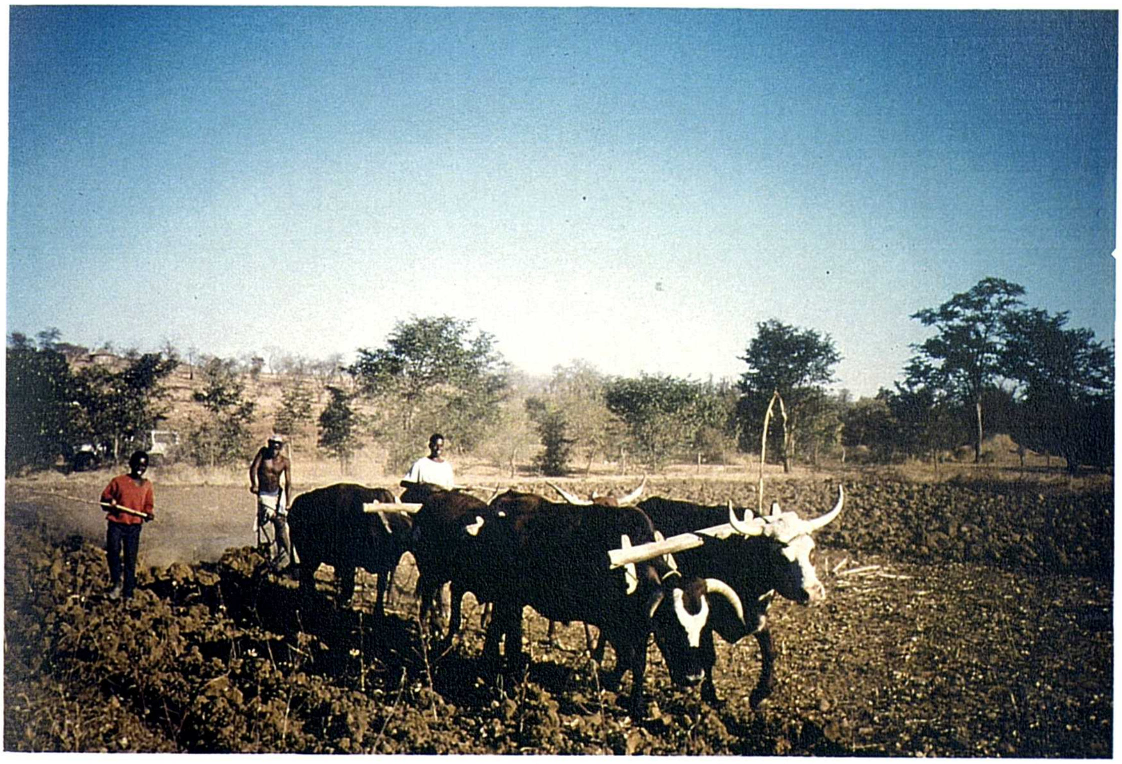


Plate 12: Oxen ploughing in Zimbabwe

Plate 13: Motorcycle in Sri Lanka

Plate 14: Motor tricycle in Thailand

Plate 15: Power tiller being used for transport in Thailand

Plate 16: Power tiller being used for ploughing in Thailand

Plate 17: Power tiller being used for passenger transport in Sri Lanka

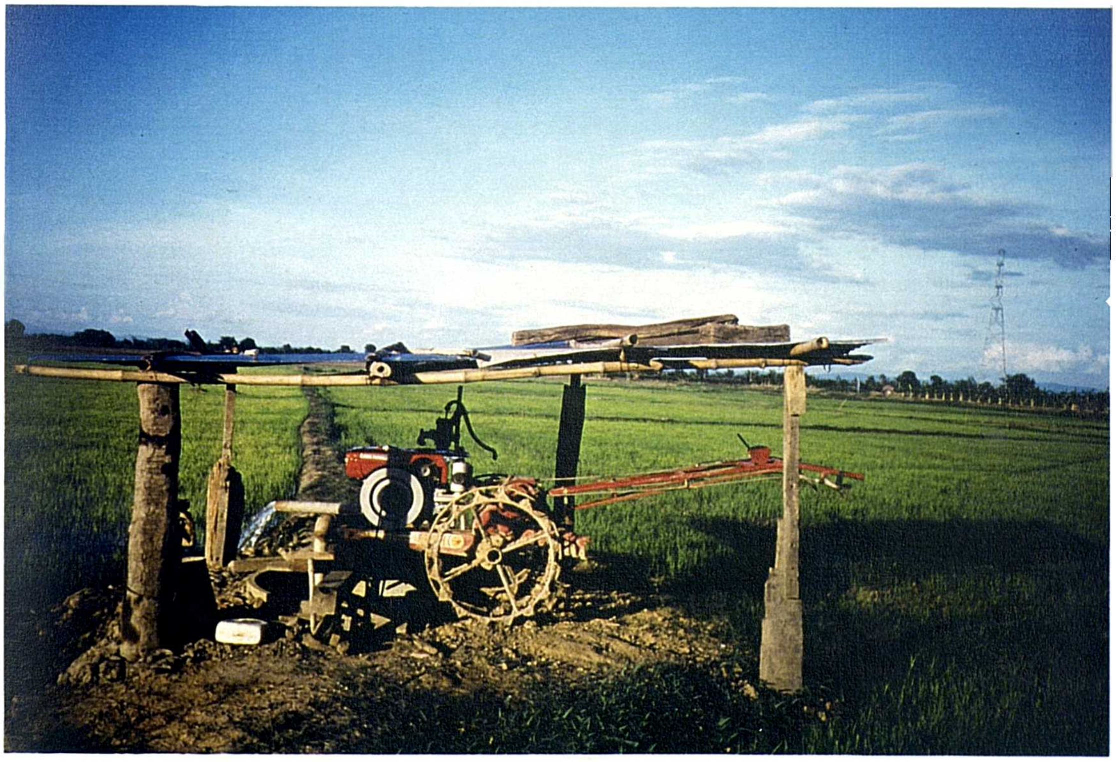


Plate 18: Power tiller being used for irrigation in Thailand

Plate 19: Farm vehicle (e-tan) in Thailand

Plate 20: Tractor and trailer in Pakistan

Plate 21: Tractor and 2 trailers in Zimbabwe

Plate 22: Taxi in Ghana

Plate 23: Suzuki pickup in Pakistan

Plate 24: Pickup truck in Thailand

Plate 25: Truck (mammy wagon) in Ghana

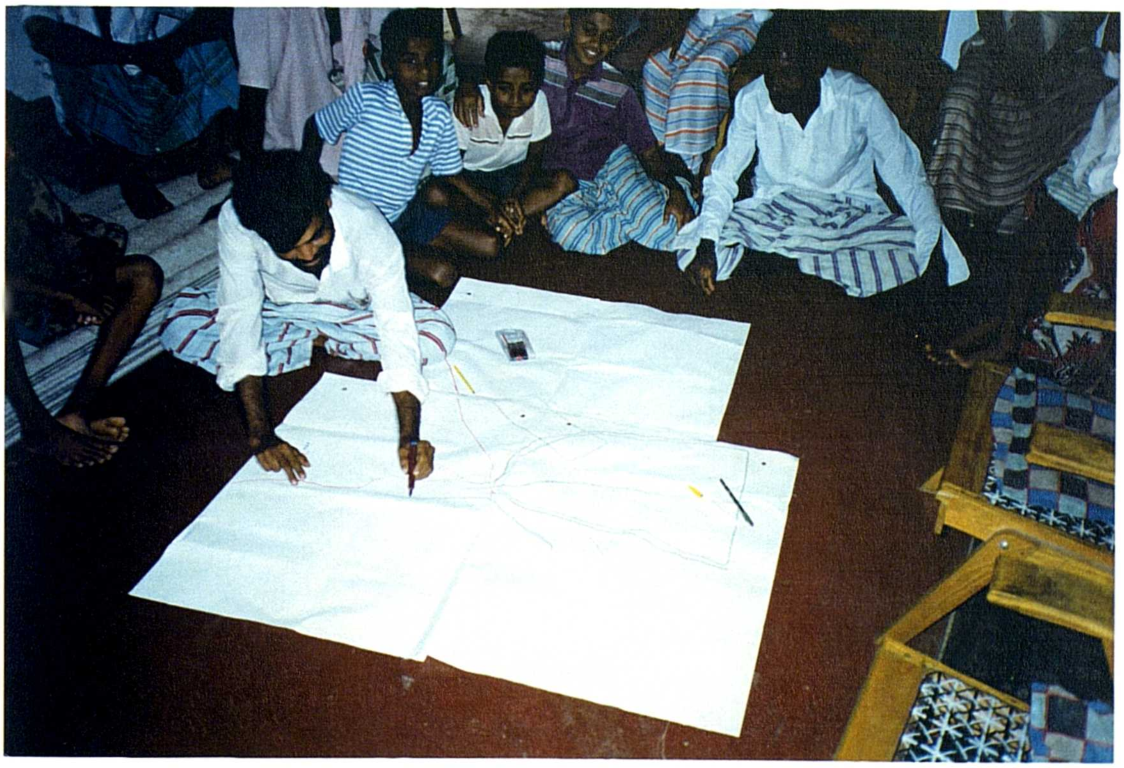


Plate 26: Participatory Mapping in Sri Lanka