**Research Project on Improved Food Crop Marketing Through Appropriate Transport for Poor Farmers in Uganda**

# The Economics of Intermediate Means of Transport

## Final Report

**By**

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## 1. Intermediate Means of Transport (IMT) Operating Costs

The two major elements of economic benefits arising from introducing IMTs are the reduction in vehicle operating costs (VOC) and time savings generated by using faster and larger capacity IMTs.

The total operating cost for IMT type (k) is given by:

TOCk = VOCk + TMCk

Where:

TOCk = total time and operating costs of IMT type k per vehicle-km
VOCk = vehicle operating costs of NMT type k, cost/km
TMCk = travel time cost of IMT type k, cost/km

The HDM-4 Vehicle Operating Cost Model, developed by the World Bank, is used here to predict vehicle operating costs. Data input required for the operation of the IMT Operating Cost model can be divided into the following:

- Road characteristics;
- IMT characteristics;
- IMT utilisation data or the demand;
- Unit costs.

The VOC Model also requires data on the cost of capital and maintenance, crew and energy costs and additional coefficients. In this study, most of the coefficients used are based on the model's default values, which are adjusted to the type of IMTs used in this research project.

## 2. Road characteristics

In Iganga and Katakwi Districts, most of the IMTs are used on tracks and paths around the farms, and in Kasese District on hilly paths. The current state of the tracks is not suitable for motorised vehicles. This deters potential motorised traffic from using them. Following a site visit, most sections are considered to be have a gravel surface and the measure of the average road roughness is estimated to be around 15.0 IRI. This measure is used to compute the operating cost of all IMTs.

## 3. IMT characteristics

The three selected districts (Iganga, Kasese and Katakwi) have various levels of accessibility. While Iganga and Katakwi are on flat terrains where most type of IMTs could be appropriate, Kasese is in a mountainous region where animal drawn carts could not be a technically viable option.

For the purpose of this research, project the estimation of operating costs of each of the following Non-Motorised means of Transport (NMTs) are addressed:

- Headloading
- Bicycle
- Pack donkey
- Donkey cart
- Oxen cart

### 3.1 Headloading

PRA results show that headloading is the predominant means of transport used by poor farmers and particularly among women. Various forms of human porterage were identified; shoulder, head, hand and back loading. Men predominately use the shoulder, and to an extent the hand and head, whilst women mainly use the head, followed by the back and then hand. The percentage of women using their primary form (i.e. using the head) of human porterage is considerably higher than the equivalent of men, being respectively 91% and 65%. Loads are gender sensitive: women typically collect water and firewood, and also carry crops, while men carry production and construction materials and crops. Women, by necessity, also carry their young children.

**3.2 The bicycle** - The bicycle is undoubtedly the most widely used IMT in rural Uganda and is one of the principal physical assets owned by households. The main uses for the bicycle include travel to external sources of income (for example, teachers to schools, and labourers to farms); travel to markets to buy or sell produce; travel for personal reasons (for example, to see friends and relatives), and to health or educational facilities; travel to and from fields during the crop production season; and travel in a marketing role (for example, selling cash crops around the village or between villages). Farmers may use bicycles to transport a plough to the field, and also to fetch water and fire wood. In Uganda, bicycles are also used to transport people (i.e. as a taxi) against a fee (known as the 'Boda-Boda'). The Boda Bodas are mainly used by young men around villages. A bicycle has a load capacity of around 65kg.

Whilst in Northern parts of Uganda women have adopted bicycles already, in the Central Region they are primarily used by men; but the slow process of the acceptance of women riding bicycles has started. It is normally women engaged in

professional activities such as school teaching who are taking the lead in using bicycles. However, there is still a feeling that women riding bicycles are trying to behave like men and that this behaviour is culturally unacceptable. As a result, many of the household tasks are still conducted by women head loading water and firewood to the house. The presence of bicycles has reduced their burden by transferring some of the work onto men, in particular for travel to the grinding mill and to markets. The women also benefit from the bicycle because they can travel as a passenger on the rack at the back.

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

### 3.3 The pack donkey

While bicycles are widely used in Uganda, ownership of donkeys, donkey and oxen carts or motorised vehicles was rare among farmers in the three districts under study**.**

Donkeys are long-lived, cheaper to maintain than horses, have great endurance, and are agile on poor tracks. They remain of crucial economic importance in many developing countries.

Donkeys are efficient and easily managed transport animals and can be of special benefit to women. As part of this project, pack donkeys are introduced in all districts and particularly in the mountainous district of Kasese.

### 3.4 The donkey cart

Donkey carts are introduced in the three districts but only used on flat terrains. The cart is

pulled by one donkey.

### 3.5 The oxen cart

Oxen can be attached to a plough, and it is possible for four animals to plough an acre in a day. Two animals attached to a cart can pull one tonne or more depending on the size of the animals. They are used for the transport of firewood, crops and building material at the village level and will be taken to market for the sale of harvest. The ox cart is preferred for the transport of delicate perishable goods such as eggs and bananas. As the cart moves slowly it is unlikely to do much damage to the produce on rough roads.

### 3.6 Summary

Bicycles are already in use in all districts. The type and number of IMTs introduced in each district with their payload is presented in Table 1.

Table 1: IMT characteristics

| IMT type | Payload (in Kg) | Numbers by district | | |
|---|---|---|---|---|
| | | Iganga | Katakwi | Kasese |
| 1 – Bicycle | 65 | **NA** | **NA** | **NA** |
| 2 - Pack Donkey | 175 | **17** | **20** | **47** |
| 3 - Donkey cart | 550 | **5** | **6** | **3** |
| 4 – Ox-cart | 1,000 | **12** | **1** | **2** |

NB: In Iganga, a total of 30 oxen were introduced, plus 17 ploughs; In addition, the NGO Fabio has distributed bicycles in Kasese District as part of a partner project.

## 4. IMT utilisation data

It should be noted that IMT operating costs are very sensitive to levels of utilisation (i.e. demand). The utilisation of IMTs was estimated through monitoring surveys in all three districts. Monitoring forms have been completed by farmers with the help of facilitators on a daily basis. The information collected covers the origin and destination of each trip, distance, time, type of goods and its weight and whether the IMT was used for personal gain or for hire by another person.

Each animal was monitored using two survey forms, one for IMT utilisation and the second for animal feed and welfare. The duration of the monitoring period per animal varies from one to 24 months.

To complement the above quantitative surveys, qualitative surveys were carried out through operators' (farmers') interviews in each district over two weeks. An estimate of IMT utilisation is presented in the Table below.

Table 2: IMT utilisation data

| | IMT Category | | | |
|---|---|---|---|---|
| | Bicycle | Pack Donkey | Donkey cart | Oxen cart |
| Annual utilisation (km) | 2,500 | 3,000 | 4,000 | 1,250 |
| Average vehicle life (year) | 10 | 20 | 20 | 15 |
| Annual hours used | 200 | 550 | 750 | 350 |

Source: Consultant's estimate from transport operator's surveys

## 5. Unit IMT prices

Animals and the carts are of Ugandan origin. Donkeys mostly come from Kapchorwa District, except in Katakwi District they have been acquired locally. The carts have been manufactured by local artisans based in Iganga, Katakwi, Kamwenge and Bwera . Table 3 presents the capital cost of each IMT. The price of a donkey and oxen includes transport costs from their place of origin to the three districts.

Table 3: IMT prices, in Ugandan Shillings (in Ug-Sh, 2004 prices)

| IMT Category | Bicycle | Pack Donkey | Donkey cart | Oxen cart |
|---|---|---|---|---|
| Price of IMT when new | 110,000 | 160,000 | 660,000 | 1,200,000 |

Source: Consultant's estimate from artisan and transport operator's surveys

### 5.1. Feed and animal welfare

Along with grazing, animals are given a supplement of food to compensate for the effort made after carrying goods. This consists of maize blend, dry cassava and other wheat based food. Cost of animal feed is difficult to estimate and varies significantly from one keeper to another. Data analysis of the monitoring forms shows that on average 125 UG-Shillings are spent daily to feed a donkey.

Animal preventive care is the most practical way to deal with health problems and evidence suggests that much ill-health could be improved by a combination of better husbandry, routine de-worming, routine foot care, well designed harnesses, and regular, consistent, considerate, and hence less stressful, working practices. Again, the cost of preventive care varies from one animal keeper to another and the analysis of the monitoring forms show animal keepers spend daily on average 200 UG-Shillings on preventive medicine. This cost is above the daily cost estimate of feed supplement

given to an average animal. For some reason, animal caretakers seem to have overestimated the cost of preventive treatment when filling in the monitoring forms.

## 5.2. The production of carts

In Iganga, donkey and ox carts are manufactured by a local artisan who is based in the district capital. A total of eighteen (18) wooden carts (with metal shell) of 1,000 kg capacity, resting on two pneumatic tyres were produced over the last 18 months. Thirteen (13) were produced for the research project and 5 for other operators. The prototype is similar to the one produced for the Kenyan project (KENDAT).

Wood and metal are procured locally, the wheel bearings are supplied by special dealers on the road to Jinja (40 km) and used tyres are purchased from local petrol stations. The rate of integration of the production process is high enough to locally sustain the activity. An estimate of the production cost and its structure is presented in the table below.

Table 4: Production cost structure of a locally produced cart, (in UG-Sh. 2004)

| Item | Unit | Quantity | Unit price (UG-Sh) | Amount | Origin |
|---|---|---|---|---|---|
| - Wood | Sq-foot | 30 | 1,500 | 45,000 | Local |
| - Metal | Piece | 5 | 28,000 | 140,000 | Local |
| - Bearings | Unit | 1 | 7,000 | 7,000 | Jinja |
| - Tyre | Unit | 2 | 10,000 | 20,000 | Local |
| - Labour | Man-day | 10 | 5,000 | 50,000 | Local |
| - Transport | | 1 | 20,000 | 20,000 | Local |
| - Welding material* | Unit | - | - | 10,000* | Local |
| - Overheads | - | - | - | NA | Local |
| Total | | | | 292,000 | |

Source: Artisan's interview – * Consultant's estimate

The cost estimate of production of one cart, excluding overheads, is around 300,000 UG Shillings. The current purchasing price of carts is 420,000 UG.Sh, delivery cost not included. The majority of cart users are encountering problems with frequently punctured tyres. The artisan is currently using recycled tubeless tyres purchased from local petrol stations, which are not suitable for use on rough tracks. Using tyres in better conditions would significantly improve a cart's performance.

## 5.3. Unit costs summary

Unit costs data used for this study are summarised in Table 5 below.

Table 5: Unit costs – economic prices, in Ug Shillings of 2004

| IMT components | Bicycle | Pack Donkey | Donkey cart | Oxen cart |
|---|---|---|---|---|
| Price of animal (s) | 110,000 | 100,000 | 100,000 | 640,000 |
| Cart | - | - | 500,000 | 600,000 |
| Tyre | 5,000 | - | 30,000 | 30,000 |
| Saddle/Harness | - | 50,000 | 50,000 | 50,000 |
| Interest (%) | 12 | 12 | 12 | 12 |

Source: Consultant's estimate, based on artisan and transport operators' (farmers) interviews

## 6. IMT Vehicle Operating Costs

The cost of operating each IMT type is obtained from the costs of capital depreciation, repair and maintenance, crew (if any), energy and overhead.

**VOCk** = CAPCk + RMCk + CRWCk + ENCk + OVHDk

Where:
VOCk = total vehicle operating costs of NMT type k per vehicle-km
CAPCk = capital cost of NMT type k per km (excluding pedestrians) (cost/km)
RMCk = repair/maintenance cost of NMT type k (excluding pedestrians) (cost/km)
CRWCk = crew cost of NMT type k (excluding pedestrians) (cost/km)
ENCk = energy cost of NMT type k (cost/km); and
OVHDk = overhead cost of NMT type k (excluding pedestrians) (cost/km)

Table 6 presents the operation cost and the journey time required to transport one tonne over one kilometre using each IMT.

Table 6: IMTs vehicle operating costs (in Ug Shillings of 2004)

| Cost item | Bicycle | Pack Donkey | Donkey cart | Oxen cart | Headloading |
|---|---|---|---|---|---|
| | | | | | |
| Capital cost/km | 4.40 | 3.50 | 8.88 | 79.47 | 0.00 |
| Interest cost/km | 0.03 | 0.04 | 0.11 | 0.72 | 0.00 |
| Overheads cost per km | 3.60 | 6.00 | 6.75 | 21.60 | 0.00 |
| | | | | | |
| Repair & Maintenance Costs | 7.71 | 52.97 | 717.29 | 168.11 | 0.00 |
| Crew cost per km | 31.68 | 72.60 | 74.25 | 110.88 | 0.00 |
| Energy cost/km | 180.00 | 118.80 | 118.80 | 237.60 | 259.20 |
| | | | | | |
| **Total** | **227.41** | **253.91** | **926.07** | **618.38** | **259.20** |
| | | | | | |
| Payload (tonne) | 0.065 | 0.175 | 0.550 | 1.000 | 0.020 |
| Number of trips required for one tonne-km | 15.4 | 5.7 | 1.8 | 1.0 | 50 |
| Time (hours) required for one tonne-km | 1.23 | 1.05 | 0.34 | 0.28 | 12.50 |
| **Cost of transporting one tonne-km** | **3,499** | **1,451** | **1,684** | **618** | **12,960** |

## 7. Time savings

A critical aspect of examining alternative IMTs is an understanding of the impact of improvement (bigger capacity, higher speed) on journey time, and therefore (beyond the impact on IMT operating costs) on productive time saved.

Assuming an hourly value of time is equal to one eight of the average daily subsistence of a poor farmer in Uganda (living on $1 US a day), the value of time will be estimated at 225 UG. Shillings per hour (i.e. 1,800/8).

## 8. Calculation of total operating costs savings

Headloading and bicycles were the most common modes of transport used in the three districts prior to the introduction of the pack donkeys, donkey carts and ox carts. Table 7 presents the economic benefits (savings) generated by the introduction of IMTs to the three districts.

Table 7: Total savings generated by each introduced IMT in transporting one tonne-km (in UG-Shillings, 2004)

| IMT used at present | IMT used as an alternative mode of transport | Operating cost savings | Journey time savings | Total savings |
|---|---|---|---|---|
| Headloading | Pack donkey | 11,509 | 2,577 | 14,086 |
| Bicycle | Pack donkey | 2,048 | 41 | 2,087 |
| Bicycle | Donkey cart | 1,815 | 200 | 2,015 |
| Headloading | Donkey cart | 11,276 | 2,736 | 14,012 |
| Headloading | Oxen cart | 12,342 | 2,750 | 15,091 |
| Bicycle | Oxen cart | 2,880 | 0.95 | 3,094 |

The results show that all alternative modes of transport are economically viable. The critical variable that determines the choice of a mode of transport remains the level of demand for transport (utilisation). A recent DFID Knowledge and Research project[1] carried out in five Sub-Saharan African countries shows that an upper quartile threshold of 1.2 tonne-km is required to shift from headloading to the use of an IMT, and where conditions were conducive the IMT was usually a bicycle. Above a transport load of 8 to 10 tonne-km there was an increasing demand for an IMT with higher payload such as animal-drawn carts.

[1] Demand Appraisal For IMT and Transport Services, DFID KAR project R7787, January 204