Transport in Rural Areas of Developing Countries: Empirical Findings from Western Province, Zambia

BEN H. IMMERS, ERNST J. MALIPAARD, AND MICHEL J. H. OLDENHOF

The focus of this paper is the transport problems of people living in rural areas of developing countries. Because the majority of these people are engaged in small-scale farming, special attention is given to the relationship between agricultural activities and transport. It is indicated that although the quality of the road infrastructure in the Western Province of Zambia is very poor, attention should be paid first of all to both the small variety and low availability of intermediate transport means. In addition, it is noted that agricultural transport is heavily influenced by the organizational structure of farming households and by governmental involvement.

The quality of the transport system is an important indicator of the level of socioeconomic development of a specific country. Harbors, railways, and roads are necessary for import, export, and distribution of goods and movement of people. More or less in accordance with size and nature of transport demand, the coarse network of railways and motorways (trunk roads) branches into a dense network of arterials, feeder roads, rural access roads, tracks, trails, and footpaths. As a result of the amount of goods to be transported, the topography, and the local level of technical advancement (motorization), among other factors, most countries have a variety of vehicles to transport people and goods.

This general picture also applies to African (sub-Saharan) countries. With respect to these countries, however, some further comments must be made:

- The local level of technical advancement is low, even in comparison with developing countries in Asia and South America;
- The majority of the population lives in rural areas and consists of subsistence farmers; and
- The transport system in rural areas is poorly developed.

This transport system, consisting of both roads and vehicles, often acts as a major bottleneck in realizing any socioeconomic development. Many donor aid programs are therefore geared toward improvement of the transport system. These projects often have the following characteristics in common:

- The chosen solutions and applied techniques require skills that deviate greatly from the local level of expertise. This inevitably leads to exclusion of the local population in realizing the project. Consequently, the local population does not feel any responsibility for continuing (maintaining) the project.
- Many solutions are heavily biased toward motorized traffic, even though most of the local trips (both rural and urban) are made on foot or by bicycle.
- A sectoral approach is used that does not take into account interrelations with other sectors, for example, agriculture. This approach does not recognize that transport is actually a derived need.
- The technical approach chosen leaves out the social and cultural factors that will be predominant in determining the acceptance of chosen solutions.

This kind of development strategy has resulted in many large-scale, high-tech development projects that benefit only a small part of the population, that is, those living in urban areas. The greater part of the population is still facing the same (or even worsened) problems. The transport demands of this group are directly related to basic needs fulfillment: fetching water, collecting firewood, and farm-to-field transport and marketing of agricultural surpluses. Almost all of the trips necessary to perform these activities are made on a network of tracks, trails, and footpaths, far away from the paved road (*1*, *2*). The means of available transport are very simple: at best, an oxcart, wheelbarrow, or bicycle, and in most cases, head-, shoulder-, or back-loading. This transport situation has several consequences (*3*):

- Transport is time consuming and, consequently, particular services (rural health center, school, etc.) are out of reach; and
- The transport of goods on head or shoulder (often several times per day) is arduous; in combination with other factors (e.g., poor marketing facilities) this factor may restrain farmers from producing surpluses.

The rural transport situation in relation to agricultural activities and accessibility of services and the possibilities for improvement by use of low-cost transport facilities are the main topics of this paper. The findings presented are the result of a research project carried out in 1986 in Western Province, Zambia. In consultation with the local transport authority, the Western Province Planning Unit, three project areas were

B. H. Immers and E. J. Malipaard, Faculty of Civil Engineering, Delft University of Technology, P.O. Box 5048, 2600 GA Delft, The Netherlands. M. J. H. Oldenhof, Section on Developing Countries, Faculty of Economics, Tilburg University, P.O. Box 90753, 5000 LE Tilburg, The Netherlands.

selected to get a general overview of the actual situation in Western Province.

First, an overview of the local economy of Western Province is given. This overview and the description of the local transport system are based on interviews with farmers as well as with key informants. Some of the conclusions and recommendations, which are based on the fieldwork, are generalized with respect to developing countries (with particular reference to sub-Saharan Africa). More detailed information on this study can be found in the work by Kolsteeg et al. (*4*).

LOCAL ECONOMY OF WESTERN PROVINCE

The vastness of the province, in combination with an extremely low population density (4.2 people/km^2), has had a severe impact on the development of the Western Province (Figure 1). The agricultural potential of the sandy uplands is generally poor because of the low fertility of the soils. More than 75 percent of the population is directly engaged in subsistence agriculture, and 87 percent live in the rural areas. Employment in the formal sector is very low, and employment in the informal sector does not seem to be significant (*5*).

In line with the national policy, maize (American corn, *Zea mays*) has been promoted as a dominant staple crop through favorable pricing, marketing, and credit facilities, whereas hardly any marketing outlets were provided for traditional staples. Although traditional staples require less input for surplus production and are less sensitive to timely input and distribution, their cultivation involves disadvantages as well. Urban consumers have long been used to maize consumption (a colonial inheritance) and therefore prefer maize as their staple food over cassava, sorghum, or millets. Also, cassava requires extensive processing before milling.

As in many other African countries, the lack of sufficient human resources is a severe constraint on agricultural development. In Western Province, this constraint has been slightly loosened by a wider use of cattle for tillage and transport purposes. In contrast to farm machinery (tractors), the use of animal draught power (ADP) has several advantages. The number of cattle in Western Province is favorable and should be sufficient to extend the role of cattle in cash cropping. In addition, ADP is less dependent on external factors, for example the devaluation of the Kwacha (currency of Zambia), which drives up the import price of machine fuel.

However, an extended role for cattle is severely hampered by several other factors. The geographical distribution of cattle within the province is highly uneven, mainly due to traditional factors. Generally speaking, oxen are underutilized, also mainly for traditional reasons. The role of cattle in the traditional economy is not restricted to transport and tillage; as an

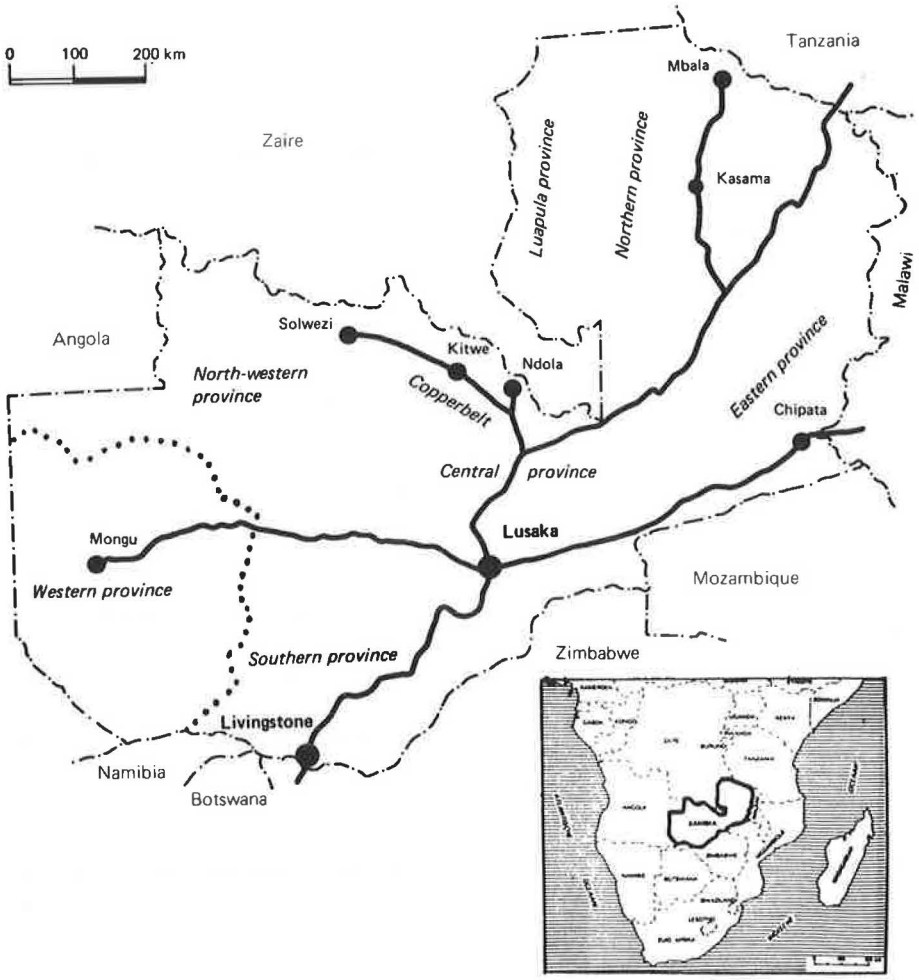

FIGURE 1 Zambia.

example, exchange of cattle is also used to build social relationships. Therefore, efficient commercialization of cattle is not that simple. Another factor is that hardly any medium-term credit facility is available for the procurement of a span of oxen in combination with a plough or oxcart. Additionally, an increasing number of parts of the province are infested with tsetse flies, which carry a cattle and horse disease called nagana as well as the notorious human "sleeping sickness." Finally, the quality of farming implements is poor. Oxcarts are expensive and rarely available. In addition, facilities for farming implement repair are scarce.

For most rural inhabitants, farming (cultivation of staple crops) is the primary source of income. It is hard to quantify the extent to which this income is replenished by additional sources of income. An estimate of an average farming household's income is shown in Table 1. It has been assumed that maize is the only cash crop. As an illustration of the purchasing power of the calculated income in Table 1, these 1986 prices of essential consumer goods should be considered:

Sugar (2 kg): K 4 (K = Kwacha);
Cooking oil (750 ml): K 7;
Blanket: K 45;
Pair of trousers: K 40–80;
Bicycle: K 545;
Public transport (100 km): K 5.

The inability to invest in farming equipment is clearly illustrated by these 1986 prices:

Oxcart: K 2,500;
Plough: K 250;
Wheelbarrow: K 250;
Span of oxen: K 1,200–1,500.

TABLE 1 GROSS CASH FARM INCOME, SMALL-SCALE FARMER (1985–1986)

	Cost/ Revenue (K)
Seasonal expenditures	
Ploughing	160
Fertilizer	301.1
Seeds	47.1
Transport, maize bags	51
Transport, fertilizer and seeds	10.8
Handling charges	8.5
Labor costs	70.4
Total expenditures	648.9
Revenues from maize	1,196.8
Average gross cash farm income	547.9

NOTE: The following assumptions were made: average hectarage of maize cultivated, 1.28; application of fertilizer, 245 kg/ha; no seasonal load obtained; land ploughed by (hired) oxen; labor costs (weeding), K 55/ha; and marketed maize production: 1957.5 kg/ha. The share of transport costs is 10.6 percent of the total costs.

Obviously, despite some nonagricultural extra earnings, the general outlook for the financial situation of most farmers is gloomy and can even be expected to deteriorate. Because of the fluctuating exchange rate of the Zambian Kwacha, the farm income is hard to translate into U.S. dollars. For comparison, in July 1986, $1 = K 5; but in October 1986, $1 = K 13. It is important to note that the calculation of "gross cash farm income" uses the marketed surpluses instead of the actual production. The difference between actual production and marketed surpluses is the portion of the production that is retained for home consumption. Therefore the retained quantity should be added to the calculated "gross cash farm income" to arrive at the "gross farm income." The problem with maize, however, is that the subsistence part can be valued at the official producer price, at the cost price plus normal profit margin, or at consumer price.

LOCAL-LEVEL TRANSPORT SYSTEM

Trip making is necessary because of the variety of activity locations. Thus the local-level transport system and the activity pattern of the household are interrelated. To gain insight into the local level transport system, it is useful to distinguish the demand for trips and the supply side of the transport system. Through a comparison of supply and demand the inadequacies of the transport system will become visible.

Supply Side of the Transport System

The supply side of the transport system is mainly determined by vehicle ownership, supply of road infrastructure, and operations management. In general, transport conditions within Western Province are poor. Most of the province is covered by a deep mantle of Kalahari Desert sands. Consequently, the quality of feeder roads is low, mainly as a result of loose sand. Only in hard-sand areas (the northeastern parts of the province) are the feeder roads negotiable by conventional motorized vehicles (two-wheel drive). Ownership of motorized vehicles is negligible and is mainly restricted to the government and donor aid institutions.

The density of paved and all-weather gravel roads is low. There are not sufficient funds for maintenance of the present trunk and feeder roads, mainly due to the scarcity of road-building material and the long haulage distances.

Nearly all public transport services in Western Province are offered by the United Bus Company of Zambia. The areas served are restricted to those accessible by paved or gravel road. Both the frequency and reliability of these routes have tended to decrease. The shortage of foreign exchange has direct repercussions on the operational fleet (acquisition of spare parts, fuel, etc.). Finally, the majority of people cannot afford frequent use of public transport.

The most common means of transport used by farmers is the ox-drawn sledge (Figure 2). A sledge consists of a solid wooden frame, V-shaped, with a load carrier of sticks and shelves mounted on the runners. High tractive power is required, especially in loose-sand areas. However, sledges cost little, require no spare parts, and are mostly manufactured by the owner. Sledge ownership is mainly constrained by the availability of trained oxen. The average carrying capacity is about 200 kg (a sledge weighs 70 kg), depending on the number of oxen (one, two, or three pairs) and the condition of the track. The average speed of a sledge is only 3 km/hr when

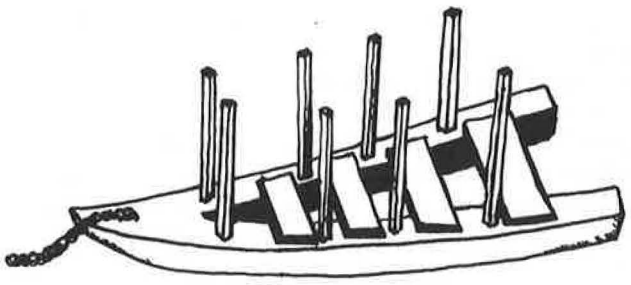

FIGURE 2 Ox-drawn sledge.

loaded. The oxen need 1 hour for grazing and resting after every 2 hours of hauling.

Oxcarts are less common. The low level of ownership is caused by the current low manufacturing capacity within Western Province and by an inadequate supply of spare parts and tire repair facilities. In addition, the majority of farmers cannot afford this mode of transport (*2*). In general, the inhabitants have a very positive attitude toward the use of oxcarts. The use of pneumatic tires is justified because the large contact area of tire and road surface allows transport even in loose-sand areas (*6*). Those few people who are familiar with wooden wheels regard them as inferior.

Private ownership of tractors for both land cultivation and transport is negligible. Tractor ownership in Western Province has decreased as a result of the high foreign exchange component in operating costs and the economic recession.

Bicycles are common in rural areas of Western Province, although usage is mainly restricted to hard-sand areas. The quality of bicycles is poor. Although people are eager to maintain their bicycles properly, a considerable number have broken down because of a lack of spare parts (mainly inner tubes and tires, patches and adhesive) and tools. Because of their poor quality, bicycles are seldom used for agricultural transport. There is only one bicycle factory in Zambia. Recent price increases are discouraging wider ownership.

Wheelbarrows have proved to be a very useful means of transport, both for on-farm transport (using narrow footpaths) and for short marketing trips. However, all wheelbarrows are made of steel and thus expensive. Donkeys are not common in Western Province, although they could be very useful for personal and goods transport, especially in loose-sand areas. Pack panniers or carts would be used to allow efficient transport by donkey. The low level of ownership can be partially explained by the fact that donkeys, in contrast to oxen, do not give their owners any status. In surrounding countries (e.g., Botswana, Zimbabwe), donkeys are used extensively.

Demand Side of the Transport System

The demand for transport can be subdivided into on- and off-farm transport (Figure 3). On-farm transport is characterized by trips for agricultural and domestic activities, whereas off-farm transport can be defined as the movement of goods from farm to market, Primary Cooperative Society, or road and back again. Trip making for social contacts and services is included in off-farm transport.

General features of the on-farm transport are

- Movement of small loads (10–100 kg),
- Relatively short distances (1–5 km),
- High frequency, and
- Potential involvement of all members of the household (women perform the majority of transportation tasks by head-loading).

The off-farm transport can be described by

- Movement of heavier loads (up to 500 kg),
- Relatively long distances,
- Low frequency, and
- More involvement of men, combined with the use of an intermediate transport means (all modes above human portage

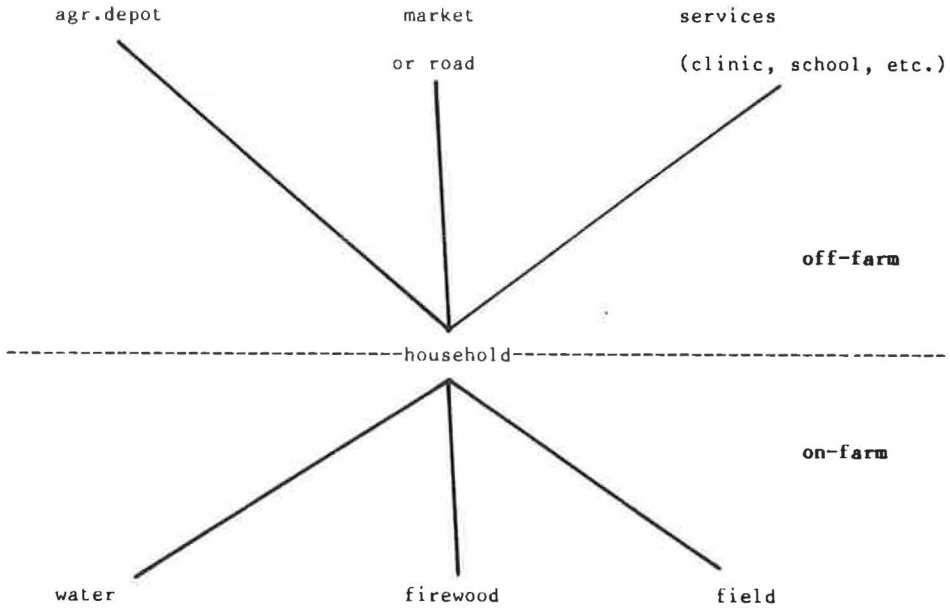

FIGURE 3 On- and off-farm transport destinations.

and below motorized vehicles, e.g., sledge, wheelbarrow, bicycle).

On-Farm Transport

Agriculture The majority of the rural population are small farmers. Thus trip patterns, which are the result of activities that pertain mostly to land cultivation, are determined primarily by the location of farm and fields. The determinants of demand for transport are as follows:

Distance from Farm to Field (Table 2) Cassava and sorghum fields are always located close (within a few hundred meters) to the farm. Transport of these subsistence crops is nearly always undertaken by women, using head-loading.

TABLE 2 DISTANCE FROM FARM TO MAIZE FIELDS

Distance (m)	Percentage of Farms
<100	18
100–500	33
500–1000	24
1000–2000	12
2000–3000	13

Ownership and Availability of Transport Means In Table 3, the modal choice of farm to field and return trips is given for transport of maize input and output. All farmers who own wheelbarrows use them for transport of unhusked maize from field to farm. The average farm-to-field distance for this group is about 400 m. Shoulder-loading is practiced by farmers who do not own any other means of transport and do not want to rent any for these trips. In addition, the roughness of ploughed fields and the insufficient width of tracks hamper the use of some intermediate means of transport.

TABLE 3 MODAL CHOICE FOR FARM TO MAIZE FIELD TRIPS

	Percentage of Transport Trips	
Transport Means	Input	Output
Sledge	29	29
Bicycle	8	–
Tractor	4	4
Oxcart	17	17
Wheelbarrow	17	25
Shoulder-loading	25	25

Required Quantity of Input (Seeds, Fertilizer) It is estimated that about 450 kg of input are required for the cultivation of 1 ha maize. Average hectarage under cultivation ranges from 1 ha to 1.5 ha. For cultivation of traditional crops, no significant input is required.

Frequency of Cultivation and Seasonal Peaks In general, maize is harvested once a year, with transport peaks during July–September. The cultivation of traditional crops does not produce transport peaks.

Quantity of Output An average farmer in fertile areas transports up to 4 000–5 000 kg of unhusked maize per year from field to farm. Maize is usually husked on the farm.

Firewood A present, there is no shortage of firewood in Western Province. Distances are mainly determined by land ownership because firewood can only be collected from an individual's own land (see Table 4). Collection of firewood is done by men, women, and children. Men carry the larger poles; women and children carry bundles of smaller branches. Firewood collection is often combined with a trip from the field. The frequency varies from daily to twice a week. Occasionally, the sledge is used for this purpose. Firewood consumption for domestic use is estimated at 3 kg per person per day (pppd).

TABLE 4 DISTANCE TO FIREWOOD LOT

Distance (km)	Percentage of Farms
<1	34
1–2	42
2–3	12
3–4	7
4–5	3
>5	2

Water Fetching water is a task typically performed by women and children. Water is fetched 2–3 times per average day; 15–20 liters are carried each trip. Average water consumption is about 15 liters pppd. Table 5 shows that people who live relatively far from water sources (say, more than 500 m) use a different water source during the wet season. Obviously, the distance to the water source is a major problem for these people. The water is always carried by head-loading, using steel buckets or calabashes (dried, hollowed-out gourds).

TABLE 5 DISTANCE FROM FARM TO WATER SOURCE DURING DRY AND WET SEASONS

	Percentage of Farms	
Distance (m)	Dry Season	Wet Season
<100	35	35
100–250	12	12
250–500	12	15
500–1000	20	35
1000–1500	6	–
>1500	15	3

Off-Farm Transport

Agriculture Transport of cash crops from the farm to the buying center (established by the Primary Cooperative Society) is generally undertaken by the farmer. In some areas, the Primary Cooperative Society has decided to build collection points (Figure 4). These simple storage facilities are provided if distances to the nearest buying center are considered too great (say, more than 10 km). The maximum distance to be covered by an ox-drawn sledge is estimated at 20 km per day. Either the

FIGURE 4 Transport chain in official maize marketing, by time of year.

Western Province Cooperative Union or the Primary Cooperative Society transports the bags of maize from the collection points to the buying center and eventually to the district center.

Supply of input (seeds, fertilizer, empty grain bags) is influenced by a lot of external factors and is thus often inconsistent. On the other hand, application of farming inputs is often very time-sensitive. During periods in which these supplies are vital, transport peaks occur, and the transport capacity may be too low. This is a source of many problems because farmers often do not own any transportation and have to rent or borrow on an ad hoc basis. In general, a more efficient use of oxen and sledge or oxcart is achieved through the current private renting out of this equipment among farmers. The use of sledges prevails for these trips (Table 6).

TABLE 6 MODAL CHOICE OF TRIPS TO COLLECTION POINTS

Transport Means	Percentage of Transport Trips	
	Input	Output
Sledge	61	60
Bicycle	4	–
Tractor	–	5
Oxcart	20	21
Wheelbarrow	15	–
Minivan	–	9

Social Contacts Social contacts include the following:

Education Long walking distances cause fatigue among pupils, resulting in absence (Table 7). The journey to school must sometimes begin while it is still dark, which is considered disadvantageous. This occurs because children attend school in shifts, so school starts early.

TABLE 7 DISTANCE FROM FARM TO SCHOOL

Distance (km)	Percentage of Farms
<1	11
1–5	39
5–10	42
>10	8

Medical Treatment In the case of acute illness, a patient cannot wait for a convenient transport opportunity. Consequently, patients are often transported under miserable circumstances (back-loading, wheelbarrow) over long distances (Table 8) or die along the road while waiting for transport.

TABLE 8 DISTANCE FROM FARM TO RURAL HEALTH CENTER

Distance (km)	Percentage of Farms
<1	11
1–5	36
5–10	33
10–15	15
>15	5

Visits to Relatives and Friends Visits to relatives and friends are very important because these trips are often the only way to obtain information and spend leisure time.

Comparison of On- and Off-Farm Transport

To compare the relative shares of on- and off-farm transport in local-level transport, determinants like total distances covered, travel time, quantities of transported goods, or derived magnitudes can be used. The following example involves an average farmer in the Western Province whose only cash crop is maize. The following assumptions are made:

- A household of five people: one male adult, one female adult, and three children;
- Total hectarage of maize is 1.2;
- Husking of maize is done on the farm, and 2 kg of maize in the husk yields 1 kg of husked maize;
- Agricultural input (seeds and fertilizer) weighs 300 kg and must be transported from selling point to farm (10 km) and from farm to field (2 km);
- Total output of unhusked maize (subsistence and surplus) is 4000 kg, which must be transported from field to farm, and total husked maize surplus has to be transported from farm to selling point;
- Water usage is 5 kg pppd, and the water source is 0.5 km from the farm; and
- Firewood usage is 3 kg pppd, with the source 2 km from the farm.

The transport flow per year may be calculated as follows:

On-Farm

Water: 5 people * 5 kg * 365 days =	9 125 kg km
Firewood: 5 people * 3 kg * 365 days =	5 475 kg km
Agricultural inputs: 300 kg * 2 km =	600 kg km
Agricultural outputs: 4 000 kg * 2 km =	8 000 kg km
Total, on-farm	23 200 kg km

Off-Farm

Agricultural inputs: 300 kg * 10 km =	3 000 kg km
Agricultural outputs: 1 800 kg * 10 km =	18 000 kg km
Total, off-farm	21 000 kg km

This example shows that the share of on-farm transport is quite large. Still, some other factors must be considered, because this example is incomplete. For example, transport of subsistence crops like cassava is not taken into account (this is nearly always on-farm transport). Also, only goods transport is considered. The distances covered for social contacts (for example) are not taken into account. Finally, the aggregation of transport activities to kilogram kilometers does not reveal the differences in consumed time and energy. For example, transport of 1 kg km water by a woman who uses head-loading is far more arduous than transport of 1 kg km maize by oxcart, a task done by men. To solve this problem, a (subjective) weighing factor could be applied. It is likely that this change in estimation technique would stress the significance of on-farm transport.

The relative share of on-farm transport in the example is quite large. On-farm transport is, as already stated, characterized by large involvement of women, and thus women are contributing significantly to transport activities in general. In comparison to off-farm transport, on-farm transport is less sensitive to external factors. For off-farm transport, the time of arrival of input at the selling point, the hiring or borrowing of transport means, and other factors should be taken into account, but on-farm transport is usually undertaken on foot and is thus within the power of the farmer himself (*3*).

CONCLUSIONS AND RECOMMENDATIONS

In general, agricultural transport activities are influenced by the kind of crops cultivated. The introduction of maize and rice as cash crops (and consequently as staple crops) could have many unexpected and undesirable consequences, especially in regions where subsistence farming predominates. In contrast to a traditional staple crop like cassava, maize and rice require excessive labor and timely transport during specific, brief periods. These requirements do not fit in well with other tasks that have to be performed daily on a Zambian farm.

Within Western Province, Zambia, the low availability and variety of intermediate transport means is a more pressing problem than the lack of road infrastructure. Traditionally, the responsibility for road construction is in the hands of the government. The issue of improving the quality and availability of low-cost transport means could also be seriously influenced by government initiatives. These changes depend on the following:

- Level of local skills, which is a direct consequence of available educational facilities;
- Research into the use of appropriate, locally available materials;
- Support by the local administration in establishing (private) workshops;
- Economic viability of newly introduced techniques (prices should be subsidized only to a small extent by donor aid);
- Government encouragement of provision of some technologically advanced items (e.g., bearings, pneumatic tires, spoked wheels, axles) because these components enable local manufacturers or even the farmers themselves to build vehicles with locally available materials, as has been done in the People's Republic of China and Vietnam.

For Western Province, Zambia, some specific remarks can be made. First of all, attention should be paid to the current low educational level of the few craftsmen available. Local craftsmen must be trained for manufacturing (or assembly), maintenance, and repair of transport means. This work could be combined with provision of repair facilities for farming implements. To overcome the remigration problems that have been experienced at training centers, training should take place within the area that is to be served.

The final goal should be the establishment of private rural workshops. Pairing workshops with the activities of cooperatives is not recommended because there is no direct relationship between the membership fee and the advantages of membership (e.g., maintenance and repair facilities). In addition, supervision might be difficult, and abuse of facilities could occur. In general, it appears that private entrepreneurs have more incentives to keep facilities in good condition.

The initiatives to establish workshops should focus primarily on high-potential areas. Training courses on carpentry, blacksmithing, welding, and bicycle repair should start on a very small scale because the actual and future demand for services cannot be estimated with any degree of accuracy.

Animal draught power seems to be the most viable solution in areas that face a deteriorating supply of motorized transport. Oxen should be owned privately. Experiments in other parts of Zambia have shown that communal use of oxen is not feasible. Initiatives for the hiring out of oxen on a commercial basis should be encouraged because this practice will reduce the need for credit for the purchase of oxen by individual farmers.

The present low availability of scrap axles and tires is constraining the manufacturing of oxcarts within Western Province. Replacement of heavy scrap axles by locally manufactured wooden axles, which will eventually need wooden wheels, will cause problems in loose-sand areas. Although oxcarts have proved to be useful, encouragement of oxcart use (e.g., by credit supply) should be undertaken carefully because a sufficient supply of spare tires and repair facilities at rural workshops is a prerequisite. If current constraints on extending oxcart use prevail, a more extensive use of sledges is foreseen. For sledges, the present low availability of chains, used in linking sledge and yoke, is the only problem that requires attention.

Decisions on improvements of bicycle quality and prices are being made at a national level. The only local manufacturer of bicycles is an organization that is state-supported and thus has no incentives to improve quality. Bicycle repair facilities should be included in the establishment of rural workshops. These facilities should be combined with the retailing of bicycles, spare parts, inner tubes, tires, patches, and adhesive, as well as some basic tools (wrenches). In addition to their use as personal transport, bicycles could be very useful for on- and off-farm transport activities. Bicycles specifically designed for

load carrying would be very useful in hard-sand areas of Western Province (7).

The construction of wooden wheelbarrows on an experimental basis is recommended. Wheelbarrows could be made entirely of locally available wood. A wheelbarrow with an open platform would ease transport of bags of agricultural input and output and loads of firewood. Wooden wheelbarrows are already being constructed in other parts of Zambia for K 60. As a comparison, a steel wheelbarrow costs K 310 (1986 prices).

If the condition of the road infrastructure within Western Province is examined, the following conclusions emerge:

- The density of the road network is sufficient;
- The quality of the roads is only low in loose-sand areas; and
- Maintenance activities are scarcely being carried out.

Bridges are often bottlenecks in road infrastructure. Maintenance funds could be raised by taxes on agricultural in- and outputs. These funds, which would be controlled by the cooperatives, should be distributed to local administrators.

Table 9 is based on findings in Western Province. The table presents allowed maximum distances to particular activity locations in combination with frequency and weight of load. In addition, an attempt has been made to rank the activities in terms of difficulty and time consumption; thus fetching water is the most arduous task. Fetching water also appears to be the most arduous and time-consuming task performed by women. In general, women have less access to transport means and are therefore confined to head-loading. The use of intermediate means of transport will be a definite benefit to women only in those tasks presently carried out by both men and women (firewood transport and farm-to-field transport for both cash and subsistence cropping). Improvements in water transport can only be achieved by a reduction of the distance to the water source. Thus the introduction of improved boreholes, which might result in longer haulage distances, does not seem viable.

TABLE 9 MAXIMUM ALLOWED DISTANCES IN ACTIVITY PATTERN OF RURAL HOUSEHOLD

Activity	Frequency (trips per year)	Load (kg)	Maximum Allowed Distance (km)
Fetching water	700–1,000	15	0.5
Farm to field transport	300–500	10–100	5
Collecting firewood	100–150	5–30	5
Off-farm transport of agricultural input and output	5–50	50–500	10
Services	2–10	–	10

NOTE: Tasks are ranked in terms of difficulty and time consumption; fetching water is the most arduous.

REFERENCES

1. C. Heidemann and U. Barth. *Rural Transport in Developing Countries.* IFR Research Report. Institut für Regionalwissenschaft der Universität Karlsruhe, Karlsruhe, West Germany, 1987.
2. G. C. Edmonds. Towards More Rational Rural Road Transport Planning. *International Labour Review,* Vol. 121, No. 1, Jan.-Feb. 1982.
3. M. McCall. *Distance Constraints in Peasant Farming Systems.* Working Paper 9. Vakgroep Ontwikkelingskunde, Technische Hogeschool Twente, Enschede, The Netherlands, Dec. 1983.
4. P. A. Kolsteeg, E. J. Malipaard, M. J. H. Oldenhof, and H. F. M. Vrenken. *Transport Survey, Western Province, Zambia.* Final report, ISP Zambia. Delft University of Technology/Tilburg University, The Netherlands, May 1987.
5. *Provincial Medium Term Development Plan 1986–1991.* Western Province, Zambia, 1986.
6. E. J. Malipaard. *Possibilities for Improvement of Intermediate Transport Means in the Western Province of Zambia.* Delft University of Technology, The Netherlands, 1988.
7. B. H. Immers. *Towards More Rational Transport Planning in Developing Countries.* Delft University of Technology, The Netherlands, 1985.