Appropriate Transport and Rural Development

Economic Effects of an Integrated Rural Transport Project in Tanzania[1]

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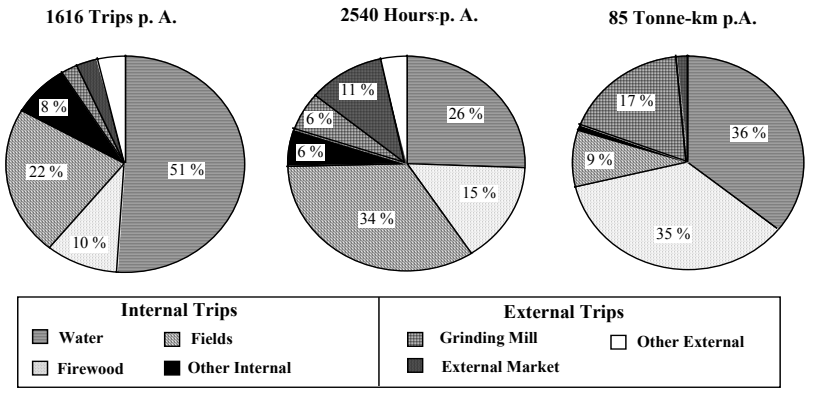
Abstract:

Poor Transport Conditions are a substantial constraint for the increase of agricultural production in Sub-Saharan Africa. Conventional rural transport projects, which focus exclusively on motorised transport can only partly remove these restrictions. Therefore an Integrated Transport Approach is proposed, which takes into account as well the non-motorised transport. A field study in Tanzania demonstrates that these interventions have at least the same magnitude of effects as rural road improvements. A system dynamics model shows that a succession of road improvements and non-motorised interventions constitutes an optimum scenario, which can be entirely financed by road pricing. This new approach towards rural transport necessitates an extension of the conventional appraisal methodologies.

Poor transport conditions are regarded as one of the main constraints for rural development in Sub-Saharan Africa. Therefore since 1940 the World Bank spent more than $ 62 billion world-wide in over 1,000 transport projects. Transport investments, comprising 13-16 % of the total Bank's expenditure, were exclusively used for the improvement of motorised transportation.

The focus of donors on 'roads and cars' is criticised since the 1980s, because the transport needs of rural households, comprising two thirds of the population, are neglected. In his famous World Bank Paper "Rural Poverty Unperceived" Robert CHAMBERS (1980) linked rural indigence firmly to lack of mobility. Four years later another World Bank Paper by EDMONDS and RELF concludes that 'plans, projects and existing policies in the transport sector do nothing or little for the rural poor'. This group of 'transport disenfranchised' can be conservatively estimated at world-wide to the order of 700 million people. One of the main reasons is the low rate of motorisation, which comprises in Sub-Saharan Africa 8 vehicles per 1,000 inhabitants[2]. A number of recent studies[3] show that the rural population of many Developing Countries moves mainly by walking on paths and trails away from the rural road network and undertakes very few motorised trips. The majority of time and effort is spent for transport purposes which secure the household's subsistence needs. Here the Makete District in Tanzania may serve as an example[4]: A household with five persons undertakes more than 1,600 trips annually, which require more than 2,500 hours (Fig. 1). The



Source: Own graph according to BARWELL/MALMBERG (1989) pp. 71

Fig. 1: Transport activities in Makete District 1986/87

procurement of energy and water, which is available in Industrialised Countries within few seconds, requires annually more than 1,000 hours. During one year an average household transports 85 tkm. Two third of the transport time is spent in and around the village. The biggest share of the transport burden is carried by women.

The effort, drudgery and the high time requirements for the transport purposes significantly hamper the growth of the agricultural production: In labour intensive economies this allocation of time is a drain on the households labour resources. Time constraints may have severe negative impacts on the productivity, especially during peak working periods, e.g. in the harvesting season. In Makete more time is spent for transport activities than for labour in the fields. JENNINGS (1992, p. 29) reports that many women in the Makete District "indicated that they had additional shambas (fields) which they could cultivate if they had additional time". According to the International Food Policy Research Institute (MELLOR, 1985) the lack of labour is the main reason for the low agricultural production: "Africa's poor record on food production is largely due to labour constraints ... These serve to reduce labour input into agriculture, slowing the expansion of area cultivated as well as the yields per acre."

Therefore one of the main goals of rural transport projects should be to reduce the household's time requirements for transport purposes. The question arises whether the time savings will be used for production increasing activities. The farm households can use 16 hours of their daily time budget[5] for labour on the fields, for leisure and for household's domestic tasks like water and firewood collection. The amount of time used for household tasks determines how much time is left for leisure and labour. In the initial situation household tasks **restrict** the maximum available for leisure and labour to time L_{maxR}. The production frontier P_R indicates how much output can be produced with different inputs of labour time within the given time restriction L_{maxR}. The decision how much time is used for crop production and how much leisure time remains can be visualised by a set of

indifference curves I_1, I_2 ... I_n, each of them symbolising a different level of utility of a given utility function. The farmers will choose the indifference curve I_R in order to find the optimal production O_R, which necessitates a labour input of L_{maxR} - L_R and leaves leisure of L_R.

A different situation occurs after transport interventions have reduced the time requirements for household tasks: the maximum labour time moves from L_{maxR} to L_{maxA}, the production frontier shifts from P_R to P_A, a new indifference curve I_A is chosen resulting in an output of O_A. The graph shows that the saved time will be partly used for leisure, but the remaining time is used to increase agricultural output. Thus a reduction of the household's transport time will entail a production increase.

Therefore the transport planning must be adapted to the needs and economic means of the rural population:

- Promotion of affordable Intermediate Means of Transport (IMT).
- Implementation of a network of paths, trails and tracks, which can be used by the IMT and complement the existing road network.
- Labour based and low cost construction and maintenance of the infrastructure.
- Transport avoiding measures to reduce trip length to public services and to sources of energy and water.

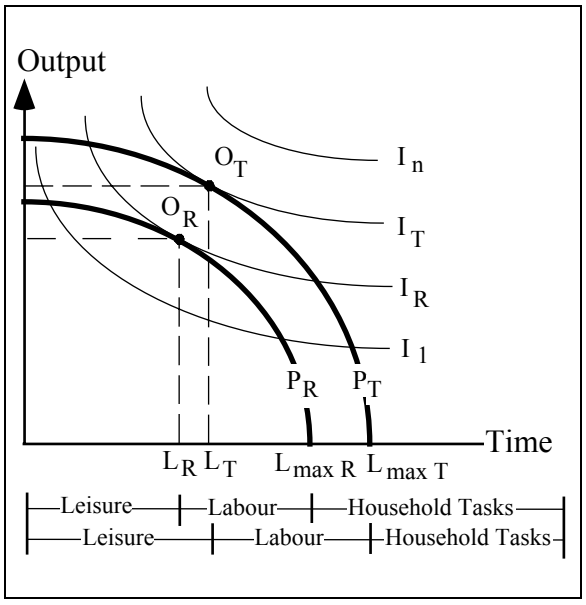


Fig. 2: Effects of reduced time requirements for transport

Economic Effects of the Makete Integrated Rural Transport Project

The understanding that "Roads Are Not Enough"[6] was the reason why the International Labour Office conducted an Integrated Rural Transport Project in Makete District, Tanzania. The district is located in the south west of Tanzania and stretches over a mountainous plateau containing mountains, hills, ridges, valleys and steep escarpments. The population lives mainly in scattered settlements and the average density amounts to 18 persons/km^2. The economy basically relies on subsistence agriculture. The agroecological conditions are favourable for the rainfed cultivation of crops from tropical and moderate climates. The latter are traded with the hot lowlands. The salient feature of the regional development in the Makete District is the shift from subsistence economy towards market orientation. In 1994 still less than half of the

products harvested are marketed which generated annual revenues of 80 $ per household.

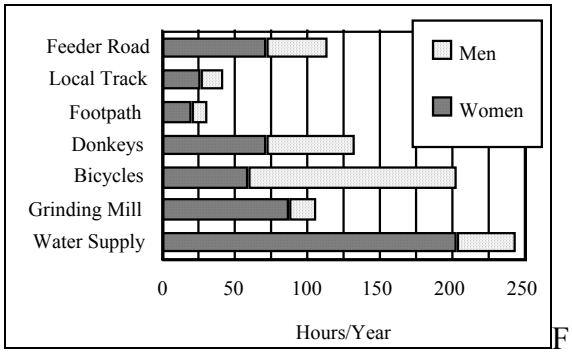


Fig. 3: Time savings per household

The project had the aim to reduce the transport burden of rural households. Low-cost roads and tracks were constructed and improved with unpaid Self-Help-Labour, Intermediate Means of Transport were developed and promoted and a number of transport avoiding measures introduced. Before the project started and at its termination a survey of the transport and production activities of rural households was conducted. The data base allows a detailed analysis of the impacts of the various transport interventions on the household level.

One of the salient effects are time savings, which are an indicator for the reduction of the transport burden. Fig. 3 shows the changes of the time budget of an average household benefiting from the transport improvement. The biggest effects can be achieved by the installation of water supply systems followed by the promotion of bicycles and donkeys. While mainly women benefit from the first intervention, the bicycle reduces the time consumption predominantly for men. Women profit more from grinding mills and donkeys. But also the feeder road causes a significant reduction of the female time used for crop marketing.

Fig. 4 lists the total monetary benefits[7], which are made up of the monetarised time values, the increase in marketing, the salaries earned by the project implementation and other sources of income like hiring of vehicles, lending of donkeys etc. The biggest monetary benefits are caused by **DONKEYS** which are followed by the **BICYCLES** with a large distance. The survey found that both have very strong impacts on the market production: They enable the farmers to cultivate bigger fields and use more fertiliser. Donkey-households are marketing double as much, and bicycle-households two fifth more than comparable non-IMT-households. The purchase of an IMT changes the productivity of the household from decreasing to increasing returns to scale. Donkeys are mainly used for the transport of products from the field, while bicycles transport fertiliser and grain to the grinding mills and generate more trips outside the village than in non-bicycle-households. The latter reduces the isolation of the household. The main restriction for the purchase of IMT are the relative high procurement costs. 80-90 % of the households desiring an IMT stated that they could not af-

ford the price, which amounts to the annual marketing revenues.

Traffic avoiding measures like the installation of **WATER SUPPLY** systems have a significant impact on the time budget of rural households. The relatively high costs for piped water entails a benefit/cost ratio lower than one (Fig. 5). If low cost wells instead of expensive pipes are chosen the ratio increases up to 3. The non-monetary benefits from the improved water supply due to enhanced health situation cannot be assessed.

The benefits of the **FEEDER ROAD** consist of time savings (46%), marketing increases (27 %), income by hired vehicles (21%) and income by project employment (6 %)[8]. The benefits from road improvements are distributed unequally among the survey villages. Two survey villages with the best road access could not take advantage of the improved marketing possibilities: In the first village which was a traditional source for migrant labour, the rural exodus increased and the agricultural production stagnated. The second village could not compensate for the breakdown of the regional pyrethrum market, while a neighbouring village performed surprisingly well, even though it's road access strongly deteriorated. The latter village profited from it's traditional trading links and transported the whole market production by headload down a steep escarpment. The strongest impacts of the road investment were registered in a village, which is too far away from the market to undertake daily return trips and where heavy, low value products are cultivated. Here transport by headload would be too time consuming and tiring.

Agroecological frame conditions, traditional trading links and walking access to the markets seem to be as important for market integration as road access. Many inhabitants of villages within walking distance to the market prefer to carry a big portion of their goods by headload to the market in order to profit from price arbi-

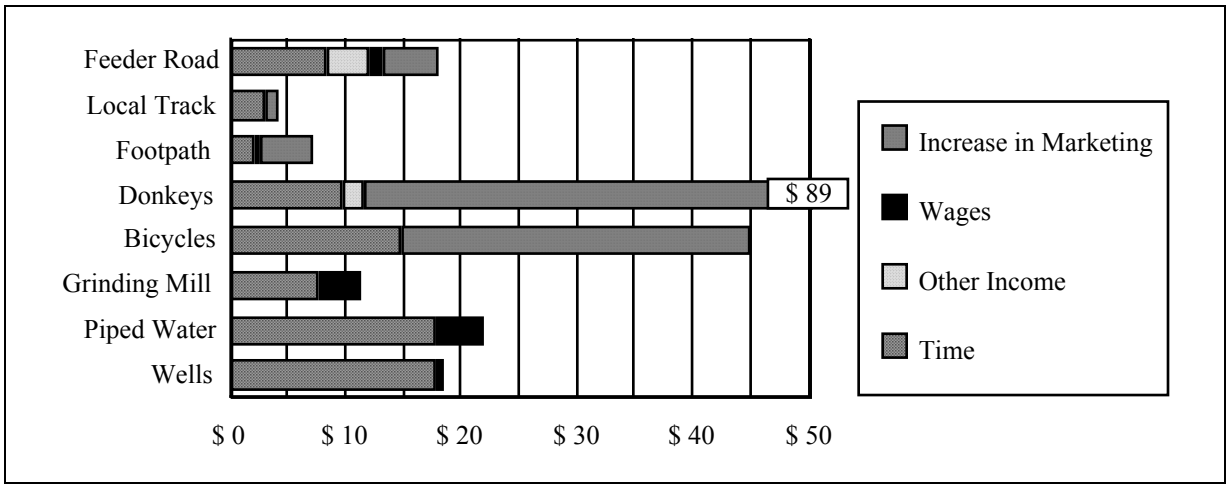


Fig. 4: Average monetary benefits per household

trage. This is even the case when a good road access exists. The feeder road shows the second best benefit/cost ratio (Fig. 5). The main reason are the low costs of the road rehabilitation with high labour- and low machinery-input. If the costs of commercial capital based road construction projects in Tanzania would be applied the benefit/cost ratio of the feeder road would decrease to two!

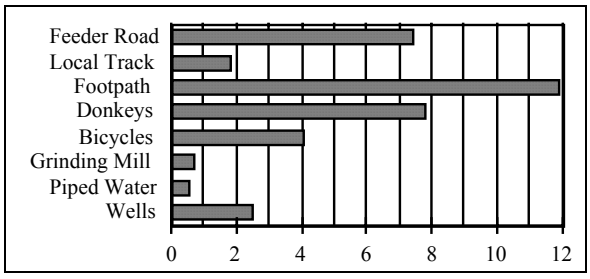


Fig. 5: Benefit/cost ratio

The feeder road is performing better than the **GRINDING MILLS**, which benefit mostly from time savings. The high costs entail a benefit/cost ratio below one. The fact that households use their scarce monetary resources to pay the fees for grinding shows that benefits other than transport time savings must be taken into account. The alternative of grinding by hand seems to be so arduous, that the service is valued more highly than the benefits from the saved transport time.

The cheapest transport intervention was the improvement of a **FOOTPATH** with regional importance leading down a steep escarpment to a regional market. Especially during rainy season when the paths become slippery like soft soap, travelling is a dangerous undertaking and more often than not these paths are avoided. Obstacles like rivers, marshes and invading vegetation force the travellers to walk big detours. The project trained gang leaders and foremen to conduct simple improvements on the path such as building wooden bridges and staircases, digging small ditches for drainage, constructing timber guard barriers and winding the path on steep slopes. The local population gave very positive feedback regarding the impacts of the improvements: Travel is much faster and safer, bigger loads can be carried and one third of the households is able to reach new places. The latter statement must not be underestimated because the path improvement is an appropriate measure to reduce rural isolation. Agricultural production in the catchment area increased more strongly than in the comparable villages. The number of pedestrians using the path to reach a regional market is higher than that of passengers using the feeder road mentioned above. A considerable amount of traffic was generated by the footpath improvement. The absolute benefits from the improvement are nevertheless quite small, because the catchment area has a "traditional" low market orientation. But the low construction costs attribute the high benefit-cost-ratio to the footpath improvement.

A local trail connecting a village with the ward centre was widened to a **MOTORABLE TRACK**. While the village repre-

sentatives emphasised the large benefits due to increased health care and the appearance of traders in the village, the monetary benefits and the benefit/cost ratio are relatively low. The construction of tracks could possibly be economically warranted if they would be used by bicycle-trailers or animal drawn-carts.

Conclusions

The improvement of footpaths can be a very efficient and cheap measure to stimulate the marketing of primarily subsistence oriented villages within walking distance to regional markets. If the distance to the market is longer than half a days walk than motorised access is a necessary precondition for regional market integration, but it does not automatically stimulate the development process. The increasing marketing entails the growth of production and market related transport tasks: in this phase the purchase of Intermediate Means of Transport can induce another sharp increase of agricultural production. The strong effects and the high benefit/cost ratio warrant the promotion of IMT. Traffic avoiding measures can only be economically justified if they are low cost interventions. Other non-transport effects, like e.g. health improvements, are probably bigger than transport related benefits. **Comparing the absolute effects and the cost efficiency it can be safely stated that non-motorised transport interventions have the same magnitude of impacts as interventions in the motorised sector.**

Transport Interventions and the Dynamics of Rural Development

A rural development process entails increasing time requirements for production and marketing related transport activities. The limited time budget sets restrictions for the further increase of productive activities. On the other hand the rising cash income gives an opportunity to use more non-labour inputs like seeds and fertiliser, which entail a further growth in production. It is difficult to judge the effects of the various interrelations, feedbacks and restrictions. Therefore an econometric model was designed in order to analyse these interrelations by using a system dynamics approach. The software used was developed by the Michigan Institute of Technology and it's most popular applications were the world development scenarios published by the Club of Rome.

The model describes the nexus of production and transport as it was observed in Makete. The main system features are given in Fig. 6. The agricultural production, which is the salient variable of the system, is determined by the following inputs: labour, cultivated area and amount of fertiliser used. The biggest share of the products is consumed by the farming households and only a small share is traded on markets. Marketing revenues reduced by the input costs determine the agricultural income of the region. The main negative feedback loop is caused by the transport activities, which are determined by the transports nec-

essary for subsistence, crop production and crop marketing. A rising transport burden reduces the disposable time of the time budget. If more time is used for transport activities, less time can be spent for labour in the fields. This feedback loop establishes an equilibrium between the time needs for labour and transport. The number of working hours is rising as long as enough time is disposable. Increasing labour makes the cultivation of more plots possible and leads to a bigger acreage. A positive feedback loop exists between the amount of fertiliser and the income. Transport interventions influence the transport patterns of the household and modify the time budget, which leads to a changing production. Some of the interventions have direct impacts on the household's income situation.

The following assumptions are constituent for the model:

- The external demand for agricultural produce is unlimited and the local production does not change producer prices, which give sufficient incentives to stimulate production.
- A free transport market exists assuring the evacuation of all crops offered by the farmers.
- The sectoral division of labour does not change during the observed period.
- The time saved by transport interventions will be entirely used for direct productive or production related transport activities.

The model simulates the process of a growing market integration of a predominantly subsistence oriented region over a period of 20 years. The initial situation assumes the complete isolation of the idealised region (Fig 7), where 20,000 people dwell. Five scenarios are set up to assess the different impacts of transport interventions.

Initially the model region is completely isolated and the agricultural production is used to satisfy the subsistence needs. The regional economy stagnates because the low internal demand is not able to generate a significant growth. This process is induced by the construction of a **FOOTPATH** from Village B to Market C in Fig 7. Because the market is within walking distance some villages begin to increase their production and sell crops outside the region. The disposable income

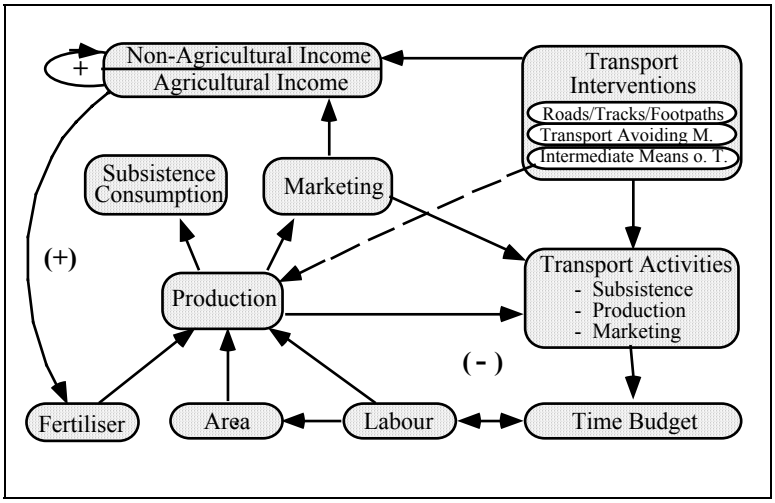


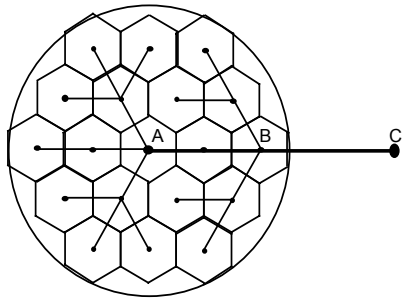
Fig. 6: Main features of the model

increases annually by an average of 3.8 %. The low construction and maintenance costs make it possible to obtain an internal rate of return of 114 %. The rate seems to be quite elevated, but the initial situation with an assumed complete isolation of the region has to be taken into account[9]. It can nevertheless be stated that the production is very soon restricted by the limited time requirements for the long walking trips to the external market and the lack of fertiliser, which is not available without motorised access.

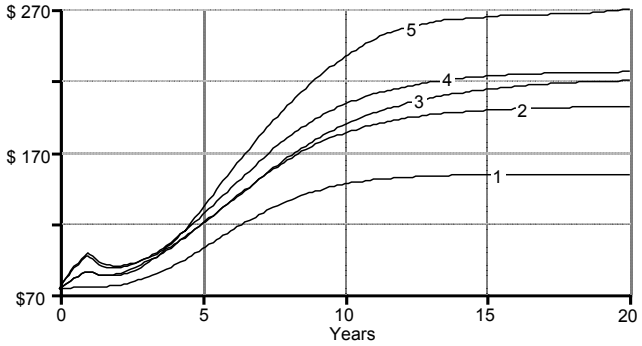
Thus the construction of a footpath seems to be an efficient transport intervention, if the region has no motorised access, markets are within walking distance, funds available for road construction are not sufficient or a risk averse investment strategy is preferred.

The construction of a **FEEDER ROAD** between the regional centre A and market C (Fig. 7) reduces the time requirements for the evacuation of crops and makes fertiliser available, both of which cause a stronger increase in production and in income than in the previous scenario. The increasing number of trips to the fields and to the collection points reduces the disposable time budget and sets limits to the production. The disposable income increases by 5.2 % annually. If a low cost road is built the internal rate of return amounts to 56 %. The good initial conditions and the low construction costs favour a high rate of return. The construction of a feeder road is the basis for all the following scenarios and the effects always have to be regarded in relation to this scenario.

The third scenario tries to reduce the time constraints by supplying every village with motorised access. The construction of a network of **MOTORABLE TRACKS** combined with the above described feeder road causes a reduction in the transport time to markets and gives rise to another increase of production. The disposable income increases slightly faster than in the



Idealised Region



Disposable Income

1: Footpath (Village B - Market C)
2: Feeder Road (Regional Centre A - Market C)
3: Feeder Road + Local Tracks to All Villages
4: Feeder Road + Transport Avoiding Measures
5: Feeder Road + Promotion of Donkeys and Bicycles

Fig. 7: Main features of the scenarios

previous scenario, but due to the high investment and maintenance costs the rate of return reaches only 37 %. Of course the roads would have other non-transport impacts, which cannot be monetarised here: Reduced drudgery for market trips, access of ambulances and mobile health services.

In the fourth scenario the effects of **TRANSPORT AVOIDING MEASURES** in combination with a feeder road are simulated: All villages receive wells, water pumps and low consumption stoves[10], which reduce the time budget for subsistence transport. Production reaches the same level as in the previous local-track-scenario, but the lower Vehicle Operating Costs cause a slightly higher disposable income. The high investment costs reduce the rate of return to 32 %, which is below the previous scenario.

The biggest effects after the construction of a feeder road can be achieved by the promotion of **DONKEYS AND BICYCLES**. The main reason why farmers are nowadays not purchasing the IMT is their high price: Without any access to credits only 15 % of the households would be able to purchase an IMT. The scenario simulates the effects of a revolving fund for small scale credits. A credit coverage of 75 % would give altogether 62 % of the households access to IMT at the end of the simulation period. The IMT have two general effects: They reduce the transport time and they increase the productivity from decreasing to increasing returns to scale. These effects induce a strong growth in production. Disposable income increases annually by 6.7 % and exceeds the growth rates of all previous scenarios. The rate of return can be estimated at 58 %. The model shows, that the purchase of an IMT even with a high real interest rate of 12 % could be very profitable for the farmers.

The main problems of these types of funds are the high overhead costs and the low repayment morale. If it is assumed that only 80 % of the credits are paid back and no credits are distributed to replace old IMT, the fund would reach positive values after 12 years. The Grameen Bank in Bangladesh demonstrates how the distribution of credits can be more efficiently organised. It seems to be sensible to design the

Scenario		Without User Charges		With User Charges	
	Investments[11]	Annual Income Growth	Rate of Return	User Charges	Reduction of Income
	$/capita	%	%	$/ton	%
Footpath	0.5	3.8 %	114 %	0.00	-
Feeder Road	6.0	5.2 %	56 %	4.01	- 3.6 %
Feeder Road + Tracks	15.5	5.6 %	37 %	9.27	- 9.7 %
Road+Wells + Stoves	23.1	5.8 %	32 %	3.42	- 3.4 %
IMT Fund + Feeder Road	15.0	6.7 %	58 %	2.62	- 3.8 %

Tab. 1: Salient results of the scenarios

credit system primarily for women in order to reduce the female transport burden. The West African savings clubs "Tontine" could be an appropriate institution.

How can Road Investments and Maintenance Be Financed?

In consideration of the desperate public financial situation in many Sub-Saharan African countries there is little hope that new rural roads can be financed by the recurrent budgets. A step towards a sustainable system could be taken if village governments, wards or districts would be permitted to levy user charges under the following conditions:

- the charges should be simple and inexpensive to collect,
- users pay only according to their utilisation,
- the revenues should be earmarked for transport purposes,
- and a locally elected committee or institution should control the adequate use of the revenues.

The revenues from the road user charges are paid in a road fund, which has the task to finance maintenance costs and repay the debt for the road construction (real interest rate 8%) within 20 years. The necessary user charges are listed in column 4 of Tab. 1. It has to be assumed that traders pass on the user charges to the farmers by reducing the producer prices of agricultural products and thus decrease disposable income (column 5). A complete cost coverage of a feeder road would imply road user charges of $ 4 per ton and a reduction of the disposable income of 4 %. In the case of the construction of motorised track access to all villages user charges of 9 $/ton would have to be levied. This would reduce the disposable income of the households by 10 %. The income would reach the same level as achieved in the feeder road scenario. The question arises whether the people are willing to pay this price for the reduced market transport and the non-monetary effects of the tracks. If only the maintenance should be financed by the fund, 35 % of the given charges would be necessary.

An integrated transport approach favours a combination of the above mentioned transport interventions as proposed in Fig. 8. The measures are financed with a Regional Transport Fund which is a combination of the Credit Fund for IMT and the Road Fund. The fund will be financed by an international credit with 8 % interest rate. In the initial phases, when the region is not accessible by motor vehicles a local footpath to an external market is improved and credits are distributed for the purchase of IMT. If the farmers respond after a period of three years by increasing their market production, a feeder road to the regional centre is constructed. After six years of simulation the total debt reaches its maximum at 9.3 $ per inhabitant. A road user charge comprising 8 % of the producer

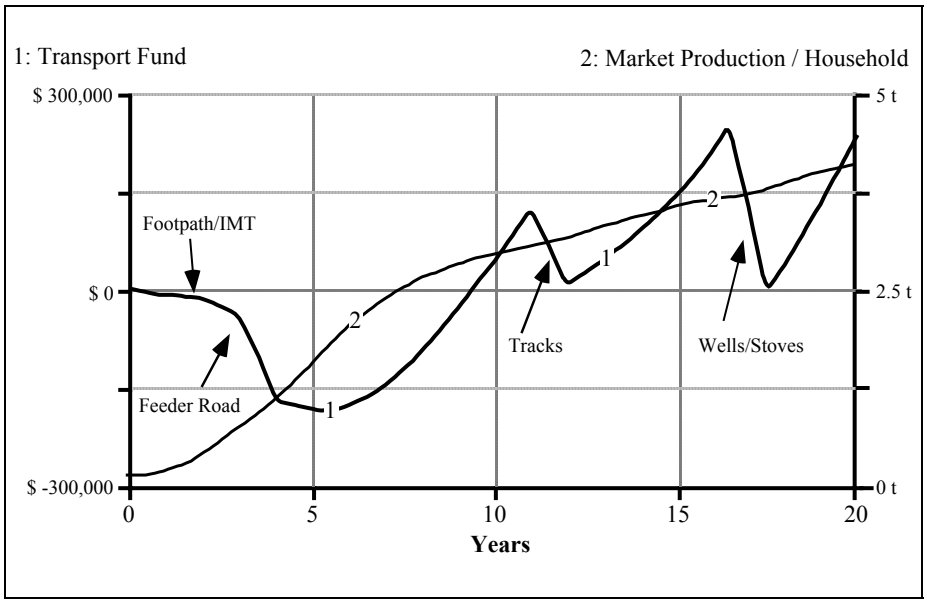


Fig. 8 Succession of various transport interventions

price is levied on the exported products. The growing market production will enable the road users to repay the debt until year nine. Now the market production exceeds three tons and transport constraints hamper it's further growth. After another two years enough user charges are collected to finance the construction of motorable tracks to every village. This investment entails another production expansion and the fund fills up faster in order to finance transport avoiding measures in the year 16. After 20 years the annual market production exceeds 4.2 t and the disposable income reaches $ 290, which implies an annual increase of 7.1 %. The income seems to be still very low, but it has to be compared to the reality in Makete, where in 1994 the revenues amounted to less than $ 80.

The model shows as well, that with increasing production the investments have smaller productive effects due to decreasing returns to scale with the given technology. At the end of the simulation period new agrarian technologies, like the use of ploughs with animal traction, high yielding varieties or irrigation schemes might entail a change of the production function. A further production increase necessitates a change of the transport technology again: the evacuation of crops can be only managed with animal drawn carts or small motor vehicles.

A New Approach to Appraisal Methodologies of Transport Projects

The new bias towards rural transport necessitates a widening of the approaches for the ex-ante-assessment of transport interventions. 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 Vehicle Operating Costs, the Makete Survey demonstrated that these benefits are relatively small compared to the other effects.

Therefore an appraisal of the different types of rural transport interventions should be based on a road and a household survey (Fig. 9). The planning methodology changes 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.

The road survey observes the existing motorised transport on the main roads. The benefits can be derived if the reduced Vehicle Operating Costs are multiplied with the expected traffic. 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 will appear. Therfore the expected vehicle supply has to be taken into account if future transport volumes are estimated.

The household survey contains an assessment of household size and composition and an estimation of the future population growth, migration and change in employment. 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 Vehicle Operating Costs give rise to future production increases (Producer Surplus Theory, CARNEMARK 1976). The household survey reveals also the actual transport patterns of rural households. The time savings per household can be achieved by reduced number of trips and decreasing trip length. 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. Direct income

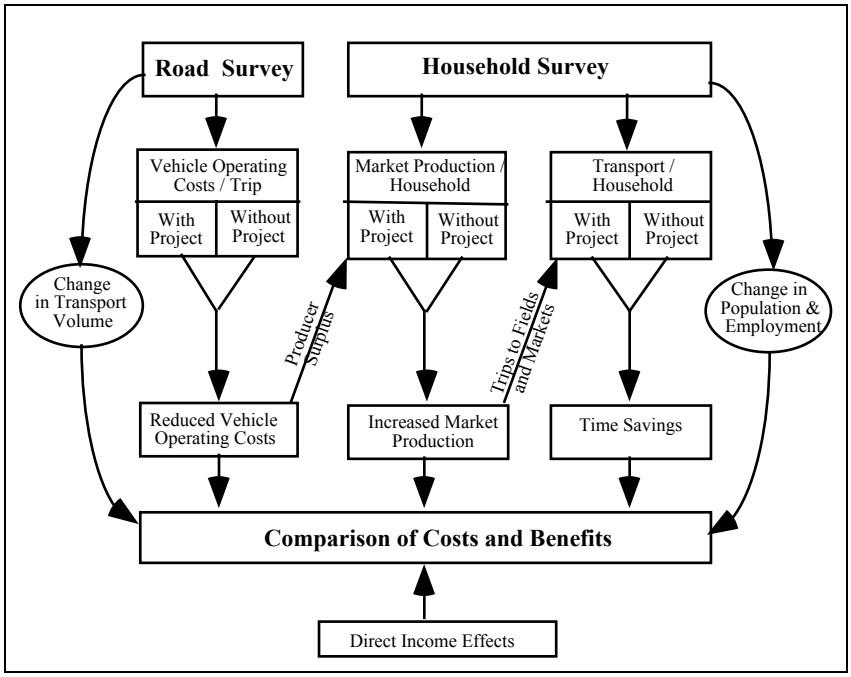


Fig. 9: Assessment procedure for rural transport interventions

effects can be assessed by the wages paid during the construction phase.

European cost/benefit calculations for road investments include a monetary value for the time savings and reduced accidents. Time savings can be valued with the opportunity costs of time. In the case of Makete the marginal productivity of labour was chosen as the basis for the valuation.

The empirical evidence from many studies about the impacts of road improvements[12] 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 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.

An eurocentric transport planning approach, which focuses exclusively on motorised transport, does not reflect the production constraints of African rural households. The improvement of the local transport system in and around the village can set forces free which stimulate economic development. Reduced effort and drudgery in transport, decreasing time constraints and better access to public facilities and markets will most probably entail an expansion of agricultural production. Intermediate Means of Transport can increase agricultural productivity, reduce rural isolation and thus raise the acceptance of agricultural innovations. Transport improvement for rural households is an important precondition for a dynamic rural development process.

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[1] This article relies on the PhD-Thesis: SIEBER, Niklas (1996): The Contribution of Transport Investments to Regional Development in the Rural Areas of Sub-Saharan Africa, Karlsruhe.

[2] UNCTADA II, The Republic of South Africa is excluded.

[3] AIREY (1992), BARTH/HEIDEMANN (1987), BARWELL (1993), BARWELL/EDMONDS/HOWE/DE VEEN (1985), BARWELL/DAWSON (1993), HOWE/RICHARDS (1984), KAIRA (1993), RIVERSON/CARAPETIS (1991).

[4] BARWELL / MALMBERG (1989)

[5] The remaining eight hours are spent with sleeping.

[6] Title of the book by BARWELL and DAWSON (1993)

[7] The benefits from reduced Vehicle Operating Costs are not listed here, because it is assumed they are included in the benefits by increased market production. Compare: ADLER (1987, p.34)

[8] The direct income effects are high, because a labour based construction technology was chosen. Compared to capital based technology the labour based approach increases the share of wages on total expenditure, reduces the financial costs and the need for foreign exchange. (RIVERSON et al 1991, HERTEL 1991, ILO)

[9] Probably the model overestimated the production increase for the footpath scenario, because no functional relation between distance to the market and market production could be implemented. The long walking distance would probably set stronger restrictions than in the other scenarios.

[10] It is assumed that wells have the same effects as the water pipes observed in Makete. Low consumption stoves reduce the consumption of firewood by 40 %.

[11] Regular Maintenance expenditure is excluded. The necessary money to fill up the credit fund for IMT is added to the total investments.

[12] A comprehensive overview of various transport studies is given in HOWE/RICHARDS (1984) and in WILSON (1973)