6 Appraisal of Transport Interventions

The new bias towards rural transport necessitates a widening of the approaches for the ex-ante appraisal of transport interventions. Conventional project assessments only emphasise motorised transport, often using crude appraisal methodologies. MANN et al. (1988, p.4) revised the assessment methodologies of transport projects in rural areas of Africa. They criticise that the majority of conventional transport demand studies are an 'addition of hypotheses and assumptions, using multiplicative factors and growth rates, which are not statistically secured'. The general procedure of the assessments is as follows:

(i) Future traffic volumes are more often than not forecasted by simple extrapolation of existing traffic volumes.
(ii) The estimations of the project's benefits comprise mainly the reduction of Vehicle Operating Costs (VOC) and the increase of market production.
(iii) Alternative investments are compared by using cost/benefit analysis.

The assessments include various economic problems such as overvalued exchange rates, estimation of future inflation, the scope of the projects and the choice of the discount rate[1]. A comprehensive overview is given in ADLER (1987).

HOWE (1994, p.35) judges "the current state-of-the-art for surveying and forecasting local level rural traffic demands ... (as) extremely crude". The concern of many studies rarely goes beyond the routine prediction of motorised traffic and growth generation. While the biggest benefits in conventional assessments are usually generated by the reduction of VOC, the Makete Survey demonstrates (compare 4.7.2) that these benefits are relatively small compared to the other effects. The impacts of non-motorised means of transport and of transport avoiding measures are not taken into account. Therefore an appraisal of the different types of rural transport interventions should be based on a road **and** a household survey. This will change the planning methodology from a top down view, where the region is regarded as one entity, to a bottom-up approach, where the household is the basis for the conception of transport interventions. A sketch of the assessment methodology is given in Fig. 6-1.

(i) The **road survey** observes the existing motorised transport on the main roads. The benefits can be derived if the reduced VOC are multiplied by the expected future traffic.

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[1] Especially the choice of the discount rate is crucial for the assessment, because future costs and benefits have a lower value than their present worth. A high discount rate favours projects which give fast returns on investment. Other problems occur with the calculation of shadow prices to overcome price distortions and with the choice of the methodology for the comparison of costs and benefits.

(ii) The **household survey** contains an assessment of household size and composition and an estimation of the future population growth, migration and change in employment. A crude assessment could distinguish between farmers, who receive their main cash income from marketing of agricultural products and non-farmers. Reference data from more developed regions can be used for the estimation of future employment patterns.

(iii) The household survey gives indication of the actual **market production** per household. The project may have direct impacts on the market production (e.g. by dissemination of IMT) or the reduced VOC give rise to future production increases (Producer Surplus Theory). Benefits from increased market production per household have to be multiplied by the expected future population.

(iv) The household survey reveals the actual **transport patterns** of rural households: trip generation for personal and freight transport purposes, distances and trip length. The increasing market production, which entails a further growth of the transport volume, has to be included in the estimation. The benefits per household are multiplied with the future number of households in order to obtain the total benefits.

(v) **Direct income effects** comprise the wages paid during the construction phases, the income from lent IMT and the effect of hiring motor-vehicles for market transport.

(vi) The **comparison of the benefits** gives an overview of the absolute effects. The efficiency can be assessed by comparing costs and monetary benefits. The efficiency of time saving measures can be appraised by setting the annual time savings in relation to the annual costs or by adding the monetarised time values to the total benefits.

Because the conduct of household surveys is time consuming and costly the relevant information could be as well achieved with the methods of the 'Rapid Rural Appraisal' (CHAMBERS 1980). Instead of interviewing many households and later on having to compute large quantities of data, the information could as well be achieved from village representatives. HILLE and JAGD (1995, Annex 4) compared the results of village surveys with household surveys in Malawi. They conclude that in general the village surveys underestimated the average distances, while the use of IMT was overestimated. Concerning transport problems and improvements household surveys show a larger variety of responses, especially in regard to gender and poverty issues. Thus a 'Rapid Rural Appraisal' can only be a complement to a village survey.

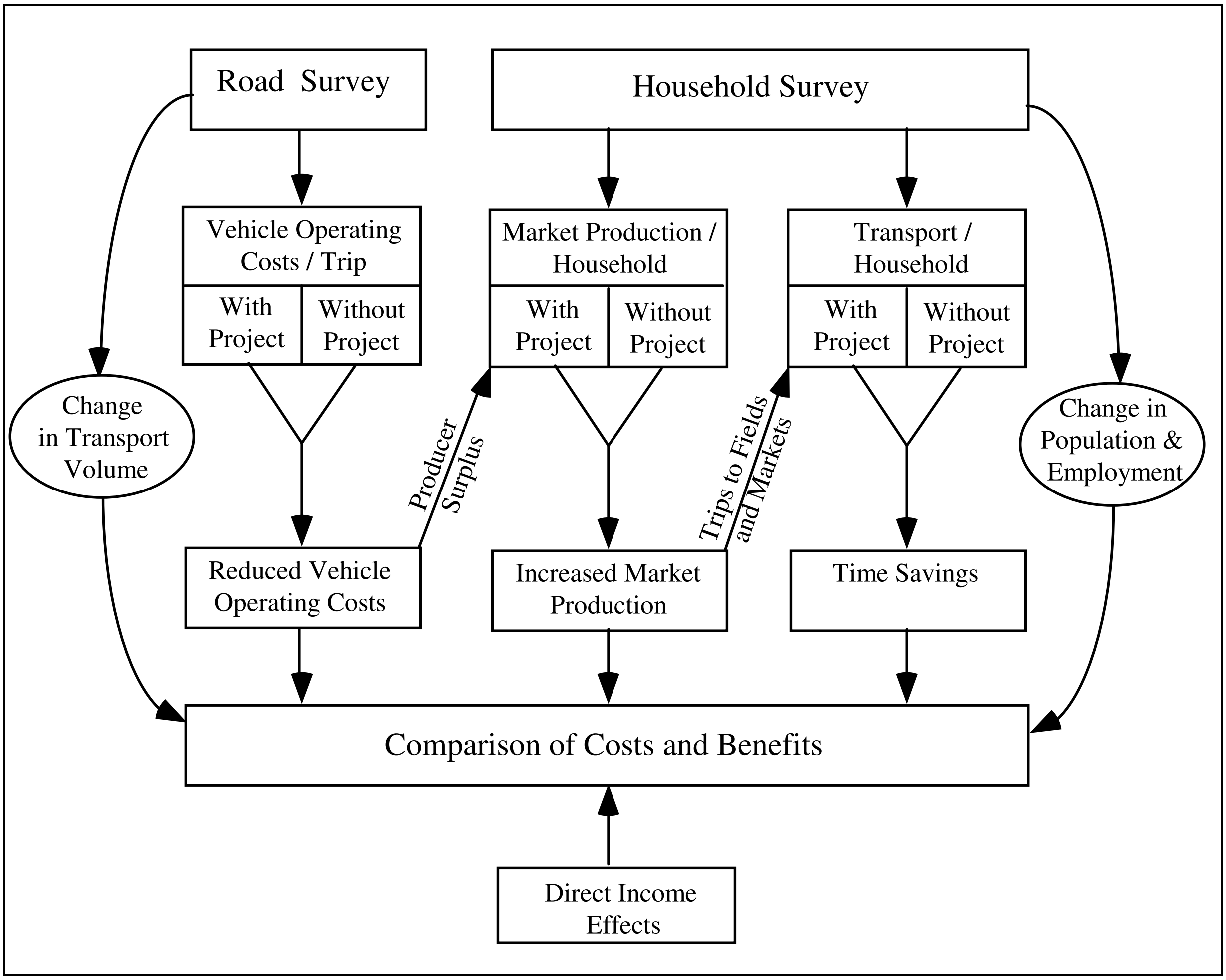

Fig. 6-1 Assessment procedure for rural transport interventions

Motorised traffic can be evaluated by traffic countings or road side passenger interviews. Countings on markets and central facilities like grinding mills could be helpful to evaluate the modal split, the trip distance and the catchment area. It is not necessary to evaluate exact data, but to estimate the magnitude of the impacts of future transport interventions. On the household level the time savings, which can be achieved by reduced number of trips and decreasing trip length are relevant. The changes in the household's transport patterns can be derived from the experience of other projects. Because IMT households have different transport patterns, the number of households possessing IMT should be estimated. Every intervention has its own area of influence: while a road may serve a whole region, a grinding mill serves a village and a bicycle is only used by one household. Often it is useful to define the area of influence by the distance of 90-95% of the users.

If it is planned to introduce several projects simultaneously, then interrelations between production, benefits from VOC, time savings and increased use of IMT might entail the calculation of feedback loops.

6.1 Benefits from Reduced Vehicle Operating Costs

The reduction of Vehicle Operating Costs (VOC) depending on vehicle type and road surface has been intensively researched in developing countries (ADLER 1987, pp 30). More difficulties are related to the estimation of future transport volumes, which determine the total benefits. ZACHCIAL (1985) criticises that the existing traffic is often simply extrapolated with assumed growth rates, which determine the results of the analysis. ADLER (1987, p. 25) counterargues that an overestimation of traffic would not entail strong consequences since "road transport is nearly always growing rapidly in developing countries" and it is only a question of time until the estimated volumes are reached. HOWE (1990) opposes that countries experiencing a severe shortage of foreign exchange may not be able to expand the size and usage of their vehicle fleet and therefore no extra traffic would appear. The vehicle possession in Sub-Saharan Africa stagnated during the last decade[2]. The provision of roads does not automaically stimulate the growth of the transport volume, if the future vehicle supply is not secured. GAVIRIA et al (1991, p 47) report that the observed increases in transport volume in Kenya during the Rural Access Roads Program were not encouraging. The estimates of expected agricultural benefits grossly overestimated the vehicle traffic on the roads. The authors criticise that rural roads are often overdesigned due to an overestimation of future transport volumes.

This discussion shows that future motorised transport volumes have to be assessed more carefully. Basis for this estimation can be the data collected in the road and the household survey. The expected vehicle supply has to be taken into account if future transport volumes are estimated. HOWE (1992, p.34) states that usually **personal transport** is more important on rural roads than the transportation of goods. The future personal transport volume is dependent on the population growth, the expected incomes and the reduced fares due to lower VOC. HOWE (1992) estimates the price elasticity of transport demand at 0.6-2.0. Reduced VOC only entail a growth of personal transport, if the cost reduction is passed on to the users. The transport markets are more often than not dominated by monopolistic enterprises, which rather increase profits than reduce the fares. A model for the forecast of personal transport was developed by MAYWORM (1982). The model (Box 6-1) assumes that future traffic is dependent on road surface, income, and the potential monthly travel. The latter can be estimated with the existing trip rates, the distance to the activity centre and the population living in the zone of influence.

The future **goods transport** volume is dependent on the estimated production increase per household and the changing number of inhabitants in

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[2] The Republic of South Africa is excluded. Compare Chapter 2.3

the catchment area. The next chapter gives an overview of how the production increase can be assessed. It has to be taken into account that many households within walking distance of markets prefer to transport their products by headload in order to save on transport costs. It can be assumed that empty goods vehicles entering the region to evacuate the agricultural products carry consumer goods, agricultural inputs and persons.

Box 6-1: Forecast of Personal Transport According to MAYWORM (1982)

$$AMT = f\,(\text{Road, Income, PMT})$$

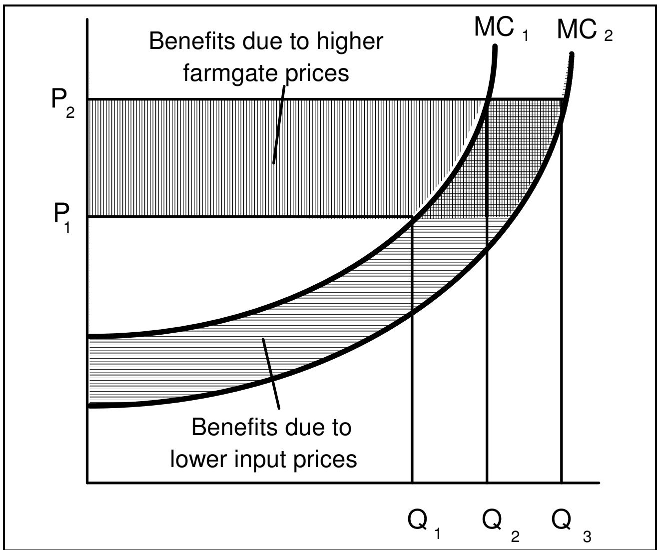
AMT = Average Monthly Travel on the Rural Road (Person Trips)
Road = Indicator for the Type of Road Surface
Income = Average Annual Household Income in the Zone of Influence
PMT = Potential Monthly Travel

$$PMT = f\left(\sum_i \frac{TRRATE_i}{D_i^{\alpha}} * POP\right)$$

$TRRATE_i$ = Average Potential Monthly per Capita Trip Rate from the Zone of Influence to the Activity Centre
D_i = Distance from the Centre of the Zone to the Activity Centre
POP = Total Population Living in the Zone of Influence
α = Real Number to be Estimated

6.2 Benefits from Increased Market Production

The improved transport situation will probably entail an increase in the agricultural market production. The possible benefits have to be evaluated on the household level according to the type of transport investment and taking the agro-ecological frame conditions into account.



Source: CARNEMARK et al. 1976, Annex 1 p.5

Fig. 6-2 Producer Surplus

Marketing Increase Due to Road Investment

The Producer Surplus concept developed by the World Bank (CARNEMARK et al 1976) tries to assess the effects of reduced VOC on agricultural marketing. It is assumed that these reductions will be passed on to the producers, that all the products are marketed via the improved road and that a perfect competition exists. The considerations are visualised in Fig. 6-2. In a situation of complete competition the farmers offer their products according to the marginal cost curve MC_1. If the producer price is P_1 they offer Q_1 tons of products. The reduced VOC will cause an increase in the producer prices to P_2, which entails a shift of the market production to Q_2. The benefits are represented by the area to the left of MC_1 between P_1 and P_2. On top of that the prices for inputs will decline due to lower transport costs: the supply curve shifts from MC_1 to MC_2 causing another increase of the market production to Q_3. The benefit area is located between MC_1 and MC_2. Both benefit areas represent the producer surplus[3]. The assessment requires an expert analysis using various input data, like crop production, market output, yields, production costs etc.

Even CARNEMARK et al admit that, if transport cost savings are not transmitted to producers, either because of government controls or due to non-competitive transport services, the development impact might be low. The static or declining transport fleet in Sub-Saharan Africa has created a situation, which favours the sellers of transport services and not the buyers. HOWE (1992, p.3) states that in many rural areas transport enterprises are not under pressure to transmit cost reductions to their clients. HINE (1993) corroborates that road investments had very low impacts on the producer prices. The Transport Research Laboratory observed that in Ghana producer prices increased by less than one percent after road improvements from earth to gravel surface. ADLER (1987 p.35) argues that transport costs are more often than not below 10 % of market prices and therefore the effects of reduced transport costs would be marginal. Mann et al. (1988) contradicts this by quoting studies in Zambia, Malawi, Zaïre and Somalia, where this share reached 25 % on distances below 150 km.

The model in Chapter 5 demonstrates that a strong growth of marketing can be expected if a road opens up a new area and creates access to markets. This might also be the case if an impassable road is rehabilitated. The empirical evidence from the Makete survey shows, that improved road access (e.g. in Ihela and Ngoje) does not necessarily give rise to increased agricultural production. Even though both villages had the best road access they were not performing as well as other villages; their marketing revenues were declining while other villages were able to increase their incomes. Other factors like agroecological regime, historical market orientation, availability of agricultural extension services etc. seem to be at least as important as motorised accessibility.

[3] If the producer surplus approach is applied, then the reduced VOC have to be excluded from the total benefits in order to avoid double counting.

Marketing Increase Due to Possession of IMT

The empirical evidence in Makete shows, that IMT possessing households produce and market considerably more than households without any conveyance. The estimated production function shows that IMT-households have increasing returns to scale, while the returns are decreasing for non-IMT households. The knowledge about the productive effects of IMT is still too small to allow conclusions for ex ante production assessments. Further research is therefore needed in this field.

Credit for the purchase of an IMT has a big advantage for the planner: it leaves it to the farmer to estimate whether the production increases will yield enough revenue to repay his loan. The household survey should contain a demand evaluation for IMT which could be the basis for the design of a revolving credit fund.

6.3 Benefits from Time Savings

Time valuations usually make up the biggest portion of the benefits in transport assessments of industrialised countries. Conventional assessment methodologies in developing countries usually ignore the individual time savings by the improvement of transport systems. They postulate that reduction of transport time entails no benefits for rural households, because leisure time is available in excess. Various studies on rural households show (Chapter 2.3) that the time budget is especially tight for women and time restrictions are regarded as a major constraint for an increase of agricultural production. The question arises as to whether and to what degree the 'saved time' will be used to increase agricultural production. The theoretical considerations in chapter 2.4.2 show, that saved transport time will most probably be used for welfare or production increasing activities. The model in chapter 5 demonstrates that a reduction of the transport time is a precondition for production increase. Further research in this field is needed to give a satisfying answer to this question. A valuation of transport time savings can be justified even if the saved time is not used for direct productive activities, because an enlarged time budget would probably be used to increase the welfare of the household. Therefore the effects of transport time reductions have to be included in the appraisal of rural transport interventions. The following time saving effects can be observed:

- Faster travelling due to infrastructure improvements (roads, paths, tracks) or new modes of transport (bicycles, motor vehicles).
- Reduced number of trips due to higher carrying capacities (motor vehicles, pack animals, wheelbarrows, footpath improvement etc.)
- Reduction of trip length by the improvement of the infrastructure endowment (grinding mills, water supply, woodlots, low consumption stoves etc.)

The estimations of the time effects have to be undertaken by comparing transport patterns of households with and without the regarded endowment. If no comparable households are available the experience from other projects has to be taken into account. It has to be noticed that compensating effects such as increased consumption of water after the installation of water supply might occur.
Before the 'saved time' is monetarised a comparison of the efficiency of different interventions can be undertaken by calculating the annual time savings in relation to annual costs (hours/$). This methodology allows a comparison on the time efficiency of different projects without attributing any monetary value to transport time. A monetarisation only makes sense, if other income or production effects occur and time savings represent only a portion of total benefits.

From the theoretical point of view the time valuations can be undertaken by sing the opportunity costs of labour: transport time for labour purposes can be valued with the marginal productivity of labour, which represents the value of the production output achieved by an additional working hour. The valuation of leisure time uses the consumers choice theory which assumes that the individual has the free choice between leisure and labour. Thus an equilibrium point is chosen where the last hour of leisure time has the same value as the last working hour (marginal rate of substitution). Therefore leisure can also be valued with the marginal productivity of labour.

The German Road Administration estimates the value of labour time and leisure time by using the National Income[4]. This methodology is not applicable in rural areas of Africa, because subsistence production is not included in the National Income Accounting and a distinction between the trips for leisure and for labour is difficult. The Makete survey allowed the estimation of a production function, which determines the marginal productivity of agricultural labour at 7 ¢/hour, while the average value comprises 16 ¢/hour and the minimum wage for government employees amounts to 11 ¢/hour. If the marginal productivity cannot be estimated a rough assessment might give an indication of the magnitude. If the total time one person is awake during one year (16 hours/day * 365 days = 5840 hours) is valued at the minimum wage of a government employee (232 $/year) then one hour would be worth 4 ¢. This value is well below the marginal productivity, which was chosen as the value of time in this study.

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[4] It is assumed that half of the National Income is produced by economically active persons during their labour time, while the remaining half is produced without monetary compensation during non-working hours:
Value Labour Time = 0.5 National Income / (Labour Time * Active Persons)
Value Leisure Time = 0.5 National Income / (Awake Time * Non-Active Persons + (Leisure Time) * Active Persons).

6.4 Other Benefits

Income can be directly generated by employment during the construction phase and by the wages paid for current maintenance works. The local benefits are higher, if labour based methodologies are applied. The Makete survey reveals that some farmers benefit from price differences between markets by transporting their products with hired vehicles to the high price markets. Other income is generated by lending of IMT to other non-IMT households. An ex-ante estimate for both types of benefits are related to high unreliabilities.

The reduction of accident rates on roads and paths[5], the better access to services and the improved health situation after the installation of a water supply system generate benefits which are difficult to monetarise. The reduction of the accident rates are usually included in road assessments of industrialised countries. The German Road Administration values the prevention of a fatality in a road accident at 1.2 Million DM (1985 price level), which amounts to 40 times the GNP per capita. If this value were to be applied to Tanzania, the costs per fatality would amount to $10,000. Scandinavian Road Administrations attribute higher values to their transport victims by including contingency valuations for a 'human value'.

Environmental benefits might occur if woodlots are planted or low consumption stoves are introduced. The benefits from these interventions might be stronger than the transport related benefits, especially if the environment is in a critical situation, when erosion occurs, desertification menaces or firewood is in shortage.

6.5 Prioritisation of Transport Interventions

The scarcity of resources necessitates a prioritisation of transport investments. The choice, which transport intervention is most appropriate for which location depends on a variety of criteria:

- **Effectiveness**: which intervention can generate the strongest effects?
- **Efficiency**: which intervention has the strongest effect per unit of cost?
- **Requirements**: in which location is the need for interventions strongest?
- **Affordability**: can public and private households afford their contributions?
- **Appropriateness**: does the local population accept the intervention?
- **Sustainability**: can the adequate maintenance of the installations be secured?

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[5] Before the Utengule path was improved several fatal accidents were recorded and after the improvement, none. Two days after the evaluation team crossed a bridge consisting of a simple pole over a river, a villager died after falling from this bridge. The village representatives judged that sick persons could be transported to the hospital with an ambulance as the major impact of the track improvement to Unenamwa. Before the improvement several fatalities were recorded during the transport of pregnant women.

The decision of which intervention should be implemented in which location is the core of a planning process, in which local decision makers and village representatives should be involved. If the quantification of project benefits is possible, transport interventions can be ranked according to their cost efficiency. If this is not the case, then standards have to be set up: e.g. maximum travel time to water supply, firewood, public services or central locations. In this case local needs more than economic considerqations determine the decision about investments.

Comparison of Costs and Benefits

The methodologies of comparing costs and benefits[6] had been intensively discussed in the 1980s. If benefits can be monetarised the cost/benefit analysis is the most common method to rank transport investments. A comparison of the ratio of the discounted benefits and costs, of the Net Present Value or the Internal Rate of Return allows a ranking of the interventions[7]. A multi-criteria analysis (Scoring Model) is conventionally used if non-monetary benefits are included in the evaluation.[8] A number of problems are related to both methodologies; considerable need of data, unreliabilities in the estimation of monetary values for benefits which have no market price, subjective weighting of benefits in the scoring model, etc. Therefore ROTHENGATTER (1980) proposes the successive conduct of various tests in order to reduce the number of alternatives before utility functions are set up. Interactive procedures, developed by STRASSERT (1984) as an alternative to conventional cost/benefit assessments, comprise a stepwise comparison of advantages and disadvantages by the decision maker(s). BÖTTCHER (1995, p. 42) criticises that interactive assessments rely exclusively on the 'individual and collective competence of the decision maker(s)', because the transparency of the preferences is not given in the procedure.

The choice of the assessment methodology depends on the available financial means for the evaluation process and the competence of the decision makers. Problems might occur if the evaluation costs are becoming too high in comparison to the investment costs. Therefore BEENHAKKER and LAGO (1983) developed a couple of simplified screening and evaluation methodologies based on the Consumer Surplus (reduced VOC) and Producer Surplus Theory.

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6 A comprehensive discussion of cost/benefit assessment methodologies for transport projects is presented in DVWG (1980); FUNCK (1989) gives a short overview of the state of the art in Germany.

7 A detailed discussion about the advantages and diadvantages of these methodologies is given in ADLER (1987, pp 49).

8 CLEMENTS (1995) proposes the distribution of points for different poverty alleviating effects with the help of a defined capabilities-based poverty line.

The German Kreditanstalt für Wiederaufbau KFW (1985) has developed a simple appraisal methodology for rural roads in Zimbabwe which is designed to be used by local planners. The investment costs for different types of roads are standardised according to the geological and morphological conditions. The region is classified according to agro-ecological zones and the potential benefits which might follow a road improvement are estimated. For each of the classes a representative area is chosen, where the expected increase in agricultural production per capita is estimated. A typical development path for population and production is assumed for every class. The total potential benefits, including reduced VOC, time savings, increase in production are estimated for every zone and the per capita net present value is computed (An example is given in Tab. 6-1). The planner can now easily calculate the benefit/cost ratios for any road improvement in the region. This methodology could also be applied in principle in the case of other transport interventions like the promotion of IMT, the improvement of paths and transport avoiding measures. Potential benefit maps can give the regional planner a good overview of the local effects of different transport interventions.

Population Density	**Flat and Rolling Terrain**			**Very Hilly and Broken Terrain**		
[Inh./km^2]	Zone I	Zone II	...	Zone I	Zone II	...
0-5	Net Present Value of the per Capita Benefits					
5-10	Discount Rate: 6 %					
...	Time Horizont: 15 years					
Source: KfW 1985						

Tab. 6-1 Example of a standard benefit table for primary roads in rural areas

Often development projects include the target of poverty alleviation. The question arises as to whether assessment methodologies for these projects have to especially emphasise the poor population strata. Distributionally sensitive cost-benefit analyses could be an appropriate assessment tool because they value benefits to poor people higher than equal benefits to rich recipients (CLEMENTS 1995). It must however be questioned whether a special poverty oriented focus in rural areas is really necessary, because the income disparities within the rural areas in Sub-Saharan Africa are much lower than those between rural and urban areas. Thus a focus on rural development will automatically include a poverty orientation. On top of that it is difficult to implement project measures which focus primarily on the poor population and limit the number of wealthy beneficiaries.

The prioritisation of interventions which entail non-monetary benefits like improved access to education, administration and health services cannot be achieved with the above described procedure. In this case methodologies of regional science have to be applied, which help to plan the optimal spatial distribution of public services and central locations. The set up of desired accessibility standards for public services can be the basis for the planning process. It should be considered whether mobile services are more cost efficient in areas with low population densities. Possibly the improvement of footpaths and the promotion of bicycles will entail a better access to services than the construction of a road. AFFUM and AHMED (1995) tested the use of Geographical Information Systems for rural accessibility planning in Bangladesh. They calculate the ratio of observed impedance and ideal accessibility (Euclidean distances) which is used as an indicator for the performance of the transport infrastructure. The change of this ratio after road improvement depicts the relative improvement of accessibility.

A Risk Averse Investment Strategy

The empirical evidence from many studies about the impacts of road improvements shows that the estimation of production and marketing changes is related to strong uncertainties. The low reliability of the predictions favours risk averse investment strategies:

- Choice of the cheapest investment opportunity related to the local needs. In an initial development phase the improvement of footpaths or construction of motorable tracks might be more appropriate than that of a wide feeder road.
- Spatial distribution of investments: build as cheaply and extensively as possible or undertake spot improvements on existing roads and wait for the response of the producers. If bottlenecks occur then further investments can be warranted in the responding regions.
- Choice of labour intensive construction methodologies in order to distribute the direct income effects more equally among the local population.
- Leave the risk assessment to the producers: a small scale credit system delegates the decision about the productive effects to the farmers. Probably the individual appraisal of the farmers is more reliable than the global assessment of a highly educated planner.