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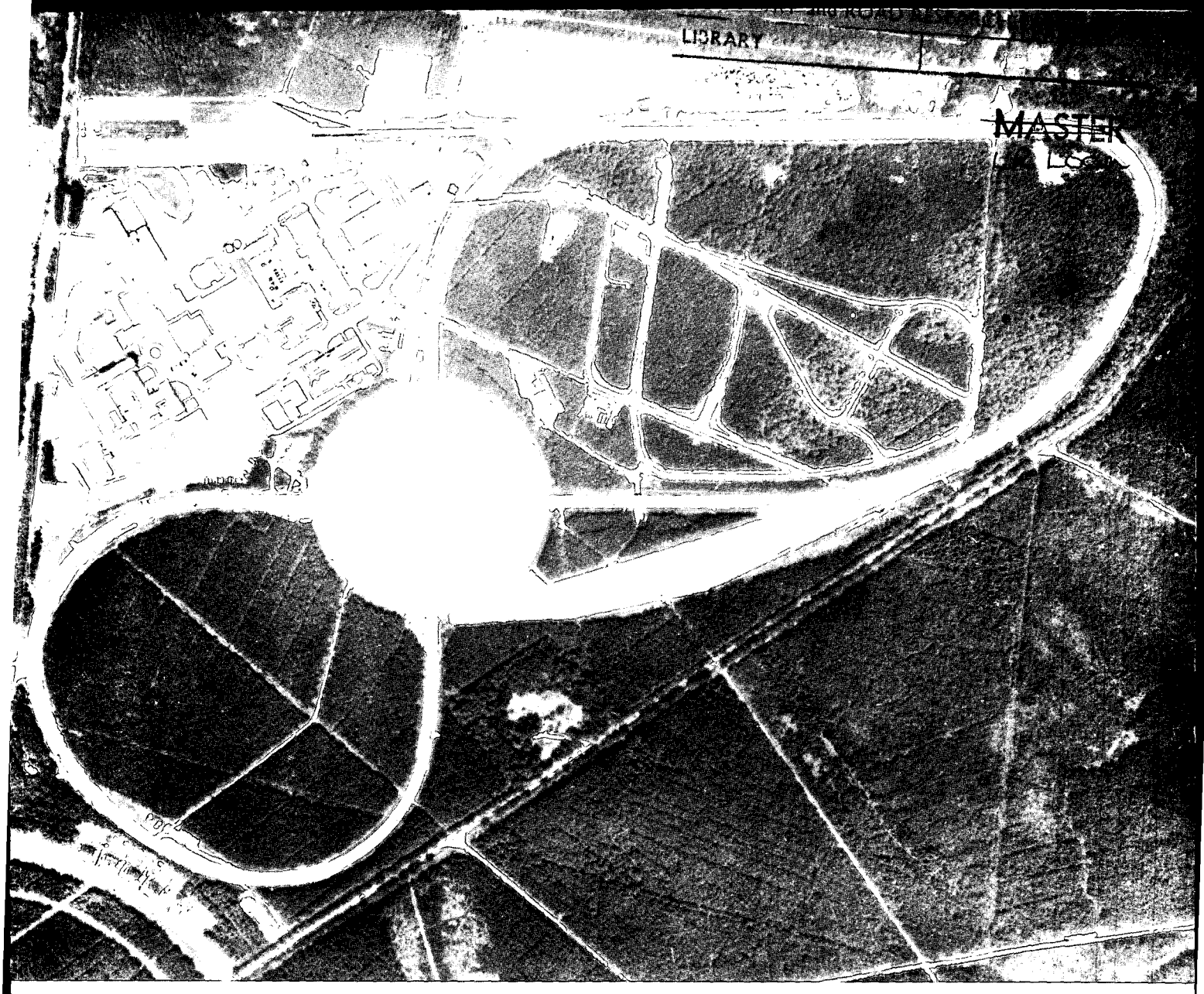

Road planning for rural development in developing countries: a review of current practice

by

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ROAD PLANNING FOR RURAL DEVELOPMENT IN DEVELOPING COUNTRIES: A REVIEW OF CURRENT PRACTICE

Author J L Hine

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This Digest is based on a submission to an OECD Working Group set up to consider the problems of planning rural roads in developing countries.

Road transport is by far the most important form of transport for the rural population of the developing world. Subsistence farming communities have comparatively low demands for transport outside their immediate locality. It is only when market agriculture is established that transport for farm inputs and farm produce is required. But in most rural areas, even when agriculture is developed, the movement of agricultural products will generally account for only a small proportion of total traffic movement.

Rural populations frequently exert strong political pressure for roads for reasons often unrelated to agricultural development. Significant increases in passenger movement have been found to occur with new road building.

Evidence from various case studies points to certain characteristics which in conjunction with road investment may stimulate agricultural development; crops with low value to weight ratios, crops that deteriorate easily, the presence of under used land, a skilled mobile workforce and a competitive transport industry are some of the factors that have been identified. However scarcity of unutilised land and a lack of complementary inputs are two of the key factors which can prevent agricultural development from taking place following road investment.

Given a favourable economic environment new road investment is most likely to stimulate rural development when a large change in relative transport costs is brought about. This will occur most often when road vehicles are able to replace expensive human or animal transport, when a new road enables a substantial reduction in journey length to take place or when a relatively lengthy road (over 200 km) is upgraded. However there are reasons to believe that the construction of small roads in areas already partially accessible to motor vehicle traffic will have little effect on development.

The way rural communities respond to a road investment or any other development input will depend on social and cultural factors as well as the more clearly identifiable economic parameters. The acquisition and application of new knowledge and technology are critical factors in rural development, yet little is known about the extent to which they are affected by accessibility.

The measurement and prediction of traffic on roads with an average of less than twenty vehicles per day is both expensive and unreliable. Difficulties are encountered in estimating vehicle operating costs on poor earth roads and tracks, where precise engineering standards cannot be specified. Low initial traffic volumes will often suggest that rural road investment is not justified purely on the grounds of savings in transport user costs. Yet it is easy to exaggerate additional benefits accruing to agricultural production stemming from road investment.

If there is a secure basis for predicting changes in agricultural production the producer surplus approach[1] is a useful way of planning rural roads. However, care needs to be taken to ensure that a bad investment in a road is not made within a good agricultural development scheme to which the road is not really essential. Benefits arising from the investment package need to be assessed both without the road as well as with the road to ensure that the road investment is really worthwhile.

Planning roads on the basis of total minimum transport costs is a useful procedure to adopt where interaction effects are difficult to predict and where changes in the level of road investments are unlikely to have much effect on the level of rural production or passenger transport. This is most likely to occur with large regional development projects (where roads may form only a small part of the total investment) and with road rehabilitation and maintenance programmes.

Reference

1. CARNEMARK, C, J BIDERMAN and D BOVET. The economic analysis of rural road projects. *World Bank Staff Working Paper* (241). 1976.

The work described in this Digest was carried out by the Overseas Unit (Unit Head: Mr J N Bulman) of TRRL.

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The work described in this Report forms part of the programme carried out for the Overseas Development Administration but any views expressed are not necessarily those of the Administration

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ROAD PLANNING FOR RURAL DEVELOPMENT IN DEVELOPING COUNTRIES: A REVIEW OF CURRENT PRACTICE

ABSTRACT

This report is written as a guide to assist with all road planning in rural areas of developing countries, but the focus of attention is on the smaller rural roads. A critical examination is made of the relationship between road investment and rural development. In addition, a variety of economic appraisal techniques are reviewed.

Case study material is used to identify some of the circumstances which will induce a favourable response to road investment. The evidence suggests that this is most likely to occur when road investment brings about a relatively large change in transport costs in an area which has under used land, a skilled mobile workforce and a competitive transport industry.

The treatment of benefits accruing to agriculture in the appraisal of rural road projects has generally been poorly carried out. The basis of the forecasts tend to be weak and a failure to consider all the relevant costs of production has meant that on balance it appears that road benefits are often overvalued.

Where there is some basis for predicting changes in agricultural output the World Bank's producer surplus approach is cautiously advocated. For road planning within larger regional development plans, for road maintenance and rehabilitation programmes and in situations where prediction is more difficult a minimum transport cost solution is suggested.

1. INTRODUCTION

This report is based on a submission to an OECD Working Group set up to consider the problems of planning rural roads in developing countries. The recommendations of the Group have been reported already[1]. The purpose of the present report is to make the evidence available to a wider audience, to examine critically the relationship between road investment and rural development, and to review a variety of economic appraisal techniques that may be applied to rural road investment in developing countries. The report considers the case study evidence and examines the transport cost appraisal techniques that have mainly been used to appraise rural road projects in the past. The producer surplus approach and other approaches to road planning are reviewed.

2. ROAD PLANNING AND DEVELOPMENT – AN OVERVIEW

2.1 General

Rural transport in the developing world is dominated by the motor vehicle. Developing countries as a whole have in the order of 16 times more route miles of road than railway and about 7 times more trucks and buses than railway wagons and carriages[2,3]. Although non-motorised road transport is very significant in a few countries (eg in South Asia) in most countries the motor vehicle provides the principal means of transport.

Whilst rail transport is used to service rural areas the main advantage of rail transport lies in its economy for long distance bulk flows of passengers and raw materials. Hence rail transport is mainly used for inter-urban and mineral transport.

In a few particular locations water transport is more important than road transport; Bangladesh, the Amazon basin, the Gambia and parts of Thailand and the Sudan are examples. Generally road transport's inherent flexibility makes it much better suited than rail transport or waterways to meet the spatially dispersed transport needs of the developing world's population. The carriage of goods by individual men and animals play a particularly strong role in the initial movement of produce from the field or the dwelling. However if goods are to travel more than a few kilometres and the routes are also accessible to motor vehicles then the higher unit costs of animal transport usually make it uncompetitive with motor transport.

Relative to the developed world the developing countries are poorly supplied with transport facilities. For example, developed countries have in the order of twenty times more commercial vehicles per head of population and about thirty times more kilometres of improved roads per head than the developing countries. Moreover there is a considerable variation between different developing countries in the provision of certain transport facilities. For example, India has about thirty times more paved road per unit area than Ethiopia[2].

Even within developing countries transport facilities tend to be concentrated close to the centres of the highest demand and the rural population continues to have the poorest access to transport facilities.

2.2 Rural roads and road transport

This report is concerned with planning roads whose primary function is to serve the needs of rural areas. The standard can range from bituminous surfaced roads of many hundreds of kilometres in length to earth tracks of a few kilometres in length. The report is not concerned with roads designed to meet the needs of urban or inter-urban traffic.

Most often rural roads are of simple construction and drainage, relatively short in length and have relatively low traffic volumes. Commonly they represent the grass roots provision of the means of transport between rural areas and regional urban centres.

Roads cannot be considered in isolation from either the vehicles that are to use the roads or from the factors which determine transport demand. They are best viewed as a component of a much larger total transport and distribution system. Changes in one aspect of the system can cause repercussions on all other components. For example, the case for an all weather road may well diminish if extra crop storage capacity is provided. Likewise better handling and packaging of crops that are easily bruised or damaged in transit may reduce the need for a good riding surface of the road.

There is an obvious interaction between the vehicle and the road surface. Agricultural tractors in most cases need only the provision of a right of way over unprepared ground. Likewise rugged four wheel drive vehicles can operate efficiently on comparatively poor road surfaces. Such vehicles are, however, generally more expensive to operate than comparable two-wheel drive vehicles that require a higher quality road surface. Large lorries with axle loads of 11 tons and above need very expensive road pavements to withstand their heavy loads but they can offer the lowest total transport costs for long distance movement by road.

2.3 The demand for rural transport

2.3.1 The political demands of the local community. Rural populations frequently exert strong political pressure to gain road access. This is partly because of the real benefits such as cheaper and more frequent passenger transport and because of lower costs and greater availability of goods they wish to buy. It may also be because of a real, if unfounded, belief that a new road is the precursor of other features of development aid such as a school, a health centre or government credit. In turn local politicians ask for roads because they are a very visible symbol of government activity.

2.3.2 Passenger movement. Passenger movement frequently accounts for a high proportion of vehicle journeys in rural areas of developing countries[4]. Salaried officials such as tax collectors, police, teachers and the many kinds of extension workers all tend to make more frequent journeys both because of the demands of their job and also because their relatively higher incomes permit them to make more trips for purely personal reasons. However, the non-salaried population can also be a very important component of rural passenger movement. Trips are made to visit friends and relatives, to shop or see what is happening in the towns, and less frequently for medical, religious and educational reasons.

Almost by definition transport costs form a high component of the price paid for a passenger fare. This is not true of the transport cost component of the prices paid for other goods or services purchased directly by the consumer. Evidence from some countries suggests that a significant reduction in vehicle operating costs which has been passed on to the travelling public in lower fares stimulates a significant rise in the demand for passenger movement[5]. This greater mobility may be the result of better and more certain access to transport facilities as well as to changes in fare levels.

2.3.3 Transport for agriculture. The majority of the rural population of most developing countries depends on subsistence agriculture. Food is produced, harvested, stored and consumed within the local community. In practice most of the developing world's agricultural produce does not move outside the village area where it is grown.

It is only when market agriculture develops that agricultural produce is transported away from the village area. Even then the resulting produce movement is likely to generate only a very small demand for transport for each village community. When, however, the components of development aid such as fertilisers, tractors and extension workers are introduced a significant demand for transport can result. The relationships between road investment and agricultural development are explored in Section 2.5 and in Section 3.

2.3.4 Non-agricultural product movement. The more modern parts of the non-agricultural sector of the rural environment are amongst the heaviest users of transport. Retail distribution is an obvious example. Products such as petrol, kerosene, beer, soft drinks, cooking oil, tinned food, clothes, footware, cooking utensils, bedding and hand tools are all very widely distributed throughout the whole of the developing world. Furthermore stocks of those products tend to be replenished at frequent intervals.

New road investment can alter the pattern of transport and distribution in a rural area. If a bus or goods vehicle operator believes that there is a good chance that his vehicle will suffer serious delays when using a particular road then he will try to keep the number of trips on that road to an absolute minimum. However if the road is improved and the chance of delay lessened then the operator may respond by increasing his journey frequency.

If transport is more frequent and reliable then it is possible to maintain better product control and lower stock levels. Improved road networks will also generally encourage more competition between retailers through better mobility and knowledge of market opportunities.

Besides retail distribution other activities can be important sources of demand of transport. Traditional occupations like brick making, housebuilding, weaving and furniture making are examples; more modern activities like local government and agricultural processing can also be found in rural areas.

Improved transport can alter the balance between traditionally established craft industry and industrially manufactured goods. An inefficient retail distribution system based on high transport costs can act as a way of protecting local craft industry from outside competition. Hence new transport investment may have the effect of providing additional markets for industrially manufactured products at the expense of the craft industries.

2.4 Transport costs and relative prices

Transport costs represent only a small component of the final prices of most agricultural commodities. Miller[6] found that in Argentina total transport costs for wheat made up only 8 per cent of the total sales price. After an intensive investigation of data going back centuries and relating to many different countries Clark and Haswell[7] found that if grain were moved 10 kilometres then (using the median values of their data) transport costs would account for only 9 per cent of total costs if porterage were used, 3 per cent if carts and wagons were used, and only 1 per cent if motor vehicles were used.

Transport investment is most likely to affect agricultural development in situations where large changes in relative prices will occur. This could happen in places which are either very isolated (eg the Amazon basin) or which have very poor accessibility (eg parts of Nepal and Ethiopia). However for most of the developing world small rural roads of less than 20 kms are very unlikely to change the relative prices of most agricultural products to any considerable extent, although crops which have a particularly low value to weight ratio may be responsive to transport price changes. Crops such as sugar cane, coconuts and to a lesser extent cassava and plantain are likely to come into this category.

2.5 Transport investment and the distribution of benefits

The benefits of road investment need to be passed on to agricultural producers before agricultural development can take place. The World Bank found in Columbia and Iran[8] that truck users (usually commercial middlemen) could capture a large proportion of the transport cost savings; the benefits to consumers and producers were limited.

It may be possible for an increase in road density to encourage a more diverse marketing structure and hence break down local monopoly. New through routes passing areas formerly connected by one access road are likely to help considerably in bringing increased competition to the transport and distribution industry.

Simpson[9] found that the isolated location of Khartoum in the Sudan encouraged a monopolistic food marketing structure in which both truckers and wholesalers participated. By contrast where there is a large dense trading network as with food marketing in Southern Nigeria monopolistic collusion is harder to sustain[10]. However, the most effective way of combating a monopolistic distribution system is to introduce measures which will directly reorganise the structure of the transport and marketing industry.

3. IMPACT CASE STUDIES – DISCUSSION

This section considers evidence drawn from a number of case studies on the relationship between road investment and rural development. A more detailed review of the individual case studies is given in Appendix 1.

Most of the case studies considered are optimistic about the relationship between road investment and agricultural development. However, they cannot be regarded as representing an unbiased sample of all road projects in developing countries. It is probable that they are more representative of the 'success stories' than the 'failures'.

The studies demonstrate that agricultural development is often associated with road investment and that areas close to roads are more likely to demonstrate development than areas further away. Unfortunately these relationships may be of little value for overall planning purposes because it is necessary to know what development would have taken place without the road investment both in the immediate vicinity of the road and in the rest of the economy. In this context an understanding of the mechanism between road investment and development is required.

It is possible for a locational relationship to exist between agricultural production and road investment and yet the road investment may have contributed nothing to raising total agricultural production. It has already been suggested that rural populations will often greatly benefit in social, economic and political terms from a road investment which may have little to do with the improvement of agriculture. Greater social mobility, better access to schools and hospitals, a wider selection of industrial products to purchase, a better chance of a job in an urban centre or plantation some distance away are all benefits that derive from living close to a road. Furthermore there is evidence to suggest that because of the perceived benefits, rural populations will migrate towards areas recently provided with roads[11]. Consequently in view of the higher population densities next to roads, it is not surprising that land near a road will be more intensively cultivated than land further away. Greater agricultural output per unit of land near a road does not necessarily mean that in the absence of the road the same output would not have been achieved by the same population, perhaps dispersed over a wider area.

Similar arguments apply to plantation agriculture. Cash crops that are expensive to establish such as cotton, coffee, tea, rubber, and oil palm can often be dependent on the availability of capital, entrepreneurship and marketing expertise from urban areas or from the developed countries, and from other non-subsistence sections of the population. Inevitably in choosing suitable locations for the initial establishment of such crops relatively undeveloped areas close to new roads will be the first to be investigated. Again this does not mean that similar levels of production could not have been achieved elsewhere.

In some of the studies an attempt has been made to estimate the value of increased agricultural production stemming from road investment. However, there are reasons to believe that this has not always been accomplished satisfactorily as it is necessary to subtract the correct cost of any increase in other inputs which has also contributed to the increased value of production. Increased agricultural production will often require increased inputs of labour, fertilizer and seeds. Arguably a complete analysis should also incorporate other investments such as irrigation, drainage, malarial control, forest clearance,education and health.

Unfortunately there is a tendency to cost these items in terms of their market price and not in terms of their opportunity cost in alternative situations (ie their value in contributing to increasing production elsewhere). This procedure will tend to overestimate benefits to projects which have many items in short supply and which have a real value far above their apparent market price. Entrepreneurial ability is an obvious example which is frequently ignored and very difficult to price.

It can be argued that the whole procedure of attempting to attribute increased agricultural production to roads alone is misleading because it assumes, without proof, that accessibility is the critical factor to development and so any residual profit should be attributed to road investment. It can be equally well argued that the transport input should be included at cost and that any residual profit should be attributed to any other of the capital inputs such as malaria eradication, irrigation, fertilizers, etc.

The valuation of agricultural benefits arising from road investment is further discussed in Section 4.8.

Several of the case studies draw attention to the relationships between road investment and the development of sugar cane and cotton. Both are bulky crops with low value to weight (and volume) ratios. It is possible that transport improvement may play a part in their development for this reason. Similarly, improved transport may have a role to play in the development of fresh vegetables (and in the case of Nepal fresh ginger) because of the need for speed.

By contrast, none of the studies in Thailand and Bolivia found any relationship between road investment and rice production. This is possibly because of its higher value to weight ratio and its good storing qualities. It is also the staple diet of the villages in which it is grown so only a proportion will travel outside the local village area.

Most of the studies identified some complementary characteristics which were needed for agricultural development. Population migration was a key input mentioned in five studies. Underdeveloped land was a requirement in at least seven studies. A lack of complementary investments was the most frequent reason given for a failure to develop agriculture. The need for a competitive transport system was highlighted in Iran and the need for a resourceful labour force was mentioned for Peru.

Most of the cast studies dealt with road investments which brought about large changes in transport costs. This was either because the new roads were relatively lengthy (eg over 200 km long) or because they enabled vehicles to replace very expensive human and animal transport. In comparison the effects of upgrading an existing vehicle track of 30 km or less in length were likely to be minute. If there were a favourable economic climate the effect of road investment on rural development will, in theory, be heavily dependent on the relative change in transport costs.

4. ECONOMIC COST BENEFIT ANALYSIS

4.1 Introduction

This section deals with the application of cost benefit analysis to rural road planning. Comments are based on a number of unpublished consultants' reports*. User cost savings and induced production benefits are analysed. The producer surplus approach[12] is examined in Section 5.

* A list of road investment appraisals is included in Appendix 2.

Economic cost-benefit analysis is an appraisal technique frequently used in both developed and developing countries as an aid to investment decision making. Basically it is a procedure used to assess the validity of proposed investments by estimating the cost of a project in terms of resources employed and comparing these costs with the value of benefits produced by the project. Both costs and benefits are expressed in money unit terms using resource cost values.

There are two principal components of benefit which are commonly found in rural road planning. These are:

a) user cost savings
b) increases in agricultural production

To evaluate costs and benefits in the future a discounting procedure is adopted which values the present and immediate future more highly than the intermediate and distant future. A number of different decision criteria (such as net present value or internal rate of return) can be applied to the sums of discounted costs and benefits which will indicate the best investment programme taking into account factors such as mutually exclusive options, budget constraints, possibility of failure and optimal timing (see Henderson[13] for a good overall view of these issues and Marglin[14] for a detailed analysis of the optimal timing problem).

Initially the limitations of economic cost benefit analysis are discussed in relation to national objectives. This is followed by a critical description of cost-benefit methods that have been used to appraise rural roads.

4.2 Objectives

The final measurable objective of economic appraisal methodology has largely been accepted to be the net increase in income generated by the project, but economic cost-benefit analysis has a number of well recognised limitations. Because of the limited freedom of action governments have in implementing their taxation policies the problems of distributing the net increase in income arising from the project between people remain. The use of distributional weighting in project appraisal has only recently been adopted and then on a comparatively limited scale. The World Bank[15] has published a guide showing how this may be carried out. In contrast the Overseas Development Administration manual[16] on project appraisal recommends that distributional matters should not, in general, be incorporated in the calculation of benefits. Instead a separate assessment should be made of the groups which will benefit from the investment so that the two issues of income generation and the distribution of income can be considered independently of each other.

The problems of income distribution have a particular relevance to road investment in rural areas. A common criticism of road investment programmes of the developing world is that they have concentrated on providing benefits to the richer urban populations and have ignored the needs of the rural poor. This has happened because the better off are more politically vocal, more mobile, possess higher time values and are more concentrated than the rural poor. To some extent this is a reflection on conventional cost-benefit analysis which will not discriminate between projects which will benefit the rich rather than the poor.

Even the benefits of most new inter-urban roads go overwhelmingly to the better off. For it is they who consume the largest proportion of marketed industrial and agricultural production which will gain the benefits of lower freight transport costs following inter-urban road investment. Thomas[17] has suggested

that the substantial benefits from road investment can be shared by the whole community only if a system of road tolls is implemented. However this will benefit the non road user only if these sums are redistributed through tax reductions, subsidies or direct aid.

It is of course doubtful whether a measure of income generated by one project in isolation can be regarded as the sole indicator of a project's potential contribution to the development process. In addition to the problems of isolating one project's impact on the total economic environment it must be recognised that there are many consequences of an investment project besides a net increase in income. Income represents one dimension of social change. Other aspects of social change are less easily measured but could play an equally fundamental role in the development process.

An assessment of change in the fields of health, education, political development, organisational structure and the many other aspects of socio-cultural life should all be incorporated into the decision making process*. In practice many governments do recommend that an assessment of the project's impact in these other areas be carried out in parallel with the economic appraisal.

4.3 The financial appraisal

Besides the economic appraisal (and the assessment of the other non economic factors) it is important that a separate financial analysis be made of the project to show how the funding will be carried out and what future loan repayments (if any) will be required. In order that the social worth of the project can be assessed independently of its financing the source or costs of funding a road investment should not, in general, be incorporated into the social cost-benefit analysis.

However in certain circumstances (such as when aid funds are tied to a particular project which could not otherwise be spent in the recipient country) then the opportunity costs to the recipient country of employing resources financed by aid funds to the project will be much less than the normal cost benefit evaluation would suggest. In such cases it may be felt desirable to evaluate the project, together with its financial implications, purely from the point of view of the recipient country by ignoring the cost of resources supplied under aid terms and adding into the cost stream any associated loan repayments to be made at a later date. It may still be necessary to carry out a conventional economic cost benefit analysis to demonstrate to the aid agency that the project is viable in its own right.

4.4 Investment costs

In comparison with other components investment costs are comparatively straightforward to calculate, although in practice they are often underestimated. Once the resource costs for each investment option are totalled for each year they may then be included in the cost-benefit framework.

To calculate resource costs the taxation component is generally omitted from the analysis; likewise pure financial costs (such as interest charges during construction) are also excluded.

Problems can arise if a system of shadow prices (also called economic or accounting prices) is adopted (see Section 4.10). For example low cost rural roads are frequently built using labour intensive methods which in most instances will give a much lower shadow price than its corresponding market price. In comparing

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* A way of incorporating social factors – such as health or education – into a cost-benefit framework is suggested by Bovill[18].

costs with conventional capital intensive methods of construction it is important that recognition be given to the possible difference in evaluation that might arise.

An aspect of road appraisal that is commonly overlooked is the optimal timing of the road investment[14]. It is not commonly realised that if an investment is made too soon then resources will have been wasted. It is important to ensure that the reduction in discounted costs gained by postponement are less than the discounted benefits lost by postponement. When benefits are static or rising over time, and independent of the age of the investment, then the first year of return criterion (FYRR) provides a convenient test.

4.5 Maintenance costs

There is a trade-off between maintenance and road investment costs. If maintenance cannot be carried out satisfactorily then the case for greater initial investment is strengthened. Although road maintenance costs represent only a small proportion of total transport costs if minimum levels of maintenance cannot be achieved then vehicle operating costs can rise disproportionately[19]. In general the maintenance requirements of unsurfaced rural roads are sensitive to traffic flows. Hence estimating future traffic levels (see Section 4.7) is important for calculating future maintenance costs.

It has been common for road planners to underestimate the costs of road maintenance which are actually achieved. This has been because inadequate allowance has been made for the low levels of plant utilisation and labour productivity which are common in the road maintenance organisations of many developing countries[20].

4.6 The classification of benefits

The classification of benefits of rural roads poses an awkward problem. Ideally the benefits should be separated into non overlapping components which at the same time give complete coverage of all benefits that can arise.

Double counting is said to have occurred when different manifestations of the same underlying benefit are added together. For example if a road investment brings about a change in transport user costs which in turn induces a change in land values then double counting would occur if both the user cost savings and the change in land values were added together and attributed as the total benefit arising from the road investment.

Five distinct methods of estimating benefits have been commonly used in rural transport planning.

These are:

a) minimum cost or user cost-benefit to normal traffic
b) user cost-benefit with induced traffic
c) user cost-benefit with increased agricultural production
d) user cost-benefit with increased agricultural production and induced traffic
e) the producer surplus approach (reviewed in Section 5).

4.6.1 Minimum cost or user cost-benefit to normal traffic. The minimum cost technique and the basic user cost-benefit technique are different ways of presenting the same basic approach. Both techniques will give an identical ranking using the present value decision criterion.

The approach assumes that forecast traffic levels will be unaffected by the planned transport investment. Furthermore it is assumed that this transport demand will be accommodated at the lowest transport cost. In the conventional road appraisal alternative investment strategies are costed with their corresponding vehicle operating costs, time savings and investment costs and the least total cost solution is recommended as the best option.

The benefits of the user cost-benefit technique are calculated by measuring the total reduction in transport costs which are brought about by each investment by comparing user costs with and without the investment. The project which has the highest net benefit compared with its investment costs is selected as the best alternative. If the sum of benefits from each alternative are all less than their corresponding investment costs then no investment is recommended.

On theoretical grounds we may expect this approach always to underestimate the benefits to road investment because induced traffic benefits (or induced output benefits) are omitted. However the method is sensibly employed for an assessment of rural road maintenance and rehabilitation programmes or for road investment within a regional development plan where the level of road investment is expected to have a trivial effect on induced traffic or induced production.

4.6.2 User cost-benefit with induced traffic. This method differs from the above mentioned user cost-benefit approach in one respect only; benefits from traffic induced by the investment are incorporated into the analysis. This approach is the classic textbook method of transport project appraisal. With reference to Figure 1, if OF_1 is the number of trips without the investment at cost level OC_1 and OF_2 is the number of trips with the investment cost level OC_2 then total benefits to the investment can be represented by the area $C_1 ABC_2$. The user cost-benefit method measured only area $C_1 AEC_2$, whereas this method adds the area ABE into the analysis.

The benefits stemming from the induced traffic component are usually valued at half the unit savings in vehicle operating costs to normal traffic. This assumes that the demand curve for transport ($D_1 - D_2$ in Figure 1) is a straight line (ie that there is a linear relationship between the reduction in transport costs and the corresponding growth in trips).

For each alternative that is considered, benefits to normal and induced traffic are calculated. The best alternative is given by the project which is demonstrated to have the largest net benefit after deduction of the investment costs.

Some authors have argued that in a fully employed, competitive economy user cost savings arising from normal and induced traffic will adequately cover all the benefits which might arise from a road investment[21]. (This issue is examined in more detail in Sections 4.11 and 6.2.) However, full employment and a competitive economy are not commonly found in rural areas of developing countries. It is partly for this reason that agricultural benefits have been included directly into the analysis.

4.6.3 User cost-benefit with induced agricultural production. This is a popular method of appraising feeder road projects in developing countries. User benefits to normal traffic are calculated in the same way as for the two previous user benefit methods. To this is added the further benefit of increased agricultural production which can be identified as having been induced by the new transport investment.

The addition of induced agricultural benefits to normal traffic user cost savings will increase the benefit rate, but it will still exclude induced transport benefits from non agricultural activities (such as greater personal mobility or greater commercial trade).

4.6.4 User cost-benefit with induced traffic and induced agricultural production. This approach is one of a number of very obvious hybrid approaches to the measurement of benefits. User cost benefits to normal traffic and induced traffic are calculated in the customary fashion and then added to this is the value of increased agricultural output induced by the project. The advantage of this approach is that it gives latitude to the project planner to measure the benefits of a project in those areas in which he thinks they will arise. However, it is highly likely that double counting will occur. This is because a significant proportion of the induced traffic benefit will reflect changes in agricultural production.

4.7 Traffic prediction

It is difficult to predict traffic flows in rural areas of developing countries with much confidence. Deficiencies in traffic measurement techniques and traffic modelling are particularly apparent.

4.7.1 Traffic measurement. The accurate measurement of traffic flows on rural roads can be a lengthy task. Rural roads which have low average traffic levels also tend to have the highest proportionate daily variation[22]. The available evidence suggests that seasonal traffic variation may not be easily predicted from the annual cycle of crop harvesting. This is because harvest crop movement very often accounts for only a small proportion of total traffic flow.

4.7.2 Traffic modelling. So far the systematic study of the relationships between traffic flows and land use in rural areas of developing countries has been generally limited. However, Riverson[23] in Ghana and Howe and Tennant[24] in Kenya have made some progress in establishing significant relationships between road traffic and adjacent rural population in the former case, and between interzonal trip making and zonal employment in the latter case.

4.7.3 Existing forecasting procedures. The most frequent method of forecasting traffic levels in developing countries has been to assume a rather crude constant percentage rate of increase. This is then projected forward for the next 15 to 30 years for the appraisal. Using this approach it has been extremely easy to forecast unrealistically high traffic levels for the latter years of a project.

For most purposes traffic projections can be split into the following categories:

a) normal traffic

This refers to traffic which will continue to travel along the same route both for the 'with' and 'without' investment case.

b) diverted traffic

This traffic diverts its route between origin and destination with road investment to take account of the lower perceived transport costs made possible by the investment. In some cases it can be difficult to predict the relative perceived costs of different routes in rural areas. Problems are encountered with perceived time values and when roads do not provide all year round access.

c) induced traffic

Induced traffic is composed of new trips which are brought about by the road investment. Price theory suggests that the larger the reduction in perceived transport costs to the final consumer the greater will be the likely induced traffic component. The available evidence suggests that passenger traffic is clearly quite responsive to new road investment whereas freight traffic is not so responsive. However there has been little statistical research which will easily permit a reliable forecast of induced traffic to be made. In general, estimates that have been made for planning purposes appear to be rather arbitrary.

Theoretically, induced traffic may be predicted from the price elasticity demand for transport. Evidence from several past evaluation studies carried out in developing countries gives a range of between -0.6 to -2.0 for the elasticity of demand for transport with an average of about -1.0, ie on average, a one per cent decline in transport tariffs will bring about a one per cent rise in traffic.

4.8 The valuation of user benefits

4.8.1 Overall transport costs. To determine benefits from transport investment it is first necessary to estimate transport costs in resource cost terms for each investment option under consideration and for the 'without investment' case.

An extension of the transport network may lead to a change in the mode of transport; for example, from head-loading or bullock carts to vehicle transport. Such a change in the pattern of transport will bring about different loading, unloading and distribution costs. These costs of intermodal transfer are rarely, if ever, estimated in the appraisal of rural roads.

4.8.2 Vehicle operating costs. It is difficult to make accurate predictions of changes in vehicle operating costs following road investment. Some progress has been made in modelling vehicle operating costs for paved and engineered gravel roads[25]. In order to make use of these relationships local data still has to be collected and related to the prevailing resource cost prices of the transport industry.

However little is known of vehicle operating costs for tracks and rough earth roads. Operating cost data on the poorer class of road is of course required for any appraisal where these roads are an important component of the existing transport environment.

4.8.3 The value of time. The evaluation of time savings poses particular problems for the analyst. Leisure time savings are frequently ignored because they are not normally considered significant to the economy, yet Howe found that in Kenya businessmen valued their own time savings almost as highly as did drivers in the UK[26].

Working time valuation creates other problems. Working time is generally valued in relation to the wages paid. The value of working time savings should, in general, relate to the marginal net contribution of a worker to the economy. However, in rural areas of developing countries an important component of total time savings will relate to public servants of one form or another (ie school teachers, agricultural extension workers, doctors, medical staff, etc). For these workers wages paid will often bear little relation to their net contribution to the economy, although in the absence of other information wages may represent the best proxy value that can be used.

4.9 The treatment of agricultural benefits in road investment appraisal

Agricultural benefits have often been included in rural road appraisals in what appears to be a very arbitrary manner. Most often forecasts have been made with no empirical justification. A number of examples of how rural roads have been appraised are reported below. In no case was any justification given for the forecast differential growth rates in agricultural production.

In one appraisal agricultural production was forecast to grow at a continuous rate of one-third more with the road investment than without it. In this case benefits were estimated to be 90 per cent of the final market price of the agricultural products. In a second appraisal cotton production was forecast to grow 3 per cent faster with a road investment than without it. Benefits were estimated to be 70 per cent of the final market price of cotton.

A third appraisal suggested that coffee and timber output would grow one per cent faster with the road. Pulses, sunflowers and potatoes and rice production were forecast to grow two per cent faster and wheat at five per cent faster with the road. The largest increase was suggested for fruit and vegetables which were forecast to grow 13 per cent faster with the road investment. No difference in growth rates were suggested for tea or wattle. Benefits were estimated to lie between 65 and 95 per cent of the final price for most crops. However for wheat the estimated benefit rate was only 25 per cent.

A fourth appraisal report suggested that benefits would be 50 per cent of the incremental output. Eighty per cent of the benefits were attributed to tea production which occupied only 3 per cent of the cultivated land. For the first ten years tea was forecast to grow at 12 per cent with the road and 10 per cent without it, and for the second ten years 10 per cent with the road and 8 per cent without it. Thus by the year 2000 tea production was forecast to be 14.5 times the 1970 level whilst in the without case it was forecast to be only 9.1 times the 1970 level. Nine other crops were mentioned which had similar initially marginal differences in the growth rates of output.

This last appraisal demonstrates that a complete change in the pattern of agriculture was probably justified. It would have benefitted all concerned to have adopted a system of agricultural development which ensured the maximum adoption of tea at the expense of all other crops. In such a situation a package of investment inputs are probably required and the roads are best planned to meet the planned demand of agriculture in a systematic way.

In many road appraisals most of the agricultural benefits are attributed to forecast changes in cash crop production, with changes in subsistence agricultural practice adding little to the benefit level.

Most appraisals attempt to net out the forecast increases in the value of inputs that are associated with the forecast rise in production. A residual benefit is calculated by subtracting the value of increased inputs 'at cost' from the forecast rise in production. This benefit is then attributed to the road investment. Even when this calculation is done correctly it still assumes that road investment is the only critical factor promoting agricultural development so that all other factors of production are available and employed to the point where their marginal contribution to production equals their market supply price. This is a doubtful assumption. Entrepreneurial ability, financial capital, extension advice, fertilizers, new seeds or irrigation investment can all equally well be in critically short supply. A valuation of other inputs 'at cost' may well underestimate their contribution to the economy (see Section 3).

If other factors of production that are in short supply do not become available when required then the predicted rises in output will not be realised. On the other hand if inputs in short supply are to be made available through the deliberate intervention of government agencies then a proportion of the net benefits of the project (calculated after pricing all inputs 'at cost') should properly be attributed to these other inputs and not included as a residual benefit to the road investment.

Provided there is a basis for predicting agricultural production, one way of overcoming the 'additional inputs' problem is to treat road investment and other inputs as a joint project. Agricultural benefits and non agricultural transport benefits are then attributed to the package as a whole. Effectively this is to adopt a 'producer surplus approach' which is discussed further in Section 5.

The best package of road investment and other inputs is then the package that shows the largest net benefit after subtraction of road investment and additional input costs. Provided a sufficient range of alternative combinations of investments are considered a consistent valuation of inputs 'at cost' is an acceptable procedure because it does not presume, without evidence, that one particular input is more critical than the rest.

To date road planners have made little use of the elasticity of supply of agricultural production in order to predict changes in agricultural output following road investment. The use of supply elasticities is discussed in Section 5.

4.10 Multiplier effects

Developing country economies often have a high degree of unemployed labour and sometimes under used land. In such situations it is possible to argue that considerably more benefits may arise from transport investment than equilibrium user cost savings approaches may suggest. However, this is dependent on the changed pattern of demand brought about by the investment.

Each investment will bring about positive and negative multiplier effects in the economy. If these investment multiplier effects are on balance positive then formerly unemployed resources may be brought into productive use; if the net effect is negative then more unemployment may result. From a positive multiplier effect a rise in national production may take place on a greater scale than the user cost savings approaches would indicate.

Although this argument is in principle appealing, in practice its limitations are many. Firstly most developing countries have only unskilled labour and land as unemployed resources. To increase production in most areas of the economy resources of skilled manpower and capital are also badly needed. Hence any potential improvements in income may be constrained by shortages arising in other sectors of the economy.

Secondly if it were possible to increase production by bringing into play unemployed resources following a changed pattern of demand brought about by the transport investment, then better results could surely be achieved by a selective and conscious effort from the government. In practice many governments will attempt demand management and other measures such as investment and import control to achieve an increase in output from unemployed resources.

Different multiplier effects can arise from the differences in composition between transport costs and the average composition of costs in the rest of the economy. For most developing countries road

transport has a relatively high component of imported products and of taxation; domestically supplied resources contribute little to total transport costs. Consequently for most developing countries, when a road investment generates transport cost savings for the normal traffic component (ie traffic that would continue to run irrespective of the road investment), those savings will principally occur in terms of reduced demands for imports and a reduction in taxation revenue. When the transport cost savings are 'spent' a rise in demand for domestically produced goods (for example, for food) will take place which will not be matched by a corresponding release of domestically supplied resources from the transport sector. In the same way a net decline in taxation revenue can be expected and a net reduction in the demand for imported goods may also result. So for normal traffic a positive multiplier effect will take place compared with what would have happened in the absence of the investment, tending to increase demand for domestically produced goods.

Precisely the reverse will take place for induced traffic (ie traffic induced by the investment). In this case demand is shifted away from other products towards transport. And because of the higher import and taxation component of transport a net decrease in domestic demand will result. The total net effect of the investment will depend upon the absolute magnitudes of the normal and induced traffic and on the multiplier effect associated with the investment itself. This in turn will be dependent on the quantity and component of resources consumed and released for the investment and on the income generated through successive rounds of consumer spending.

In view of the difference in economic effect between induced and normal traffic the above arguments are of particular importance when road investments with a high developmental impact are compared with roads which have a very much lower component of induced traffic. Multiplier effects are discussed further in Section 6.2.

4.11 Taxation and shadow prices

The prices used to value resources in cost-benefit analysis should be expressed in resource cost terms. There are a number of factors in the economic environment which make the exclusive use of market prices wrong. Taxes which are usually a very significant component of road transport costs (in terms of petrol and diesel tax, purchase tax and annual road taxes) represent no direct resource cost and should, therefore, be omitted from the analysis.

Distortion in market prices can also be caused by the operation of other government policies and by the generally unresponsive and uncompetitive structure of the market in many developing economies. To counteract these distortions development planners have adopted shadow pricing techniques which they can apply in cost benefit analysis. The approaches proposed by Little and Mirrlees[27] (a system of prices valued in terms of uncommitted government funds measured in international prices) and Sen, Marglin and Dasgupta[28] (a system of prices valued in terms of consumption measured in domestic prices) are the most well known.

In common with planners working in other public service sectors, road planners have been slow to adopt recommended full shadow pricing procedures in their appraisals. However Anand[29] has demonstrated how the Little and Mirrlees technique may be applied to a road investment appraisal.

4.12 The spread of knowledge

A rise in the efficiency of production techniques can take place through the spread of knowledge. Knowledge travels with people along transport links as well as by newspaper and by radio and similar

means. The greater frequency and ease of movement following rural transport investment may lead to a greater spread of technical and marketing knowledge.

The cost of transfer of knowledge and its effects on agricultural production have not up to now been studied in relation to transport investment. Hence any increase in efficiency attributable to the spread of knowledge following a road investment will, in general, not be included in a conventional cost benefit analysis, although time savings to professional 'knowledge workers' such as extension officers will be incorporated in the valuation of passenger time savings.

4.13 Road planning within a regional development plan

Perhaps the most effective way of ensuring agricultural development is to provide a balanced package of investment inputs which may include irrigation, land preparation, extension advice, agricultural mechanisation, agricultural processing and the provision of services such as domestic water, electricity and roads.

The easiest solution to planning road investment in this situation is to plan on the basis of meeting total transport demand at minimum cost (see Section 4.5.1). Transport demand should be specified so that the planned requirements of agriculture, local industry and passenger transport are met. Forecasts of passenger transport should be linked to the income that the project will generate as a rise in incomes will inevitably mean an increased demand for passenger movement[17].

By using the minimum cost solution the interaction effects between road investment and passenger movement on the one hand and between road investment and agricultural production on the other may be lost. If they are believed to be large then the latter of these effects may in principal be accommodated in the producer surplus approach (see Section 5). The former could in theory be forecast from a constructed behavioural demand curve of passenger trips.

The minimum cost solution is likely to be an effective procedure where roads form a particularly small component of the total investment package. In this situation the other investment components will be the major determinants of agricultural production and total income generation (and hence of total transport demand).

5. THE WORLD BANK'S PRODUCER SURPLUS APPROACH

In their paper 'The economic analysis of rural road projects', Carnemark, Biderman and Bovet[12] suggest that in areas that are relatively well developed and where traffic levels are over 20 to 50 vehicles per day, transport cost savings may be used to appraise rural roads. However in less developed areas where traffic levels fall below the 20 to 50 vehicles a day level then roads should primarily be appraised using a 'producer surplus' approach supplemented by non-agricultural vehicle cost savings.

In this second situation the authors expect that complementary investments to promote development (such as extension, credit and irrigation) will generally be required. When this is the case the road plus the other investments must be appraised together.

Diagrammatically their basic model is shown in Figure 2. This shows the benefits from a road investment in terms of the increased profits to farmers who farm in the area of influence of the road. In

the without road case agricultural output is Q_1 and the farm gate price is P_1. Q_1 is determined by the marginal cost curve MC_1 meeting the price level P_1. According to his location each farmer will face a different farm gate price and each will have a different marginal cost curve. The supply curve of an area will be the sum of the individual marginal cost curves.

With the road investment two separate effects will occur which will affect agricultural production. Assuming the market price remains fixed the farm gate price will rise from P_1 to P_2 because it is now cheaper to transport farm produce to market, and the farming cost curve will fall (from MC_1 to MC_2) because it costs less to transport farming inputs (such as fertilizer, tools, fuel, etc) to the farm. This joint effect leads to production increasing to Q_2 given by the point of intersection of marginal cost curve MC_2 with farm gate price P_2. Areas A and C represent benefits from the farm gate price rise alone. Areas B and D represent benefits from the lower cost curve alone. Area E is a benefit from the joint effect. Total benefits are given by the total shaded area A B C D E. In a fully employed competitive economy and in the absence of both non-agricultural traffic and significant income effects on domestic consumption, there are grounds to suggest that the total benefits calculated by the producer surplus approach will be equivalent to the benefits calculated by the transport cost savings approach[30]. In this case areas A and B will be equivalent to normal traffic benefits and areas C, D and E will be equivalent to induced traffic benefits.

It is recognised that in practice the exact shape of the marginal cost curve will not be known and so it is suggested that average variable costs are used to determine the incremental producer's surplus. The total producer surplus benefits arising from the road are then:

(new farm gate price (P_2) – new average variable cost (at Q_2)) x new output level (Q_2)

– (original farm gate price (P_1) – original average variable cost (at Q_1)) x original output level (Q_1)

This will give equivalent producer benefits to those shown in Figure 2. By using average variable costs only two cost points of production are required rather than two continuous curves.

The main difficulty with the producer surplus approach (as with all other agricultural production models) is predicting the new level of agricultural production (Q_2) following the road investment. It is suggested that agricultural experts be involved to assess the possibilities of expanding production on existing and new land with additional use of new inputs.

A critical factor is the change in crop area associated with the new road investment. The use of Walters's model (see Section 6.1.1) to determine the area of influence of the road is discussed in the paper.

Possibly because of a desire to consider new agricultural inputs as well as the road investment itself to stimulate agricultural production, the paper makes little mention of using agricultural supply elasticities to predict changes in agricultural production. A study by Oury[31] gives a number of agricultural supply elasticities for developing countries ranging from 0 to 1.5 which could in certain circumstances be used for this purpose.

As Figure 2 shows the prediction of a change in output following a transport cost reduction will be a joint effect stemming from a rise in farm gate prices and a shift in the supply curve stemming from a change in input prices. If the elasticity of supply of agricultural production is 1.5 and if the supply curve remains fixed then a 1.0 per cent rise in farm gate prices will raise agricultural production by 1.5 per cent.

It is by no means certain that farm gate prices will rise following a road investment, for a non-competitive transport industry may prevent transport tariffs from falling and hence prevent a rise in farm gate prices. It is also possible for an agricultural supply curve to rise and not fall following a road improvement. This could happen, for example, if improved transport encourages agricultural labour to move away from the area and thus cause a rise in the agricultural wage rate in the area.

The authors pay particular attention to the likely distribution of benefits following the road investment. A perfectly competitive marketing and transport industry cannot be assumed. Hence it is recognised that some of the benefits may be held back by transporters and middlemen.

The analysis is broadened to cover such aspects as home consumption, crop substitution, additional land cultivation and the regional deficit case.

The producer surplus approach has many advantages over the transport cost savings approach. In order to apply it, it is necessary to calculate the costs of increasing agricultural production. The need for complementary investments is identified and the method is flexible enough to enable a joint appraisal of roads with other inputs to be made. Furthermore the central objective of planning roads for rural development is fulfilled directly. Necessarily this approach demands more data and different expertise compared with the transport cost saving approach.

A weakness of Carnemark, Biderman and Bovet's paper (but not necessarily of the overall approach) is that little attention is given to the possibility of a bad road investment being justified under the umbrella of a good agricultural inputs package. In order to ensure that the road investment is justified it is necessary to analyse the costs and benefits of the agricultural package without the road. If net benefits in this case exceed the with road investment case then the agricultural package is justified without the road.

The paper does recognise that for integrated projects the producer surplus approach, as outlined, is insufficient in itself to plan road design standards, hence separate transport costs and traffic forecasts must be calculated for this purpose. A slight contradiction is shown up here since the design standards adopted will in turn affect transport costs and the viability of the whole package. Ideally alternative agricultural packages should be combined with alternative road investment designs (including the no road investment case) in order to find the best overall solution.

6. OTHER APPROACHES

In this section several other approaches to rural road planning are considered. Although it is doubtful that any of them will be applied on a widespread basis (on the whole the data demands appear to be too severe), they nevertheless provide further insight as to how roads might affect the rural economy. Some of the limitations of conventional cost benefit analysis are demonstrated.

6.1 Mathematical models of the local economy and road network

There are several mathematical models which have been developed to appraise roads in agricultural areas. Some of these models predict changes in agricultural output that result from changes in transport costs.

Prices are either determined completely exogenously or given by static demand and supply schedules, multiplier effects are not incorporated. Examples of such models are given below.

6.1.1 The Walters-Ellet model. Walters[32] has developed a mathematical model (first put forward by Ellet in 1836) of a road in a rural area that can be applied to agricultural development in developing countries. The model assumes that the prime determinant of agricultural activity is the transport cost from field to market place or to port for export, ie the introduction of a new road that reduces transport costs will induce an increase in agricultural output through an increase in cultivated area. Although the model may be criticised for being rather simplistic it does provide a way of determining the area of influence of a road in areas of low road density.

For example, if a port 'P' lies on the coast of a country which is exporting a certain crop and (for the sake of convenience to the model) transport can be made only by head loading in North-South and East-West directions, then the cultivated area will be the area AJB shown in Figure 3.

If a road (PD) is constructed from port P due east into the interior of the country (for an indeterminately long distance) then the cultivated area will expand as in Figure 4 to the area ACB. The road has reduced the cost of transport in such a way as to increase the area of land that may be cultivated at a profit. If the road is subsequently improved so that transport costs fall even further,then the cultivated area will expand to AC'B.

If the price of the crop is fixed at port P at $K per ton and if transport is the only cost of production, the farmer will produce for the market if total transport costs per ton are less than this. If the cost of transport by vehicle along the road is $a per ton mile and the cost of head loading is $b per ton mile, then the area of profitable cultivation (and hence, the quantity of crop produced assuming a uniform crop production per unit of area) for the without road case is given by two right angled triangles (AJP and BJP) each of area $\frac{1}{2} K^2/b^2$. For the with road case the area of profitable cultivation is given by another two right angled triangles (ACP and BCP) each of area $\frac{1}{2} K^2/ab$.

The assumption that transport is the only cost of production will not materially affect the form of the model providing all other costs of production are the same regardless of location. By relaxing the assumption that travel takes place only in North-South and East-West directions, Walters was able to suggest how much increase in ton mileage would result from a decline in transport costs.

Another aspect that Walters investigated was the variation in the level of benefits associated with proximity to the road. Surplus profits derived from agricultural land (ie economic rent) can be shown to vary in intensity according to the pyramid in Figure 5. Those closest to the port and road gain the biggest benefits from their location whilst those furthest away gain little. By subtracting the rent pyramid associated with the no road case from the rent pyramid in the road case a rent pyramid of benefits from the road can be determined.

There is not a great deal of published evidence to suggest that agricultural development follows the Walters–Ellet model; Bonney[33] and Bouchard[34] provide contradictory findings. In making the assumption that the production costs per unit of output are the same for all producers, the model takes no account of variations in such matters as soil fertility, rainfall or terrain. Furthermore transport costs are usually such a small part of total production costs that the influence of transport alone will often tend to be over-shadowed by other factors.

6.1.2 Squire's adaptation. Squire[35] developed the Walters-Ellet model by dropping the assumption of uniform levels of production within the area of influence of the road and by introducing labour use directly into the model. The intensity of production and labour use were made a function of product price, transport costs and wages. Using data from Thailand and by making varying assumptions on the change in output that will arise from a change in labour use he calculated a set of optimum feeder road lengths. (For each set of assumptions the induced production from the last unit length of the feeder road just equalled the additional costs of construction and maintenance.)

Squire also uses his model to analyse the problem of optimum spacing of feeder roads and the allocation of a fixed budget for feeder road construction.

6.1.3 Israel's linear programming model. Arturo Israel[36] has developed a linear programming model of a local agricultural community. A set of equations relates the inputs of labour, cattle land, farm land, animal power and road transport to outputs of crop production, animal products and transport services. Outputs are valued exogenously and the resources and production function are specified. The possible range of activities which can be undertaken involve subsistence agriculture, commercial crop production, animal husbandry and transport.

In the initial situation the nearest market town is 60 km distance and can be reached only by animal transport along a trail. In this situation the model predicts that a high proportion of land and labour are devoted to subsistence agriculture. The cost of transport of cash crops is high in terms of labour and land for animal transport.

In the second situation a feeder road is built which links the area to a closer market town, so that road transport can now be used to take commercial products to market. In this situation the model predicts that the optimal situation has changed and that labour and land should be shifted towards producing marketable products and away from subsistence agriculture and from keeping animals for transport.

6.1.4 Meta Systems model. Meta Systems[37] have developed a linear programming model similar to Israel's to help determine the optimum spacing of feeder roads. Using data from Pakistan they calculated how changing feeder road grid sizes will induce different optimal cropping patterns at varying distances from market centres.

The model starts with assumed resources of land, water, labour and a bullock team and cart to each farm. Both bullock carts and vehicles are used to transport farm produce although bullocks are also used as a source of farm power as well. Extra labour, bullocks and vehicles are used as required. As road densities are postulated to increase (ie grid sizes are reduced) the hire costs of vehicles and bullock carts are reduced and domestically owned bullock cart travel times are reduced. For each grid pattern size changes in cropping patterns and farm income levels are calculated.

The model is also used to examine the separate and total effects of introducing tubewells, introducing new varieties and fertilizer together with changing road grid sizes.

Linear programming models are widely used in agricultural planning in developing countries and so the prospects of using these models for rural transport planning and road investment appraisal look promising.

6.1.5 Tanner's plantation road model. Tanner[38] constructed a simple model for determining the optimum road layout on a plantation. The model was designed to minimise the total costs of road construction, maintenance and transport costs of harvesting produce. In contrast to other models outlined in this report agricultural production was assumed to be unresponsive to road investment and changes in transport costs.

The optimum spacing of straight parallel roads and the overall pattern of arterial and harvesting roads were considered. The road layout of a circular centre-orientated estate was also analysed.

The model shows that for a parallel grid network total road and transport costs vary little for moderate departures from the optimum. It is calculated that these costs will increase by only 25 per cent if spacing is half or double the optimum. For centre-orientated estates Tanner recommended that 3 or 4 main arteries be used. This will give significantly shorter journey lengths than 2 main arteries and, in most circumstances, more than 4 arteries will provide very little advantage.

6.2 National and regional income approach by mathematical model of the economy

The approach identifies the complex network of interdependence between sectors of the economy based on econometrically determined macro relationships. The amount of information needed to calibrate a model of the economy would be prohibitive for most rural road investment appraisals, nevertheless it is conceivable that such models could be developed for investment appraisal work.

The models are characterised by their ability to incorporate a wide variety of changes in the economic structure resulting from transport investment. Price changes can be determined internally by the models, in addition multiplier effects and changes in the patterns of supply and demand can all be incorporated into the analysis. Two examples of such models are described below.

6.2.1 The Bos and Koyck model. Bos and Koyck[39] have developed a model of a developing economy in which a road is built which connects an agricultural area with an industrial port area. One of the two industries in the industrial port processes home-grown agricultural produce which is then consumed locally and sold abroad. The other industry processes imported raw materials.

The model was built up from a set of demand equations incorporating income and price elasticities for the two final consumption goods and a set of price-elastic industry supply equations. The model was designed to show what effect a lowering of transport costs, following road investment, would have on the income of the whole economy.

A parameter was incorporated into the model which altered the extent to which agricultural producers would gain higher prices for their production following a reduction in transport costs on the road connecting the agricultural and industrial areas. This parameter was varied in conjunction with a range of supply elasticities to give a series of results, obtained by solving linearised forms of the model's specified equations.

It was found that for the most favourable combination of parameters and elasticities real income rose by many times the conventional cost benefit transport savings, even including benefits to generated traffic. The reason for the forecast large increase in output relates to the assumed highly elastic supply function. In terms of a real economy this would imply large amounts of under used land, labour and capital which would be brought into use through an expansion of demand.

6.2.2 The Friedlaender model. Friedlaender[40] developed an algebraic model of the national economy. By analysis of the effect of a reduction in transport costs she demonstrated that total national production could be less than or more than the measured transport benefits of a conventional cost-benefit analysis.

The principal factors that Friedlaender isolates that would tend to increase national production over measured transport benefits are as follows:

(a) high elasticity of factor supply;
(b) high degree of substitutability of inputs;
(c) high produce substitutability;
(d) extensive economies of scale;
(e) low initial level of regional specialisation of production; and
(f) high factor mobility.

Friedlaender states that the most important determinant of output is the price elasticity of factor supply. If a rise in the price of the factor (eg labour) causes a more than proportionate increase in supply then an increase in total output in excess of the reduction of transport costs is likely to take place.

By contrast both Friedlaender and Gwilliam[41] point out that an increase in national product could be less than the measured benefits of a conventional cost-benefit analysis if demand is shifted towards products with inelastic supply functions. The net effect of reduced transport costs in this latter situation is a rise in the price of products in inelastic supply and increased unemployment.

These models demonstrate quite conclusively that the total net income effects of a road can range from less than to very much more than the measured benefits of the orthodox cost-benefit analysis. The principal difficulty with using the models in practice is the large amount of information required, also a large number of elasticity coefficients need to be determined.

Both Friedlaender's model and Bos and Koyck's model make use of multiplier effects bringing into play formerly unemployed resources (this is represented by the high elasticity of factor supply mentioned in both models). It is possible that similar benefits (if they exist) could arise through the judicious use of government demand management policies (see Section 4.9).

6.3 The rent approach

This method is rarely used to assess projects in developing countries; however it is an approach which could conceivably be adopted to measure benefits of road investments where markets for land exist[21]. The method assesses the benefits from a road project by the changes in land values or rents that result from road investment.

The idea behind this approach is that land rents are altered by the transportation system; if accessibility is improved, then one may expect land values and rents to rise. (Land values reflect the capital value of land, and rent is a payment for its use).

Besides changes in transport costs, land values and rents may also reflect other demand and supply aspects of the economic environment. Any potential rise in the rent or land value of a given area may be

assessed from the surplus return the area can produce. However, any necessary increase in complementary inputs (such as extra labour or fertilizer costs) need to be deducted before assessing an increase in land value. An example of the application of this approach to the United States is reported by Langley and Goley[42].

There are many problems with the approach. Firstly it can be difficult to obtain meaningful data on land values and land rents. The price of land will be dependant on the local pattern of land tenure. In many developing countries land owners derive their income from a variety of crop sharing arrangements. Where land is held in a form of communal ownership the rights to farm land (and hence payments made for land use) depend on the status of the prospective farmer. In this way local custom, social values and legal regulations tend to prevent a competitive market structure from emerging. Secondly, the relationship between the transport system and land values is complex. The proportion of national income which goes to land owners (either explicitly or implicitly) is not static and must be affected by the nature of economic activity.

Thirdly, it has been suggested by some economists that rises in land values in areas which are beneficially affected by changes in the transport system will in part be compensated by falls in land values elsewhere. To isolate and measure adverse rent charges poses an extremely difficult problem in attempting to assess the total net effect.

7. CONCLUSIONS

Road transport is by far the most important form of transport for the rural population of the developing world. Subsistence farming communities have comparatively low demands for transport outside their immediate locality. It is only when market agriculture is established that transport for farm inputs and farm produce is required. But in most rural areas even when agriculture is developed the movement of agricultural products will generally account for only a small proportion of total traffic movement.

It has been suggested that rural populations will exert strong political pressure for roads for reasons often unrelated to agricultural development. Significant increases in passenger movement frequently occur with new road building.

Case study evidence points to certain characteristics which in conjunction with road investment may stimulate agricultural development. Crops with low value to weight ratios, perishable crops, the presence of under used land, a skilled mobile workforce and a competitive transport industry are some of the factors that have been identified. However scarcity of unutilised land and a lack of complementary inputs are two of the key factors which will prevent agricultural development from taking place following new road investment.

Given a favourable economic environment new road investment is most likely to stimulate rural development when a large change in relative transport costs are brought about. This will occur most often when road vehicles are able to replace expensive human or animal transport, when a new road enables a substantial reduction in journey length to take place or when a relatively lengthy road (over 200 km) is up-graded. However, there are reasons to believe that the construction of small roads in areas already partially accessible to motor vehicle traffic will have little effect on development.

The way rural communities respond to a road investment or any other development input will depend on social and cultural factors as well as the more clearly identifiable economic parameters. The acquisition and application of new knowledge and technology are critical factors in rural development.

The national economic models also suggest where some of the weaknesses of the standard partial equilibrium cost benefit approaches may lie, although their scope for use as direct appraisal techniques is strictly limited. The models strengthen some of the evidence from the case studies in suggesting the importance of under used resources of land and labour which may be brought into play following road investment.

The planning of rural roads poses a variety of problems. Traffic volumes which are low initially will often suggest that rural road investment is not justified purely on the grounds of user cost savings. Additional agricultural benefits need to be handled carefully. It is easy to overestimate the benefits attributable to road investment in such situations. Difficulties remain with the estimation of vehicle operating costs on poor roads and earth tracks where precise engineering standards cannot be specified. The measurement and prediction of traffic on roads with an average of less than twenty vehicles a day will inevitably remain both expensive and uncertain.

If there is a basis for predicting changes in agricultural production then the producer surplus approach is a useful procedure for rural road planning. However, care needs to be taken to ensure that a poor road investment does not become justified within a good agricultural scheme. Benefits arising from an investment package need to be assessed both without the road as well as with the road to ensure that the road investment is actually worthwhile.

Planning roads on the basis of total minimum transport costs is a useful procedure to adopt where interaction effects are difficult to predict and where changes in the level of road investment are unlikely to have much effect on the level of rural production or on passenger transport. This is most likely to occur with large regional development plans (where roads may form only a small part of the total investment) and with road rehabilitation and maintenance programmes.

8. ACKNOWLEDGEMENTS

The work described in this report forms part of the research programme of the Overseas Unit (Unit Head: Mr J N Bulman) of TRRL. The assistance is acknowledged of members of the Overseas Unit in particular P G Hill, D I N Bovill, A J Plumbe, Dr E D Tingle and J S Yerrell and all members of the OECD Working Group on Rural Road Planning in Developing Countries.

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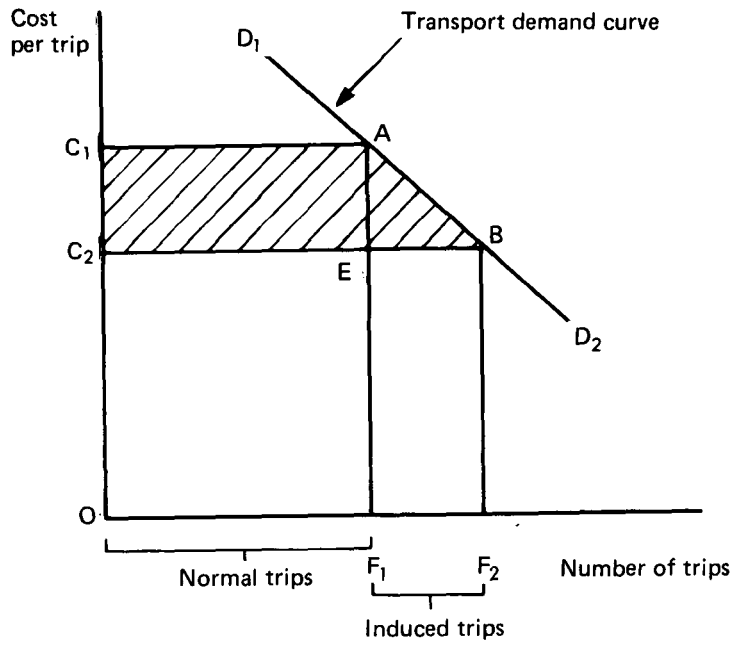

Fig. 1 The consumers'surplus transport model showing benefits to consumer arising from a lowering of transport costs

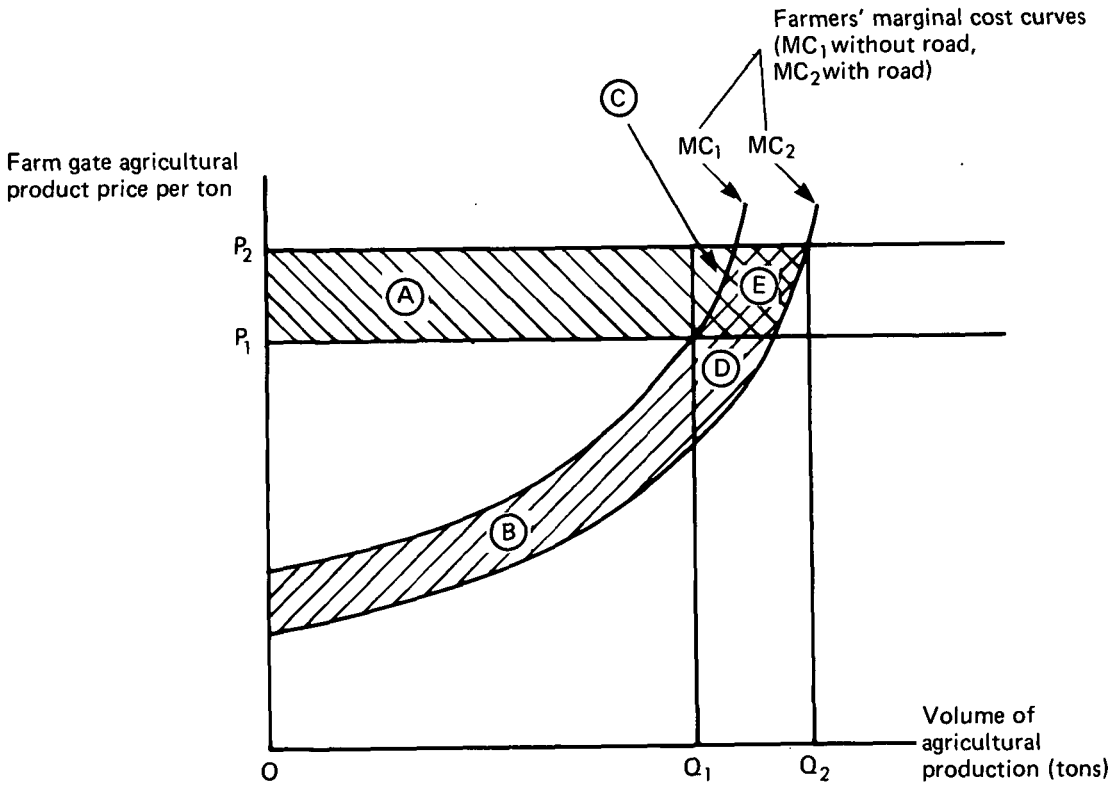

Fig. 2 The producers'surplus model showing benefits to farmer resulting from a lowering of transport costs giving rise to higher farmgate prices and lower input prices

THE WALTERS ELLET MODEL (all figures)

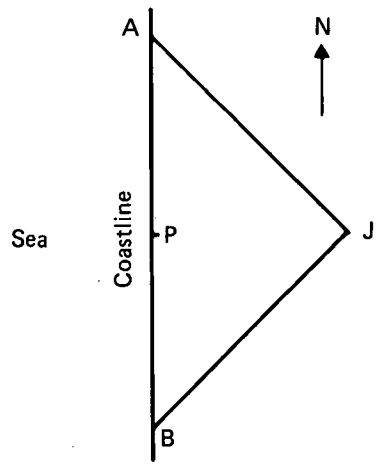

Fig.3 Area of cultivation—without road case

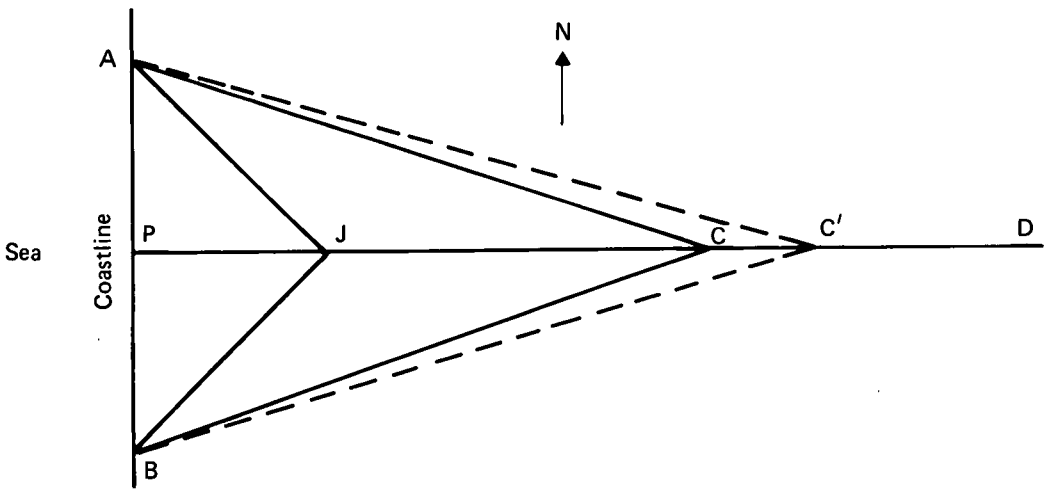

Fig. 4 Area of cultivation—with road case

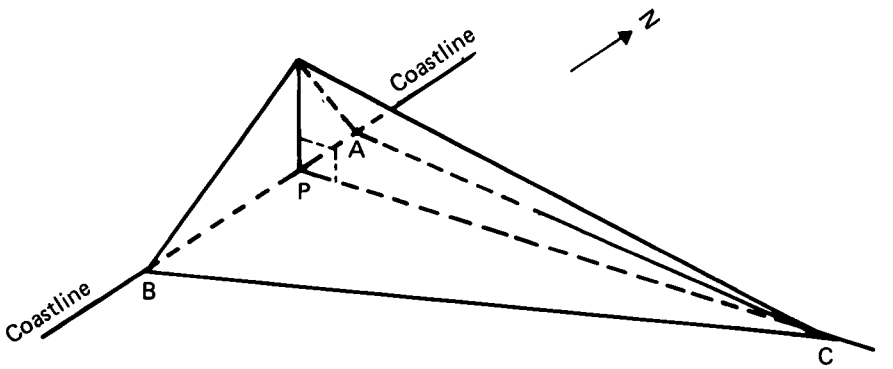

Fig. 5 The rent pyramid showing intensity of economic rent stemming purely from location (with road case)

10. APPENDIX 1

IMPACT CASE STUDIES

The impact case studies are drawn from a variety of sources; these are listed in the references at the end of the Appendix. The material is arranged on a country basis. A general discussion of the studies is included in Section 3 of the main Report. The focus of attention is the impact on agriculture.

10.1 Bolivia

Bergman[5] investigated the effects of the 555 km Cochambama-Santa Cruz highway. She suggests that the highway was partly responsible for stimulating large increases in sugar, cotton, rice and timber production in the lowland Santa Cruz area. The large increase in production was made possible by a substantial inflow of resources and people from the Bolivian highlands to the Santa Cruz area. It is argued that this was made easier by the road. An estimated economic return of 8 to 9 per cent was calculated for the road.

Wennergren and Whitaker[43] investigated the impact of a package of investments (roads, water resources, education and health) involving the construction of an 85 km access road in the Chane-Piray area of Bolivia. This area was characterised by a large inward movement of immigrant labour. An extremely high rate of return (in the order of 120 per cent) was estimated. Their analysis indicated that there was a direct relationship between land cultivation and road proximity. Sugar cane (a transport intensive crop) was only grown up to 14 km from the road. By comparison rice, which has a much higher value to weight ratio, was grown in areas over 80 km from the road.

10.2 El Salvador

Hirsch[5] investigated the building of the 318 km Littoral Highway in El Salvador along the relatively under-developed coastal plain. The building of the highway coincided with a dramatic increase in cotton production as land was shifted away from growing beans, corn and raising cattle. Hirsch recognised that cotton production was rising before the completion of the road, but he suggested that the change to cotton accelerated with the opening of the road. Of the actual rise in production from 13,000 tonnes to 80,000 tonnes he suggested that at least 20,000 tonnes should be attributed to the road.

After deducting costs associated with cotton production Hirsch calculated that the value added attributable to cotton was $7.5M on an annual basis. Adding further benefits of $2.3M for shrimp fishing the total annual benefit attributed to the road was estimated to be $9.8M. Comparing this with road investment costs and other infrastructure costs of $32.5M the highway was considered to have had a very significant payoff.

10.3 Guatemala

Klein[5] investigated the 300 km Atlantic Highway from Guatemala City to Puerto Barrios, Guatemala's major port on the Caribbean coast. The road closely follows the line of the existing railway.

As a result of road competition a very substantial decline in railway tariffs was recorded. Land values next to the highway increased from $5 per acre to $15 per acre. Some increases in agricultural production (particularly of tomatoes and melons) were believed to have taken place. Klein suggested that the agricultural

effects were limited because other complementary investments such as irrigation, drainage, power and public health were not made.

10.4 Iran

Van der Tak and de Weille[8] carried out a study on a series of major road investments in Iran. The total length of road considered was 2387 km.

The study demonstrated that the road investments were justified by the reduced transport costs that resulted. Although there was evidence that the transport rates had declined for certain routes there was no evidence to demonstrate that the range of market prices had declined between producing and consuming areas.

Because marketing of food in Iran is highly monopolistic (transport accounts for only 5 to 10 per cent of the difference between farm and retail prices), the study suggests that the total road project had few, if any, agricultural development benefits.

10.5 Madagascar

In Madagascar Mitchell and Rakotonirina[44] carried out a study of an 85 km mountain road into the Andapa Basin in the North West part of the country. Before the road was built the valley was very isolated, access being possible only by foot or by airplane. After the road was built very large increases in rice production (by over 160 per cent) and coffee production (by over 70 per cent) were reported. With the advent of the road it even became feasible to export a small quantity of rice. Production of vanilla the former most important export crop of the area, declined by 25 per cent during the same period.

Although the road obviously had a very significant impact on the pattern of agriculture it is difficult to identify the effect because of the very significant change in producer prices offered to the farmers. These commodity prices were set by government marketing organisations and were uniform at buying posts throughout the country. In real terms the price of rice offered to the farmers substantially increased, while the price offered for vanilla declined; coffee prices remained fairly static.

Using road user savings alone the authors calculated that the road investment was marginal with a rate of return of 6.5 per cent. This was increased to 11.4 per cent when agricultural benefits were included. A particular feature of the study was that increases in farmers domestic food consumption (of rice) added a significant component to the road investment benefits.

10.6 Nepal

A team from the Overseas Development Group of the University of East Anglia (Blaikie, Cameron, Feldman, Fournier and Seddon) undertook a study of three roads in West Central Nepal[45]. The roads they considered were the Mahendra-Rajmarga (the East-West Highway through the terai plains region), the Siddartha Rajmarga connecting the hill centre of Pokhara with the terai and India and the Prithivi Rajmarga connecting Pokhara with the capital of Nepal, Katmandu. The Siddartha Rajmarga was opened in 1968, the Prithivi Rajmarga was opened in 1973 and the Mahendra-Rajmarga was opened in 1975.

A major interest of this study is that the roads brought about an extremely large change in accessibility in a relatively short time. Before the road to India was opened the journey from Pokhara to India took a

porter carrying a standard load 6 to 7 days whereas with the new road the journey takes 2 to 3 hours by vehicle.

The study team found that the roads had had very little impact on rural development, in spite of the large change in accessibility. The terai road appears to have encouraged the growing of sugar cane and it may have helped the Mahendra Sugar Mill maintain its production. The road also helped to develop the centralised marketing of paddy rice. Settlement in the terai area was associated with the road but this had mainly occurred through the recent eradication of malaria and through strong pressure on land in the hill areas of Nepal.

A large increase in the production of fresh ginger, a relatively minor crop, took place in the hills between 1971 and 1974. Although a general rise in price had taken place the road had apparently facilitated its extraction. The roads appear to have brought about a substantial decline in the price of salt and small declines in the prices of rice, sugar and black pulses in the hill area. They may also have encouraged the proliferation of retail outlets for factory made clothes and shoes from India.

The study team suggested that the impact of the roads on agriculture was low for two main reasons. Firstly, extreme population pressure on land which has been subject to considerable environmental decline (for example from soil erosion and loss of tree cover). Secondly, an administrative structure which was unable to respond to the problems and opportunities of the area.

Members of the study team felt that there was scope for significant improvements in agriculture particularly for growing citrus fruits, tea, pyrethrum and spices. But such developments would require the necessary resources and a favourable administrative and economic environment. Complementary investment in feeder roads, bridges, markets, credit, adequate extension and other institutional support were suggested.

10.7 Nicaragua

Wilson[5] suggests that the 141 km Littoral Highway from Managua to Chinandega and Cortino helped the development of cotton as a cash crop. In the state of Chinandega cotton acreage increased by five times and cotton production by ten times in a single decade. It is argued that the road helped the development of the crop by enabling farmers to apply insecticides two or three times a week in the rainy season. It is further suggested that the road also helped many cotton growers who lived in the cities to make frequent visits to fields in the outlying areas.

However, it is conceded that cotton production in the area was also stimulated by the rise in the price of cotton in the early 1950s, the introduction of effective insecticides, the use of improved fertilizers and by liberal farm credits.

10.8 Peru

Wilson[5] quotes a study by Drewes on the Western Montana of Peru. Drewes studied four areas of Peru which had settlements of different ages and ethnic background. He suggested that transport exerts a direct influence on population growth and cash crop production. However, he also identified other preconditions of development including favourable attitudes, technical abilities, the provision of favourable government policies that provide public services and incentives for private services.

10.9 Papua New Guinea

Bouchard[34] investigated the improvement of a road in the Gumine region of Papua New Guinea. In terms of the savings in vehicle operating costs he concluded that the road investment was not justified. He also found a negative relationship between the number of coffee trees per grower and the proximity to the roads. From this he suggested the road had no positive effect on coffee production.

Ward[46] found that a large increase in agricultural production took place following the opening of an 80 km road connecting a relatively isolated area to the capital Port Moresby. Assuming that the increase in agricultural production could be solely attributed to the road it was demonstrated that the road investment provided a good economic return.

10.10 The Philippines

Villaneuva[47] carried out a study of 46 rural roads distributed throughout the whole of the Philippines. The method of analysis was to compare changes in agriculture, education and the availability of government services before and after the roads were built. No control areas were used.

The study found that prices to farmers increased by a greater percentage than prices in the market place. Transport costs for transporting goods to market fell by about half with the introduction of the roads. Very large increases in sales of tobacco and corn occurred. A 400 per cent increase in the visits of government officials was recorded. Daily boarding of school children declined as daily travel between home and school increased. An overall increase in school attendance was also estimated to have taken place.

10.11 Sabah

Bonney[33] carried out an investigation in Sabah on the relationship between roads, traffic and agricultural development. When the study was undertaken (in 1960) Sabah had a population of 450,000 and a road network of 500 miles and an area of 29,000 sq miles. Against this background of low population and road density Bonney found that the measurable influence of a road on land use extended about 5 miles from the road but cultivable land was only fully utilised up to half a mile from the road. With only half the land area cultivable Bonney found that per mile of road, 508 acres of land was cultivated.

The percentage of area devoted to export crop production (ie crops produced surplus to a district's requirements, including paddi, rubber, copra and tobacco) varied inversely with the distance to a local commercial centre. So that, for example, Sipitany district which was on average only 4 miles from its commercial centre devoted 83 per cent of its total cultivated area to export crops. At the other extreme, Ranau with an average distance of 75 miles to its local centre allocated 25 per cent of its total cultivated area to export crops. Bonney attributed part of the decline in proportion of area used for export crops to the quality of the connecting road.

Traffic levels were found to be related to the non-agricultural population of a district and its average distance to the local commercial centre.

10.12 Sierra Leone

In Sierra Leone, Turay, Gwynne-Jones, Airey and Vandal[48] undertook a study of the impact on the surrounding area of a new 50 km main road link between Taiama and Bo. The prime justification of the road was to provide a 30 km distance saving on the existing road to through traffic.

The study was carried out by surveying villages at different distances from the old and new roads in the area. No clear conclusions could be drawn about the impact of the road on agriculture although there may have been some shift in crop composition in the different zones of influence of the roads. However, the authors did identify considerable increases in passenger travel, rural industry and retailing activity.

In a later study of 53 settlements in Eastern Sierra Leone[49], Airey found some important differences in the pattern of agriculture between settlements based on roads and those based off roads. Of the three major crops grown in the area, upland rice, coffee and cocoa (all three grown by nearly 60 per cent of all farmers both on and off roads) Airey found little difference in the area of rice cultivation but considerable increases in coffee cultivation (by 20 per cent) and cocoa cultivation (by 100 per cent) for settlements adjacent to roads. Part of this difference was attributed to monkeys that were reported to steal a large proportion of the cocoa crop and were rarer close to roads due to hunting pressure.

A greater use of fertiliser and hired labour was also found in settlements adjacent to roads. Village amenities were also found to be road related particularly wells and pumps, rice mills, clinics and schools.

10.13 Tanzania

Luning and Sterkenburg[50] investigated the effects of a 25 mile road built in the formerly inaccessible Bundali mountains area in the western half of Rungwe District in the Southern Highlands of Tanzania. The road was completed in 1958. In the whole Rungwe District coffee production increased by 80 per cent during the period between 1958 and 1970 whereas the production in the Bundali highlands increased by 15 times in the same period.

Although head loading costs of the coffee without the road only accounted for 4 per cent of the farmer's price, the authors believed it would have been highly improbable for the coffee to have been grown on any scale in view of the large number of people required to move the coffee to market. (For the whole of Bundali coffee production in 1970, 25,000 man days would be required to head load the coffee for a total population of 28,000 in the Bundali area.)

By assuming that coffee production in the Bundali highlands would only have increased by 4 per cent per annum in the absence of the road the authors calculated a cost benefit rate of return of 40 per cent for the road network.

A slight complication to the analysis was that the Bundali area had supplied a number of migrants (amounting to 16 per cent of total male population) to work in South Africa in the early 1950s. This opportunity to earn money greatly diminished with the Tanzanian Government's order in 1963 to prohibit migration to South Africa. Part of the reasons for the successful adoption of coffee growing in the area may relate to this migration of labour, firstly by supplying some of the initial capital for coffee growing and secondly by creating a need for cash income which in time had to be met by other means.

10.14 Thailand

In a programme of research carried out at the SEATO Graduate School of Engineering and the Asian Institute of Technology, a number of road impact studies have been conducted under the general guidance of J H Jones[51].

A positive locational relationship between road investments and agricultural development was demonstrated by the recording of larger increases in agricultural production close to the new roads compared with a reference area. Several case studies reported positive relationships between new roads and vegetable production, upland crops and poultry production. There was also some evidence of a relationship between new roads and timber extraction, kenaf and rubber production. No evidence was found for any obvious relationship between road investment and rice production even though the area devoted to rice was by far the largest component of the total cultivated area considered in the studies.

Three of the case studies reported evidence suggesting a larger increase in cultivated land in areas adjacent to the new roads compared with the control areas. One case study reported a larger increase in cultivated hectarage in the control areas compared with the area adjacent to a new road. However since the completion of the case studies J H Jones has emphasised the importance of variations in the level of internal security in Thailand as a possible explanation of the variation between some of the results. Three of the case studies had reference areas close to Thailand's borders.

10.15 Uganda

Smith[52] investigated three areas within the West Nile District of Uganda. He found a positive relationship between increases in road mileage, inward migration and cotton acreage. In a period from 1948 to 1956 in Madi County, road mileage doubled whilst population increased by 20 per cent and cotton acreage by five times. In North Jonum County road mileage increased by four times, population increased by 70 per cent and cotton acreage increased by eight times. In Terego County road mileage remained static, population rose by 12 per cent and cotton acreage increased by only 20 per cent.

No other explanation is given for the relative changes in cotton production (apart from the differences in road construction); however, it is interesting to note that both Madi County and North Jonum County are on lower ground adjacent to the Albert Nile and may therefore have been more suitable for cotton growing. By contrast Terego County is on higher ground a few miles from the Nile. Overall population density in the area is low; in 1948 Terego County had a population density of 7.46 people per square mile compared with 2.83 for Madi County and 4.35 for the North Jonum County.

10.16 Upper Volta

In Upper Volta, Halcrow Fox and Associates[53] carried out a study on the impact of 14 road improvements in 7 areas. The study was carried out over a period of three years with two main data collecting exercises. Although some control data was collected in areas away from the road improvements, the main method of analysis was historically based and no clear conclusions could be drawn from the study because the time lapse between the two surveys was too short to identify any conclusive effects of the road investment. In addition the road improvements probably had only a very marginal impact on vehicle operating costs. During the period of the study Upper Volta was recovering from the severe drought of earlier years which may have contributed to the considerable year on year variability of the data collected.

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11. APPENDIX 2

EXAMPLES OF ROAD INVESTMENT APPRAISALS

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ABSTRACT

Road planning for rural development in developing countries: a review of current practice: J L HINE: Department of the Environment Department of Transport, TRRL Laboratory Report 1046: Crowthorne, 1982 (Transport and Road Research Laboratory). This report is written as a guide to assist with all road planning in rural areas of developing countries, but the focus of attention is on the smaller rural roads. A critical examination is made of the relationship between road investment and rural development. In addition, a variety of economic appraisal techniques are reviewed.

Case study material is used to identify some of the circumstances which will induce a favourable response to road investment. The evidence suggests that this is most likely to occur when road investment brings about a relatively large change in transport costs in an area which has under used land, a skilled mobile workforce and a competitive transport industry.

The treatment of benefits accruing to agriculture in the appraisal of rural road projects has generally been poorly carried out. The basis of the forecasts tend to be weak and a failure to consider all the relevant costs of production has meant that on balance it appears that road benefits are often overvalued.

Where there is some basis for predicting changes in agricultural output the World Bank's producer surplus approach is cautiously advocated. For road planning within larger regional development plans, for road maintenance and rehabilitation programmes and in situations where prediction is more difficult a minimum transport cost solution is suggested.

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