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16828

Distr.  
LIMITED  
ID/WG.482/2(SPEC.)  
15 February 1989  
ORIGINAL: ENGLISH

**United Nations Industrial Development Organization**

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Global Preparatory Meeting in Preparation  
for the Consultation on Capital Goods with  
Emphasis on Rural Transportation Equipment

Vienna, Austria, 29 May - 1 June 1989

1/87

RURAL TRANSPORT EQUIPMENT FOR AGRICULTURAL  
FREIGHT IN ASIA\*

Prepared by

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\* The views expressed in this document are those of the authors and do not necessarily reflect the views of the Secretariat of UNIDO. This document has not been edited.

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I N D E X

<u>Sr.No.</u>	<u>Contents</u>	<u>Page No.</u>
1.	Introduction.	3
2.	Factors governing transport demands.	5
3.	Rural Asia.	9
	a) India	9
	b) Bangladesh	11
	c) Republic of Korea	12
	d) Philippines	13
	e) Malaysia	15
	f) Summary	17
4.	Transport Equipment.	20
	a) Aids for human portering	20
	b) Wheelbarrows and handcarts	27
	c) Animal transport	31
	d) Pedal-driven vehicles	35
	e) Bicycle and motorcycle trailers	39
	f) Basic motor vehicles	42
	g) Agricultural vehicles	44
	h) Other modes of transport	46
	i) Performance Characteristics	47
5.	Design and manufacture.	50
6.	Approach to rural transport development.	53

## I N T R O D U C T I O N

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The main objective of this sectoral study is to provide a review and analysis of the existing modes for transporting agricultural freight in Asia.

An analysis of the rural economy of the ASIAN countries would reveal that the number of rural poor is significant in absolute terms and their standard of living is showing only slow improvement. In most of the countries the rural people are generally engaged in agriculture, working in small plots of land either for themselves or as landless workers. Most of the people are engaged in subsistence farming or generate only small marketable surplus. Family cash income is very low and most of the rural people are located in areas poorly served by almost all public amenities including transport.

According to 1983 estimates, over 70% of the population in Asia is rural. In low income countries, agriculture accounts for above 37% of Gross Domestic Product (GDP) and involves over 70% of the labour force. Agriculture's priority is obvious as a significant area of attention for any programme attempting to improve the well being of the rural poor. In view of the relatively low productivity and efficiency levels in many of these countries, agriculture also represents a major potential avenue for increasing GDP growth.

Lack of a reasonably reliable and economic means of personal and goods transport in rural areas is thought to be a major constraint to rural development. Therefore, ways and means must be considered to maximize the number of rural poor that will benefit from the limited transport investment resources.

There are large areas of potentially productive agricultural land beyond improved feeder roads, representing a significant untapped source for economic development. These remote areas are mostly populated by some of the poorest and underemployed rural groups. They must rely on networks of paths, trails, tracks and unimproved roads that connect their homes, farmlands and villages to the improved feeder roads.

Any examination of appropriate vehicles for rural transport will need to take into account the pattern and construction of rural roads, including standards and specifications, construction and maintenance costs, and appropriate technological alternatives and developments in respect of

- a) muscle-powered transport,
- b) animal-drawn vehicles and
- c) various forms of motorized transport.

**FACTORS GOVERNING RURAL TRANSPORT DEMAND**

The first consideration should be a specific analysis of the magnitude, frequency and duration of transport needs and of the distances over which movements are required. In order to obtain a better understanding of the transport needs of rural people it is necessary to consider the following three interrelated questions.

- What quantity of goods does the farmer need to transport ?
- How frequently, and at what times of the year, does he need to transport goods ?
- How far does he need to transport goods ?

The table below indicates the trends in the average distribution of Land-holdings in Asia during 1970-1981.

	Population in Agriculture (in millions)		Cultivable land (in hectares)	
	1970	1981	1970	1981
Bangladesh	20.3	25.7	8 013	8 056
Burma	7.1	7.3	18 423	10 023
China	268.0	276.0	102 233	99 200
India	154.0	167.0	164 690	169 130
Indonesia	28.6	29.8	18 047	19 500
Iran	3.8	4.1	15 708	15 950
Korea, Rep. of	5.7	5.6	2 293	2 196
Malaysia	2.0	2.3	3 950	4 310
Nepal	5.2	6.4	1 935	2 330
Pakistan	11.1	12.8	19 282	20 320
Philippines	2.3	7.9	9 557	9 920
Sri Lanka	2.3	2.8	1 979	2 147
Thailand	13.6	16.1	13 749	17 970
<b>Total</b>	<b>501.6</b>	<b>563.8</b>	<b>371 859</b>	<b>381 052</b>

- |   |  |
|---|--|
| a) Growth of Population                       | = (12.4%) over 11 years<br>(1% per annum)          |
| b) Growth of cultivable land                  | = 2.5% over 11 years                               |
| c) Average distribution of<br>land per capita | = 0.74 ha/capita in 1970<br>0.67 ha/capita in 1981 |

Source: FAO production year book 1981, Vol. - 35

This indicates that while the economically active population in agriculture increased by 12.4 per cent during the years 1970 to 1981, the total area of cultivable land increased by only 2.5 per cent during the same period of 11 years. It shows also that the average farmland per capita decreased to 0.67 hectare in 1981 from 0.74 hectare in 1970, which indicates that farm size has also declined. The implication of such a trend is that the number of smaller farms has increased as have the number of landless labourers. The countries are, therefore, laying emphasis on diversification to agriculture and introduction of high-yield varieties.

With this increasing emphasis on diversification, including the introduction of high-yield varieties, and with the implementation of the programme for integrated rural development, including the development of agro-industries the volume and frequency of the movement of goods and materials are likely to increase significantly during the next few years. Unless necessary facilities for transport of such goods are provided, programmes for integrated rural development and economic improvement of the poorer sections of the rural population are likely to be affected adversely.

It is consequently, essential for the developing countries to pay very close attention to the design, production and use of appropriate vehicles of transport within the economic reach of the average farmer in these countries.

The most important transport needs for the rural people are those relating to agricultural activities which could be divided into two categories: on-farm transport and off-farm transport. While on-farm transport needs have received little attention, it might have been observed that off-farm transport also did not receive the adequate attention of the transport planners. It may be noted that even subsistence farmers may bring to market substantial amounts of produce: small plots of one to two hectares are capable of generating transport demand of several tons. The cost and scarcity of hired motor vehicles, lack of cooperative marketing services highlight the need for low-cost but efficient transport for the small farmer. The transport available to the farmer should, however, not be so slow and time-consuming as to limit the amount carried and the distances over which it can be moved.

A major factor in determining the frequency and timing of the marketing of produce is the perishability of crops. For perishable crops, the farmer needs prompt transport on a regular basis, either during the harvesting period or throughout the year, depending on the type of produce. However, for durable crops it is generally advantageous not



to market all produce immediately after harvest as at that time there is a glut of produce and prices are at their lowest.

A World Bank study in Kenya indicated that smallholders there generally need to move small loads (10-150Kg) over relatively short distances (1-25Km). For farm-based activities, loads are about the same but distances are shorter (1-13Km). Domestic requirements involve moving 50Kg of water and 30Kg of firewood per day which takes 3-6 hours. Where additional water is required for crop spraying, 2-3 tonnes of water are required during the year to spray a half hectare of cotton - a formidable amount if headloading is used for transport.

A study in India revealed that 81 per cent of the weight of goods movement was within the village, with an average trip length of 1.5Km. Outside the village the average trip length was 8.3 Km.

A study of rural mobility and communications in Mexico found that household heads travelled, on an average, about 1100 Km. each year on journeys related to work, and over 1200Km. a year for general purposes. 65 per cent of trips were local, 10 per cent regional and 25 per cent long distance.

R U R A L    A S I A

-----  
INDIA  
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There is a wide spectrum of transport modes in India, ranging from trains and motorized vehicles through many different types of animal- and human-powered devices to headloading. Motorized vehicles have only recently begun to play a role in rural transportation. This role is at present a minor one and is unlikely to become more significant in the near future. A major reason for this is the low standard and relatively poor condition of the rural road network.

About 90 per cent of rural goods traffic relates to the movement of farm inputs, products and equipment. The transport of foodgrains, sugar cane and food accounts for 65 per cent, commercial crops for 8 per cent, and farm inputs, of which manure is the most important, for 16 per cent. The remaining 11 per cent of rural goods traffic relates to the transport of construction materials such as bricks, mud, tinsheets, etc., and fuels such as firewood and dung cakes.

Requirements for longer distance transport are less frequent, at irregular intervals, and often relate to travel for social purposes. It is not surprising therefore that tractors and buses are the only types of motorized vehicles which have had a significant impact on rural transportation.

Tractors are within the financial reach of the wealthier people in rural areas and are utilized for a multitude of purposes, of which transport is only one. Buses provide relatively cheap services which cater for the longer distance transport needs of rural people.

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**Transportation of Goods by Modes of Transport**  
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Mode of Transport	Transport output				
	Average trip distance	million tonnes	% share	million tonnes/km.	% share
Headloading	1.5	113	17.7	170	9.0
Bicycle, tricycle	4.5	4	0.5	10	0.6
Pack animals	1.0	2	0.3	2	0.1
Animal carts	2.6	462	71.8	1307	68.6
Tractor-trailers	5.4	59	9.3	353	18.5
Truck, light commercial vehicles	18.5	4	0.5	64	3.3
All modes	1.9	644	100.0	1906	100.0

Animal transport can be used on village roads, rough tracks and cropland where a significant proportion of movements takes place during the harvest period. Animal power is abundant. The carts are produced and maintained with locally available skills and materials, and can carry a variety of loads ranging from manure to construction materials. Their average speed of 3-5 km per hour is adequate for the uses to which they are put and the distances travelled.

It is the Government's policy to reserve the manufacture of animal carts to the small-scale sector. Small-scale industry development programmes are carried out by the State Governments. The services provided under such programmes include infrastructural works, technical guidance, training facilities and financial assistance.

There is no lack of schemes to provide finance at economical rates of interest for the manufacture and purchase of carts. However, the cumbersome and lengthy procedures and the requirements for securing loans make them inaccessible to many artisans and potential cart purchasers.

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BANGLADESH  
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In Bangladesh dissatisfaction expressed with the state of transport in rural areas is, at least in part, a result of a lack of vehicles, especially country boats, which therefore ties the small farmer to the local market where he is in the hands of a very limited number of traders and receives a low price for his paddy.

The role of traders in the marketing of rice and other products and in the provision of credit to farmers is of the greatest importance. Most farmers are in the hands of a very small number of traders when selling in the local markets.

Rural transport is difficult over much of Bangladesh but it does not at present provide the only constraint to

agricultural development. The vast majority of Bangladeshi farmers cultivate very small acreages and the constraints limiting their increased production are associated with unequal access to resources (particularly credit and agriculture inputs) and tied marketing arrangements with traders where competition is limited. To improve rural transport alone in this situation is likely to provide greater advantages to the larger farmers and to the traders, both groups having their own transport (bullock carts and country boats). Transport development should be conceived as part of an overall rural development package aimed at improving conditions for small and large farmers.

Transport demand is at present highly seasonal and the peak demands could be reduced and levelled out by improvements in credit and rural storage.

In areas where the cropping ratio is high and the scope for further increase in productivity is limited, the main need for improved speed of travel is for the movement of skilled and experienced manpower.

-----  
REPUBLIC OF KOREA  
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The chee-geh is a traditional, load-carrying frame which is worn on the back and is unique to the Republic of Korea. The traditional chee geh is made mostly of wood, which is readily available from the pine trees growing in rural areas.

Because the natural crotches of the trees are used for making the chee-geh, its construction is relatively simple.

The traditional chee-geh takes somewhat different forms in different parts of the country, there being variations in the number of crossbars, attachment of the backpad, relative lengths above and below the fork, overall length and curvature of the frame, width of rear extensions and legs, and position of the shoulder strap.

Although farmers were nearly unanimous that use of the chee-geh was inevitable because of its 'convenience on narrow, mountain and steep trails and in the fields of paddy.

The work at Soong Jun University shows what can be done when science is applied to the improvement of a traditional technology. The new version was acceptable to the users. Since the development work was completed, a number of potential manufacturers have expressed interest in the making of the new model. Nevertheless, they did not feel sufficiently confident to go into full-scale production without external assistance. As with many 'appropriate technologies' the missing link was the effective marketing of the product.

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PHILIPPINES  
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70 per cent of the Philippines 47 million population live in the rural areas. They depend for their livelihood on

agriculture. Farming is predominantly concerned with rice and corn for home consumption and coconuts and sugar for export. Less than half of the villages in the rural areas have direct access to roads, and movements of farm produce is initially by head-loading, animal drawn sledges and carts. The roads to which farmers do have access are generally in poor condition.

With improvement to the road system the use of motorized transport has increased. To some extent the motorised forms of transport have been brought into competition with the traditional modes. However, the most common motorized modes, jeepneys and trimobiles, are not standard western models but products of Philippine ingenuity.

Jeepneys can seat a legal maximum of 16 to 22 passengers but may accommodate as many as 10 more by using the spaces available beside the driver, in the aisles, and on the running board. Jeepneys are available with petrol or diesel engines ranging from 60-90 hp. The body and passenger compartment of a jeepney are manufactured locally, while the engine and transmission are imported. Some constructors make their own chassis while others use the chassis from a small utility truck.

The trimobile is a local adaptation of an imported technology. It is a motorcycle modified to carry additional goods and passengers by the addition of a side-car. Both new and used Japanese motorcycles with engine capacities in the

range of 100 to 125 cc. are converted into trimobiles. The local conversion process involves modifying the motorcycle frame for attaching the side-car. The wheels are sometimes reinforced and extra shock absorbers attached to cope with rural road conditions.

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MALAYSIA  
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Increasing emphasis is being placed on the development of the rural and village road network in Malaysia. Under the village roads programme, existing tracks are being upgraded to facilitate marketing and processing of agricultural produce, and to provide better access to social amenities. Village roads are passable by cars in dry weather but are more usually used by motorcycles and bicycles. The low standard of construction makes these roads less suitable for pick-ups and lorries.

Small farm holders, grow rubber, paddy and fruits. The significance of rubber to the smallholder lies in the fact that it is useful only as a cash crop and as such provides his main source of income. Paddy and fruits are grown partly for home consumption.

Inputs of fertilizer, seedlings and insecticides are generally provided free of charge by government agencies and are delivered once a year to the farm gate or a local collection point.



In terms of transporting agricultural outputs, the requirements for paddy and rubber are totally different. Two-thirds of the paddy produced is for home consumption and is either processed at home or taken to the nearest rice mill. The average production of paddy per farm is 1,285 kg. Paddy is harvested once or twice per year and thus gives rise to a requirement for bulk transportation over fairly long distances.

In contrast, smallholders tap rubber for about 200 days per year. The rubber must be collected every one or two days and sold in the form of latex, scrap or sheets. Each type of rubber can be marketed through government agencies or private sector traders. The government agencies provide collection centres and processing services. The private sector competes with the Government by providing the same services.

13 per cent of households own no vehicle at all and a further 31.5 per cent only a bicycle. The bicycle therefore is for many the only means of transport and what others aspire to. The bicycle is of significant importance for rural transport of goods and passengers, being used for travel to smallholdings, for the movement of crops and for non-agricultural trips.

The motorcycle is the major locally owned mode of off-farm transport. Presently much of the rubber, having been transported to the collection point on shoulder poles is

transferred to the motorcycle. It would be sensible to consider the introduction of locally manufactured motorcycle trailers to provide a more effective means of transporting the rubber.

Given the potential demand for bicycles and motorcycles adapted to carry freight, and the fact that local people will spend a considerable proportion of their income on transport, it is worth examining the local manufacture of such vehicles.

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SUMMARY  
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It is important to differentiate between on-farm and off-farm transport. The former comprises movements related to domestic needs, such as water and firewood gathering, smallholder cultivations, grazing of animals and transport of farm inputs and outputs. On-farm transport generally takes place away from a recognized road. Off-farm transport comprises trips to the market, to visit friends or to reach certain social amenities, for example, schools and health clinics. Off-farm transport relates more to the conventional perception of transport in that at least some of it takes place on a recognizable road and, sometimes, with a motorized vehicle.

Rural transport demand is mainly related to agricultural production and that trips for agricultural purposes are predominant. Today people in the rural areas are more mobile

than in past. Each member of rural household will make at least one and sometimes two recognizable journeys each day.

Apart from transport of farm products during harvest, it is water collection that poses the primary daily movement problem. The majority of trips involving the carriage of a load are for water and wood collection.

Trips of less than 7 km comprise the majority. As one would expect, on-farm trips are generally short. However even in India, where 'on-farm' was understood as being within the community, the average trip distance was 1.5 km. Off-farm trips were generally longer but few were over 12 km. long. Most trips are concerned with relatively small loads of between 25 and 50 Kg. The predominant means of transport in the rural areas is on foot.

	India	Bangla- desh	Korea	Malaysia
Typical distance of transport	<5 Km.	<12 Km.	<10 Km.	<7 Km.
Average on-farm distance	1.5 Km.			1 Km.
Average off-farm distance	8.3 Km.			10 Km.
Loads transported		<50 Kg.	30-80 Kg.	

In some parts of Asia there is widespread popularity of the bicycle as a means of personal transport, and a load carrier.

In China and Indonesia, the back wheels of the bicycle are strengthened to increase the load carrying capacity. In some countries two-wheeled trailers are towed behind bicycles.

The use of animals for transport obviously complements agricultural practices based on the use of animal power. The consideration of animals for transport has generally developed as a by-product of the interest in the use of animals in agriculture.

In Philippine a low-cost motorized means of transport is the motor cycle and sidecar. In Malaysia, motorcycles are used to carry agricultural produce. In Asian countries where two-wheeled (power tillers) tractors have been adopted in agriculture, they are also widely used, with a trailer attached, for transport. Similarly in India 4 wheeled tractor trailer combinations are used for transport.

It is obvious that the purchase of a car or a pick-up is quite beyond the means of most rural people. Low-cost vehicles are more widely affordable, and hence available. Personal ownership of a low-cost vehicle gives the user the capacity to meet a range of transport needs, and provides a degree of control which is not possible when he has to depend on a hire service.

Low-cost vehicles and the local transport system to which they belong must form an important element of any transport policy aimed at meeting the needs of rural communities.

T R A N S P O R T   E Q U I P M E N T

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AIDS FOR HUMAN PORTERING  
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Carrying aids enable people to carry loads on their head, shoulders or back. Their use allows people to move larger or heavier loads than can be carried by hand. They are easy to make and require little expenditure on materials, and are therefore widely affordable. They can be used where difficult route conditions prevent the use of wheeled vehicles.

Typically, loads carried in developing countries are in the range 25-30kg. Speed is limited to a walking pace of 4-5km/hr and these methods are commonly used to carry loads for journeys of up to 20km.

A report from Bangladesh indicates that fifty per cent of broken necks sustained there are the result of falls whilst carrying loads on the head. The habitual carrying and lifting of heavy loads over long periods of time can also result in damage to the spine, the joints, the muscles of the limbs and trunk, and to internal organs.

**Direct headloading**

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**Women headloading maize**

- |                      |   |
|----------------------|---|
| <b>Description</b>   | - Pad of cloth to cushion the head, and container for the load if necessary.  |
| <b>Advantages</b>    | - Very simple and cheap.  |
| <b>Disadvantages</b> | - Difficult to load without assistance;<br>- requires strength in the neck and considerable skill;<br>- load is unstable and difficult to control on steep or rough terrain;<br>- hazardous in the event of a fall. |
| <b>Remarks</b>       | - This is probably the most widely used of all methods of carrying loads.   |

**Headstrap**

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**Men carrying firewood**

- |                      |  |
|----------------------|--|
| <b>Description</b>   | - Loop of strong cloth or webbing, and container for the load if necessary.  |
| <b>Advantages</b>    | - Very simple, cheap and easy to control.  |
| <b>Disadvantages</b> | - Difficult to load without assistance;<br>- requires considerable skill, and strength in the neck;<br>- stooped posture is likely to cause long-term injuries;<br>- hazardous in the event of a fall. |
| <b>Remarks</b>       | - Widely used on rough and steep terrain, and in crowded urban areas.  |

Shoulder strap

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Women carrying water in a plastic container

- |                      |   |
|----------------------|---|
| <b>Description</b>   | - Loop of strong cloth or webbing, and container for the load if necessary.                           |
| <b>Advantages</b>    | - Very simple, cheap and easy;<br>- load is stable and easy to control.                               |
| <b>Disadvantages</b> | - Difficult to load without assistance;<br>- stooped posture likely to cause long-term back injuries. |
| <b>Remarks</b>       | - A less common alternative to the headstrap.   |



**Shoulder pole**

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The shoulder pole is well suited to awkward loads

- Description** - Section of bamboo or, less commonly, suitable timber, which tapers towards the ends. The load is suspended on rope, cane or bamboo hangers, either directly or in containers.
- Advantages** - Very simple, cheap but difficult to use on steep or rough terrain.
- Disadvantages** - Skill required to prevent the load bouncing excessively;  
- loads must be balanced.
- Remarks** - Popular in Asia.

Back frame

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Back frame with extended arms, for carrying water

- Description - Rectangular frame with shoulder straps which is carried on the back. The centre of gravity of the load should be high and close to the back. Modern frames are made of steel or aluminium tube with padded backs and shoulder straps.
- Advantages - Load is stable and easy to control.
- Disadvantages - Difficult to load and unload without assistance;  
modern versions are relatively expensive.
- Remarks - Popular in European countries.

**Chee-geh**

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**Traditional wooden chee-geh**

**Description**

- An "A" shaped back frame with extended legs such that it can be stood on the ground and supported with a stick for loading and unloading. The load container is made from woven sticks and may be lined with cloth or plastic.

**Advantages**

- Load is stable and easy to control.

**Disadvantages**

- Relatively complicated and difficult to make.

**Remarks**

- The chee-geh is indispensable for carrying loads up to fifty kilograms on mountain paths. It is used in Korea.

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WHEELBARROWS AND HANDCARTS  
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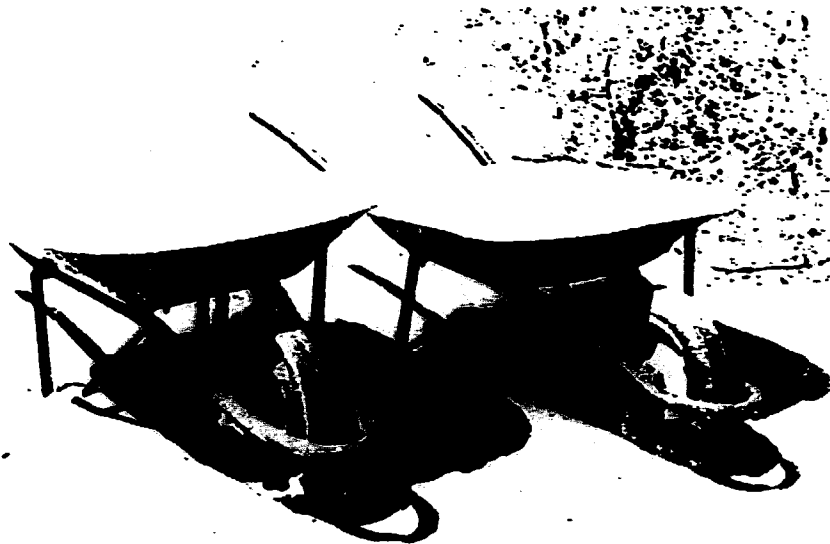
A wheeled vehicle enables loads to be moved more efficiently than is possible with a carrying aid - and indeed they are essential when more than 50kg. has to be transported by one person in one trip. Less effort is needed to move a given load because most of the weight is supported by the wheel(s). However, on steep inclines a large proportion of the weight has to be supported by the operator, and on rough ground the rolling resistance of the vehicles may be high. The simplest and cheapest types of hand-propelled vehicles are wheelbarrows and handcarts.

Wheelbarrows have one wheel and are normally pushed. The operator must maintain balance and support part of the load - which limits the maximum load capacity. Wheelbarrows can be used to move loads along narrow paths and tracks where a wider vehicle could not go. A wheelbarrow may, however, have to be pulled over exceptionally large obstacles.

Most handcarts have two wheels and may be pulled or pushed. Three or four wheels are sometimes used if a stable horizontal platform is needed. The operator doesn't have to support any of the weight if the cart is balanced by careful distribution of the load, and this means greater loads can be moved in one trip than when using a wheelbarrow. On rough ground the higher dead weight of a handcart is a disadvantage.

**Western wheelbarrow**

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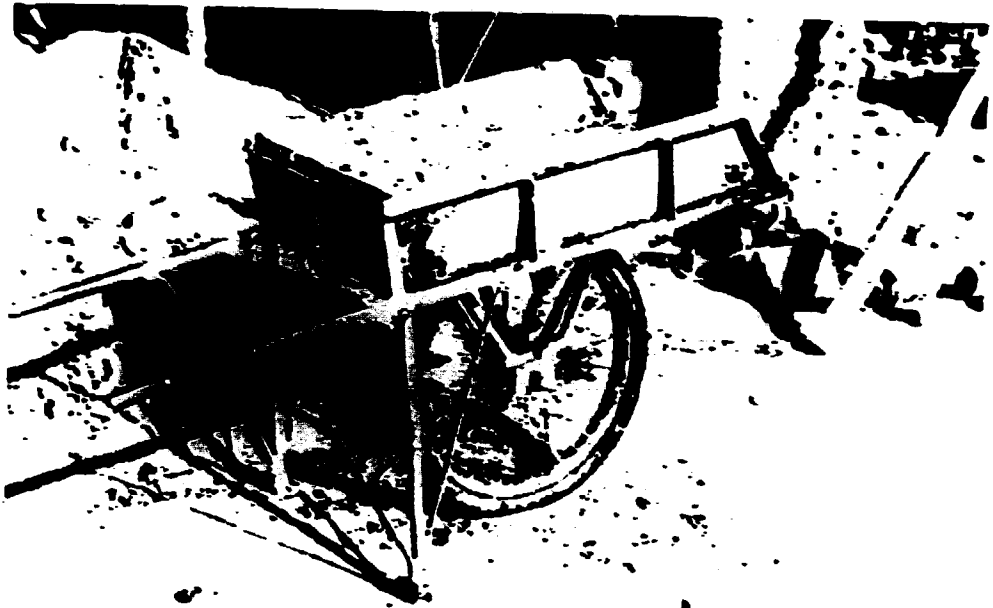
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**Modern western wheelbarrows.**

- Description** - Consist of a steel tube frame with a sheet steel tray and pneumatic or solid tyres.
- Advantages** - Simple, robust, light weight;  
- stable and easy to manoeuvre.
- Disadvantages** - Small load capacity;  
- difficult to push over rough ground;  
- very arduous for long distance use.
- Remarks** - Widely used for construction work in most parts of the world.

Chinese wheelbarrow

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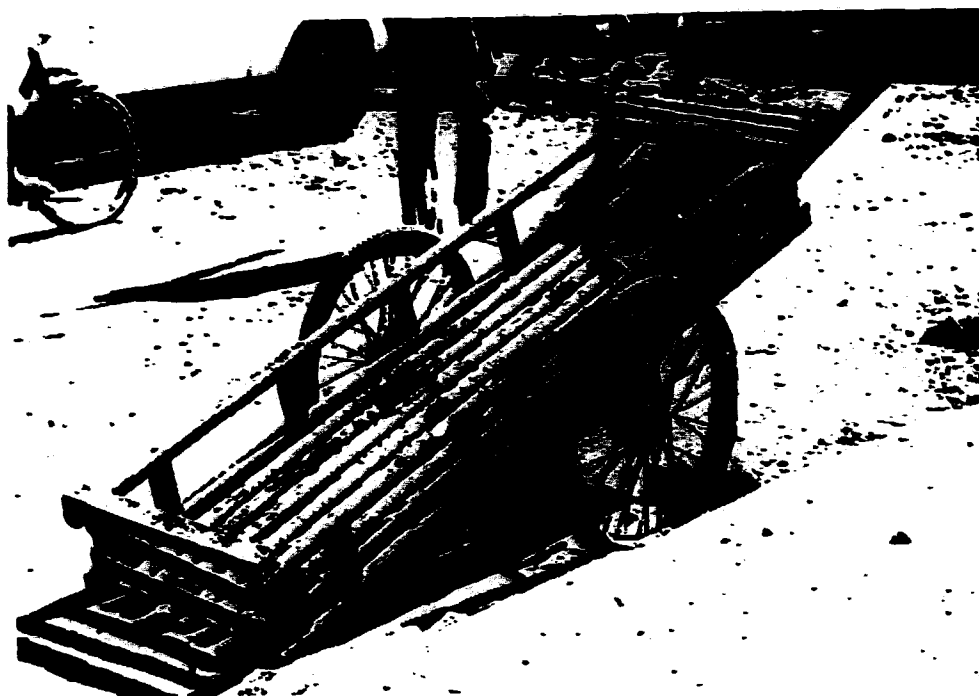
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Modern chinese wheelbarrow.

- Description** - The load container is located above, or sometimes either on side of a wheel about 70cm in diameter or more. Widely spaced handles help balance the load.
- Advantages** - Small proportion of the load supported by the operator;  
- large load capacity.
- Disadvantages** - Unstable, difficult to balance and hazardous if tipped over accidentally.
- Remarks** - The chinese wheelbarrow is suited to transporting large loads (150 to 200Kg) over long distances.

## Handcart

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Lightweight wooden handcart with pneumatic tyres

- Description** - The most common handcart, has two wheels on either side of a load platform.
- Advantages**
- Large load capacity;
  - small proportion of load is supported by the operator;
  - does not need to be balanced.
- Disadvantages** - Cannot be used on narrow paths.
- Remarks** - Load capacities vary from 150kg to about 1000kg, but 300kg. is about the maximum for one operator. Handcarts are most commonly used in urban areas, often for street trading.

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ANIMAL TRANSPORT  
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In many parts of the world domesticated animals, such as mules, donkeys, horses, oxen (particularly bullocks and buffaloes) and camels, are used in a variety of ways to transport both people and goods. Although these forms of transport are slow, generally being restricted to the walking pace of the animal, much greater loads can be moved than is possible with human power alone. Animals can move over any terrain where it is possible to walk, so they may be the only alternative to human portage in areas where the conditions or routes are unsuitable for wheeled vehicles.

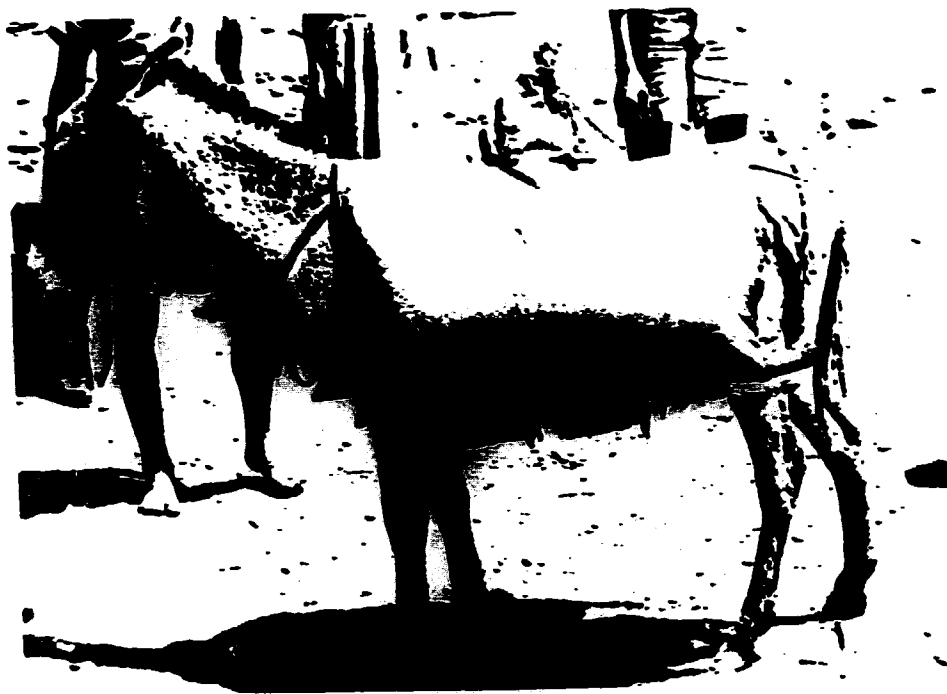
In many countries in Asia, animal-drawn carts continue to carry a large proportion of the total goods moved, especially in rural areas within and around farms and villages. Some 15 million carts are estimated to exist in India alone. Although some attempts have been made to improve the efficiency of traditional animal transport, little has yet been achieved.

Loads can be carried on an animal's back using a saddle and a pack or pannier to position the load. To carry heavier loads, at least part of the weight must be supported by the ground rather than the animal. The simplest way of doing this is to use a sledge, which is easily made from a variety of materials at very little cost. The greatest load-carrying capacity is achieved by harnessing the animal, or several animals, to a two or four-wheeled cart.



Animal panniers

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Special purpose panniers for carrying water

- Description** - The essential features are a saddle to distribute the load and protect the animal, and a load container with straps to hold it in position.
- Advantages** - Simple & cheap; can be used on narrow paths and steep, rough terrain.
- Disadvantages** - Limited load capacity.
- Remarks** - Load capacities vary, according to the type of animal, from about 150kg for a donkey to 400kg for camel. Panniers are commonly used with horses, mules, donkeys and camels, especially in mountains.

**Animal Sledge**  
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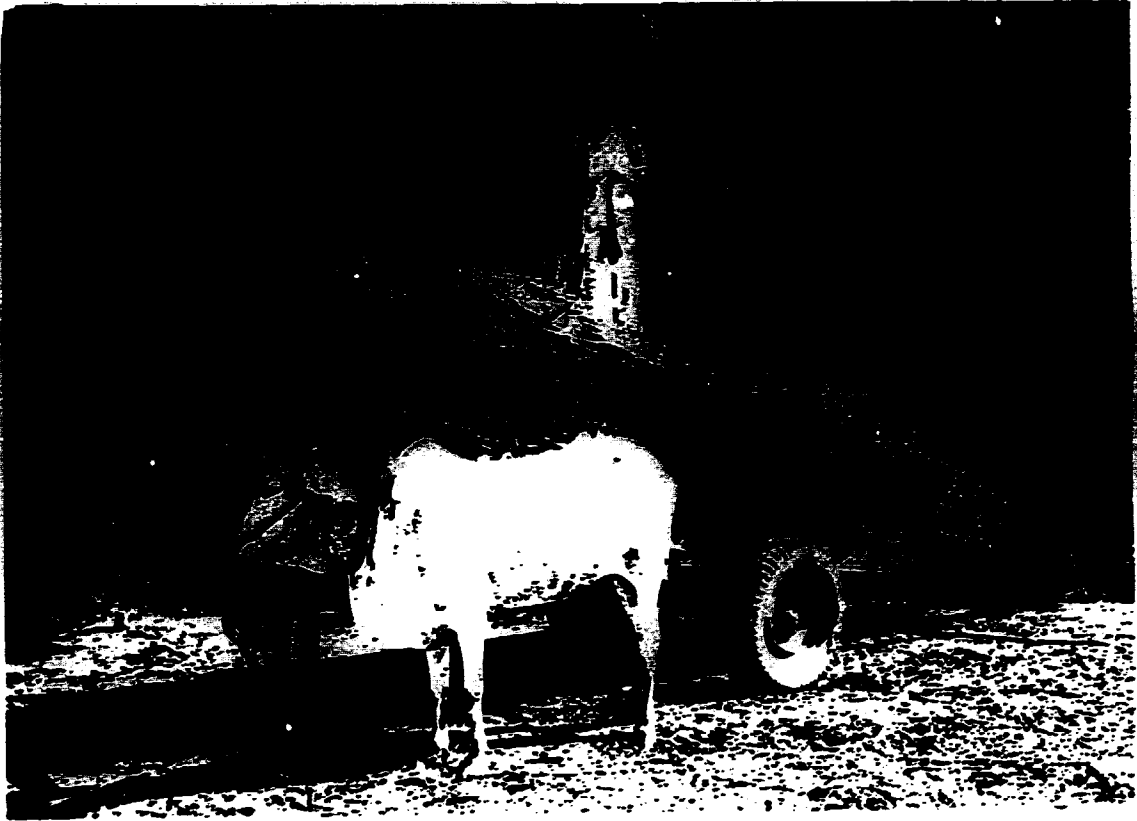


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**Buffalo drawn sledge**

- |                      |   |
|----------------------|---|
| <b>Description</b>   | - Sledges usually consist of a frame made of wood or bamboo with a yoke or other simple harness to attach the animal.   |
| <b>Advantages</b>    | - Simple & cheap.   |
| <b>Disadvantages</b> | - Inefficient use of draught power;<br>- cannot be used on narrow paths;<br>- may cause erosion of earth roads.   |
| <b>Remarks</b>       | - Load capacities vary, according to the type of animal, and route surface, but are typically about fifty percent greater than that can be carried with panniers. |

Animal cart

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Traditional bullock cart

- Description** - The most common design has two wheels, 70 - 150cms in diameter, one on either side of a load platform. The centre of gravity of the load is positioned just in front of the axle so that the animal supports only a small proportion of the load.
- Advantages** - Can carry large & heavy loads.
- Disadvantages:**
- Relatively expensive compared to other animal transport;
  - cannot be used on narrow paths;
- Remarks** - Load capacities vary from 500 to 3000kg.

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PEDAL-DRIVEN VEHICLES  
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The utility of pedal-driven vehicles extends beyond personal transport to the movement of goods and passengers. This has long been recognized and cycles are widely used for this purpose in many developing countries. Most of these load-carrying cycles are adaptations of standard bicycles. Wheels, forks and frames are strengthened and load frames added. A load platform and a third wheel may be added to form a sidecar, and tricycles are made by removing the front or rear half of the bicycle and replacing it with a two wheeled body. The wheels on three-wheeled cycles, unlike bicycle wheels, are subjected to side loads when turning and going across slopes and must therefore be stronger than bicycle wheels. Improved brakes and multi-speed gears, though desirable on load-carrying cycles, are rarely used. A wide variety of pedal-driven load carriers exists, but there remains considerable scope for the development of bicycles and tricycles specifically designed for this purpose.

Load capacity is determined by the strength of construction, the 'dead' weight of the vehicle and the physical condition of the rider. Pedalling more than 200 kg (including the load but excluding the rider) is slow and arduous, however, except on very smooth and flat terrain.

A standard bicycle is normally about the same price as a medium-sized handcart, whereas a load-carrying tricycle costs two to three times as much.

Load-carrying bicycle

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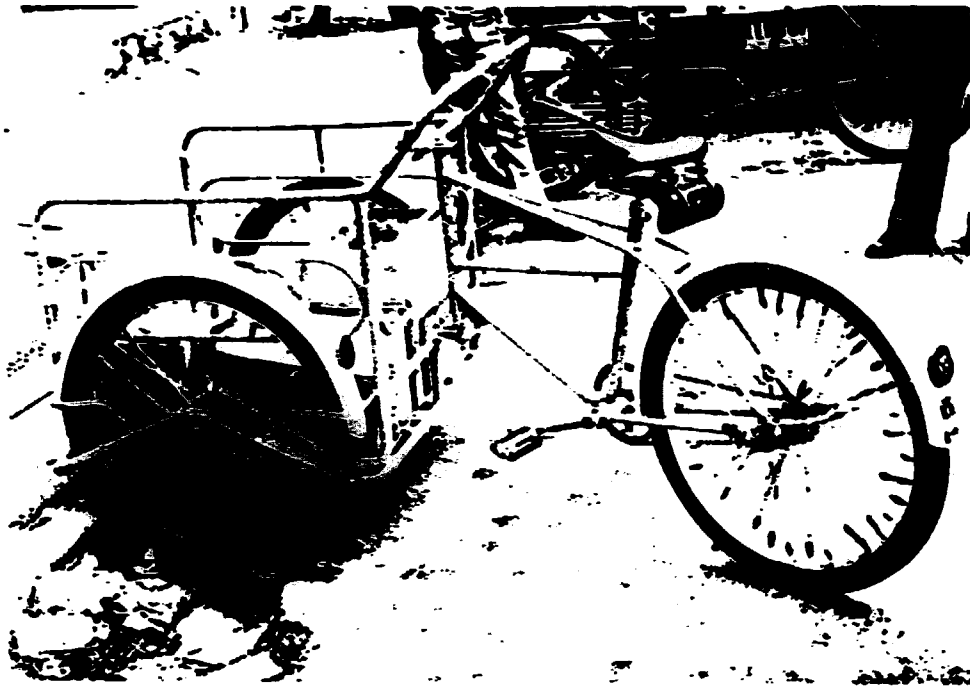
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A strengthened bicycle with a load frame

- Description** - A standard heavyweight bicycle can be modified for carrying loads by strengthening the original construction and bigger axles may be incorporated into the back wheel, extra struts may be added to the front forks, and the main frame may be strengthened with additional tubes.
- Advantages** - Can be used on narrow paths.
- Disadvantages** - Poor breaking when loaded, especially in wet conditions.
- Remarks** - Maximum load capacity is 50 - 200kg. Especially common in the far East.

Tricycle with front load platform

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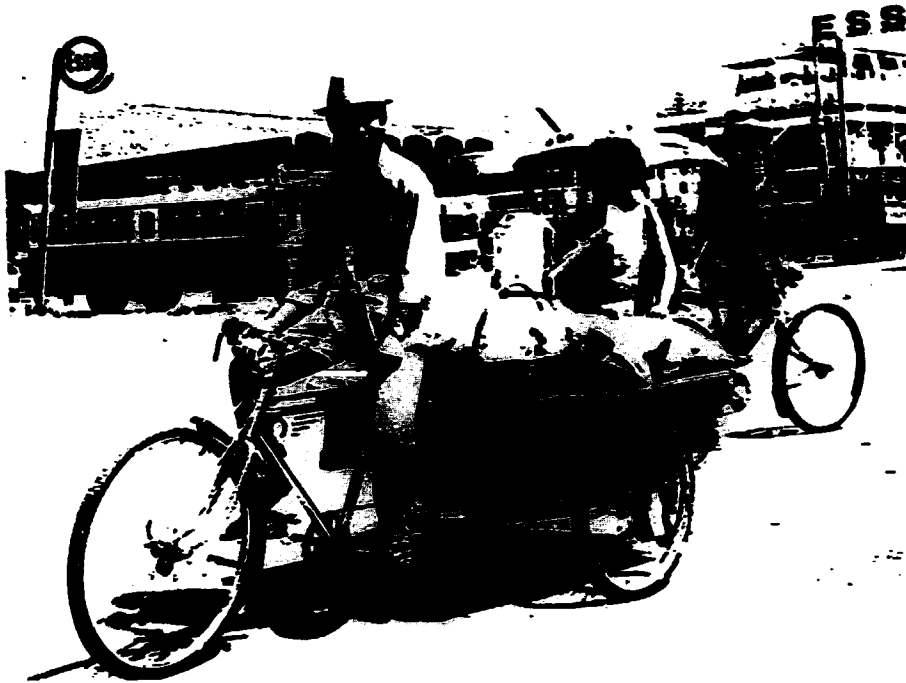
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A tricycle with a load platform in front

- Description**        - The front wheels are strengthened to accommodate side loads. A parking brake is sometimes added for convenience.
- Advantages**        - Easy to load and unload;  
                          - load platform can be very low to minimize side loads.
- Disadvantages**    - Cannot operate on narrow paths;  
                          - very poor braking when loaded, especially in wet conditions.
- Remarks**            - Load capacities vary from 150-300kg. They are used in Indonesia and Malaysia.

Tricycle with rear load platform

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Tricycle with a load platform at the rear

- Description** - Usually only one rear wheel is driven and the other is allowed to turn freely. A parking brake may also be added.
- Advantages** - Large, versatile load platform;  
- easy to load and unload.
- Disadvantages** - Cannot operate on narrow paths;  
- very poor braking when loaded, especially in wet conditions.
- Remarks** - This type of tricycle is known as a rickshaw in India and Bangladesh.

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BICYCLE AND MOTOR CYCLE TRAILERS  
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Bicycle trailers, and to a lesser extent motor cycle trailers, have been used for many years in certain parts of Europe. Yet, with cycle trailers have not been used to any significant extent in developing countries.

A trailer has several important characteristics as a load carrier. It enables a standard bicycle or motor cycle to carry substantial loads with minimal modification, yet the trailer can be attached or removed quickly and easily. The towing vehicle can be used on its own for small loads or for personal transport, and the trailer attached as and when needed for carrying larger loads (or possibly passengers). The trailer can also be used on its own as a small handcart.

A well-designed trailer will minimize the additional loading on the cycle frame. Excessive loads can make the combination unstable, and the cycle's brakes are not likely to be powerful enough for safe control. The hitch must allow the trailer to move relative to the towing vehicle, but at the same time transfer a steady pulling or braking force to it without 'snatching', and be easy to connect and disconnect.

Bicycles and trailers originally proved the viability of the system but these have now been largely superseded by small motorcycles and trailers.



Two-wheeled bicycle trailer

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Bicycle trailer used in Malawi

- Description** - A bicycle trailer consists essentially of a load container with one wheel on either side. The hitch is usually fixed to the bicycle frame above the rear wheel.
- Advantages** - Cheap and simple.
- Disadvantages** - Cannot operate on narrow paths;  
- must be loaded carefully when hitched to the bicycle to prevent tipping.
- Remarks** - A problem common to all conventional two-wheeled trailers is that they are difficult to use on poor roads which have two distinct wheel tracks.

Two-wheeled motor cycle/scooter trailer

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A scooter used to pull a trailer

- Description - The basic arrangement of a motor cycle/scooter trailer is the same as that of a bicycle trailer, although the construction is stronger to accommodate higher speeds and larger loads. Suspension is desirable to minimize the effect of the trailer on the handling of the motor cycle.
- Advantages - Large load capacity.
- Disadvantages - Requires skill to operate safely.

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BASIC MOTOR VEHICLES  
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The term 'basic motor vehicle' is used to describe a range of light goods or passenger vehicles which are less sophisticated than conventional cars, vans or trucks. They are an attractive prospect for manufacturing in developing countries because there is a comparatively low investment required for production facilities and equipment, and because a high proportion of local labour and materials can be incorporated. They are attractive to the user because they are usually less expensive to buy than conventional imported vehicles; spare parts should be easily obtainable; and, with a small engine and straight forward mechanical arrangement, they are relatively cheap to run and easy to maintain. There are two main types of basic motor vehicle three and four-wheeled.

Most three-wheeled basic motor vehicles are based on motor cycle and scooter components. Engine size vary from 50 to 250cc with load capacities up to 500kg.

Four-wheeled motor vehicles are made in many developing countries with the assistance of major international vehicle manufacturers. Many are simply assembled from kits of imported components with few locally made items. Engine sizes are between 1000 and 1600cc and payloads are 500 to 1000kg. Body panels are designed to be formed by simple bending processes.

Three-wheeled basic motor vehicles



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Goods vehicle suitable for rural areas.

Four-wheeled basic motor vehicles



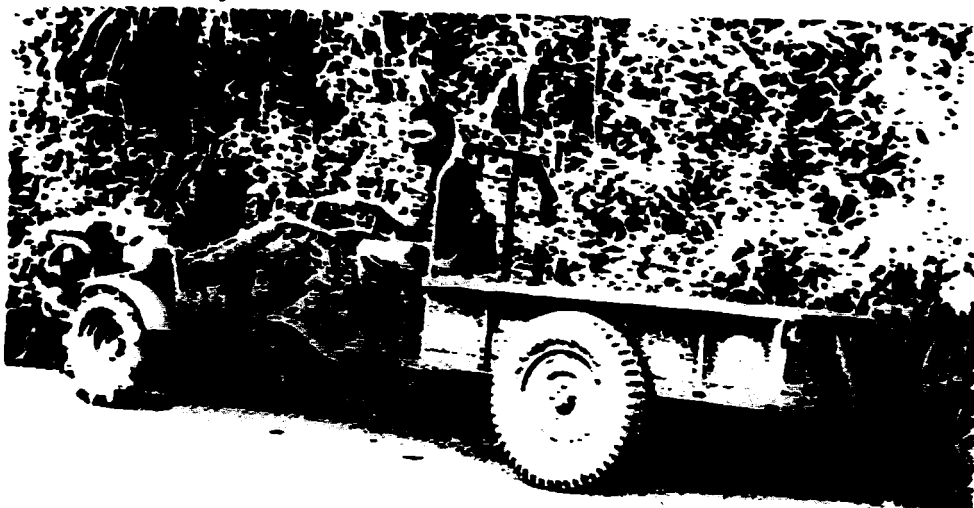
Ford AUV manufactured in Philippines.

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AGRICULTURAL VEHICLES  
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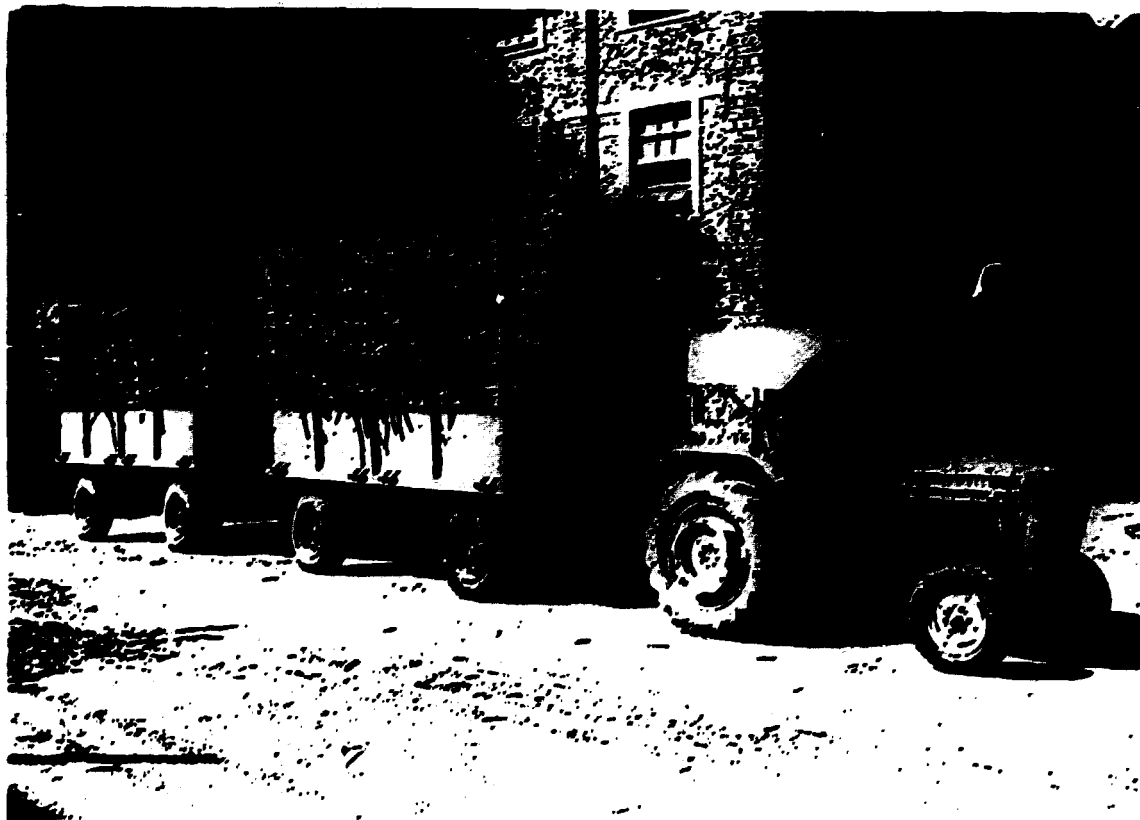
Power sources intended primarily for agricultural activities can often be utilized for transport as well. While such devices may not offer optimum transport performance (because they are not specifically designed for that purpose) they are often attractive to the farmer because they can meet many of his needs without the purchase of a separate vehicle being necessary. This not only saves capital expenditure, but also spreads the fixed cost of owning and operating the equipment over a greater amount of useful work. The dual-purpose nature of agricultural vehicles is all the more useful where the seasonal pattern of agricultural work creates needs for transport and cultivation at different times of the year.

In many countries power tiller are most successfully used for wet land agriculture. Similarly in India four wheel tractors are commonly used by affluent farmers. Power tillers and tractors can be used for transport by adding trailers. They transport both goods and people. There is normally no protection from the weather for the driver or passengers. Although these are not comfortable for transporting people, due to the low operating cost, they are extremely popular with the farmers.

Power tiller and trailer



Four-wheeled tractor and trailer



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OTHER MODES OF TRANSPORT  
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1. Inland Water Systems
2. Trucks
3. Railways
4. Air

Inland water way systems is prevailing in some of the Asian Countries. Railways and Trucks are more often used for long distance transporation of Agricultural Freights.

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**PERFORMANCE CHARACTERISTICS**  
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The following table describes the performance characteristics for the various transport equipments. The figures quoted are a brief summary of what is typical. With such a wide variety of vehicles, circumstances and geographical locations, there will inevitably be considerable local variations.

Vehicle	Relative Cost	Max. load (Kg)	Max. speed (Km/hr)	Max. range (Km)	Route limitations.
Shoulder pole	--	35	5	20	Unlimited
Chee-geh	10	50	5	20	Unlimited
Western wheel barrow	20	100	5	2	Reasonably flat
Chinese wheel barrow	30	200	5	20	Reasonably flat
Handcart	50-150	40	20	60	Reasonably flat wide track
Standard bicycle	50-90	40	20	60	Reasonably flat
Load-carrying Bicycle	60-100	50-200	10-15	30-40	Reasonably flat
Bicycle and trailer	90-150	100	10-15	30-40	Reasonably flat wide track
Bicycle and sidecar	90-150	150-300	10-15	30-40	Reasonably flat wide track
Tricycle	150-200	150-300	10-15	30-40	--- do ---
Pack animal	variable	150-400	5	20	Unlimited



Vehicle	Relative Cost	Max. load (Kg)	Max. speed (Km/hr)	Max. range (Km)	Route limitations.
Animal sledge	10 (sledge only)	200-400	5	20	Reasonably flat wide track
Animal Cart	100-180 (cart only)	500-3000	5	20	Reasonably flat wide track
Motorized bicycle	150-200	50-200	20-30	50	Reasonably flat
Motor cycle	250-600	100-150	40-90	100-200	Steep hills
Motor cycle & sidecar/tricycle	350-800	250-500	30-60	80-150	Moderate hills wide tracks
Motor cycle & trailer	350-800	250	30-50	80-150	Moderate hills wide tracks
Single-axle tractor and trailer	1500	1500	15-20	50	Steep hills wide track
AUV	4000	500-1000	90	200	Steep hills wide track

Relative Cost : No currency is quoted or intended. The figures indicate the order of magnitude of cost in relation to other vehicles in the table. For some of the simpler vehicles significant proportion of the 'cost' to the user may consist of the time needed to make the device, rather than cash outlay.

**Maximum Load and Speed :** Actual loads and speeds would normally be considerably less than these figures, and the maximum speed is unlikely to be achieved when carrying the maximum load.

**Maximum Range :** The figure quoted is an assessment of the maximum distance that is likely to be covered in one journey with a typical load, taking into account the physical effort required. Conflicting factors, such as speed, load, physical ability, terrain, route conditions and intensity of need create particularly wide variations in the distances which vehicles are used to cover.

**Route Limitations :** These descriptions indicate the types of route on which the vehicle can be used.

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DESIGN AND MANUFACTURE  
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In designing products to be manufactured and marketed in the various Asian countries, it is important to take local circumstances into account. Materials and components, which are already available locally should be utilized as far as possible. Further, the design should be capable of being manufactured with the machinery and skills which already exist or which can be obtained easily.

In transferring technologies between countries it will be considerably easier and less expensive to adapt the design to suit the local conditions, rather than attempt to change the customer attitude to suit the design.

In order to achieve successful small scale production it is often important to design by minimizing the number of different types and sizes of materials used to reduce purchasing and inventory costs and to minimize the fixed cost of manufacturing.

Many of the transport equipments required to be developed and manufactured cheaply are adaptations or conversions of other vehicles or components of vehicles which were originally designed for a different purpose.

Instead of making marginal improvements to the existing version of the transport equipment, it will be preferable to design new equipment from first principle. The new vehicle will thus be based on the same concept as the existing one

but the detailed engineering will be different. Such approach would enable the use of local raw materials and components mass produced locally for other application. The investment in manufacture can be minimised and at the same time the equipment can be sold at a competitive price.

Local adaption or modification of standard designs could prove to be sufficiently rewarding to encourage establishment of small scale workshops and repair facilities in the rural areas. This will also generate employment potential in rural areas for local artisans trained in the production, repair and maintenance of the equipment.

An approach similar to that recommended above has been tried in 2 countries viz. the Peoples Republic of China and the Socialist Republic of Vietnam. Both these countries have recognized the limitation of putting sufficient investments into both roads and vehicles to make motorized transport available to a significant proportion of the population with in a reasonable time. The dependence of most people on paths, tracks and traditional vachicles has been accepted.

In China modern large scale plants were created with the specific objective of producing ball bearings, axles, wheel components and pneumatic tyres, to enable local rural manufactures to improve the performance of traditional wheel barrows, hand carts and animal carts.

Similarly the Government of Vietnam attached special importance to the development of non motorized vehicles. They have the advantage of zero fuel consumption, high mobility, simplicity in manufacture and use, infrequent breakdown, low maintenance and repair costs, low investment and high rate of return, and they can be used in different types of terrain without large investments in road construction.

Based on the local requirements, improved designs should be developed in the respective country for local manufacture of tricycles, trailers for bicycle, motor cycles and scooters etc.

Manufacturing of tractors, trucks etc in various Asian countries are in different stages of development. At present most of the countries have already set up heavily protected import-substitution industries.

In due course, however, as manufacturing sectors become more mature each country will become more specialised in its manufacture. Intra-regional trade in manufactured goods should then grow, creating an environment more conducive to regional cooperation.

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APPROACH TO RURAL TRANSPORT DEVELOPMENT  
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It is wrongly believed by many that providing road access to the mass of rural population is the only means by which local level of transport can be improved, however this is not the case. The conventional road transport is only the final link in the whole rural transport system.

For most small farmers, the major transport need is for the efficient means of transporting small loads over relatively short distances. Short distance trips within and around the village or community make up the routine transport movements of rural households. Long distance trips outside the community are much less frequent. Trips for social and welfare activities are a significant proportion of these longer trips made outside the community. The existing of these essential services thus influences the nature of rural transport.

The planning and development of rural transport facilities is currently dominated by the provision of engineered roads. The road element, however, is only one part of the transport system. The majority of rural personal and goods movements do not take place on a road system in the generally accepted sense. The local level of transport system is the other part of the system of which little is known.

It is necessary to have greater emphasis on socio economic factors in transport appraisal and greater efforts to

understand the nature of local level of transport system could be defined so as to result in interventions that will bring about improvements in the level of basic social and economic services of the community and or region. These interventions should be lowcost and sustainable.

Perhaps the most fundamental change required is that footpaths and tracks and simple methods of movements are recognised as legitimate and essential elements of the rural transport system and equally worthy of attention as engineered roads and motor vehicles.

Present policies which emphasize the provision of infrastructure should be broadened to include the possibility of constructing and improving tracks and paths to allow the more efficient operation of low cost transport equipment. Such facilities lend themselves to construction and maintenance by local labour.

Capacity may be created in the rural areas to develop these low-cost modes of transport. It will be necessary therefore to promote the transfer of successful low-cost vehicle technologies even within the same country.

The provision of technical and financial assistance for the local manufacture of efficient low-cost vehicles and of improved traditional devices is an obvious sphere of activity for government and aid agency-sponsored small industry support organizations.

Finally, but of crucial importance in facilitating widespread availability of low-cost vehicles, there is a need to establish innovative credit schemes that provide the modest amounts of finance needed for their purchase, on terms that do not preclude participation by small farmers.



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REFERENCES  
-----

1. 'Appropriate Technology' January, 1983 issue.
2. 'Draught Animal Power' FAO 2 - 6 February, 1981.
3. 'Design of Bicycle Trailers' by Michael Ayre.
4. 'Improvement of farm to market transport services'  
Volume II - Southeast Asian Agency for regional  
transport and communication development study sponsored  
under Swiss Technical Collaboration.
5. 'Improvement Potential of non-motorized transport'  
by ESCAP, Bangkok.
6. 'Low Cost Vehicles' by Gordon Hathway.
7. 'Meeting on National and International Road Transport'  
ESCAP 20-23 November, 1984.
8. 'Rural Transport in Developing Countries'  
by I. Barwell, G.A. Edmonds, J.D.C.F. Howe & J. De Veen.
9. 'Rural Transport Services' by H.L. Beenhakker with  
S. Carpetis, L. Crowther & S. Hertel.