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APPROPRIATE TECHNOLOGY FOR RURAL TRANSPORT

APPROPRIATE TRANSPORT FACILITIES FOR THE RURAL SECTOR IN DEVELOPING COUNTRIES.

Background Paper

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APPROPRIATE TRANSPORT FACILITIES FOR THE RURAL SECTOR IN DEVELOPING COUNTRIES *

by

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* This paper has been prepared under the supervision of ILO.

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SUMMARY

This Report is concerned with the provision of appropriate transport facilities in the rural areas of developing countries. It is argued that the technologies applied in the past have been inappropriate to, and ineffective in meeting, the transport needs of their poorest people. Further there are alternative and more appropriate transport technologies which can better meet many of these needs. Past transport has been dominated by an institutional preoccupation with the provision of roads suitable for conventional motor vehicles. The supply of those vehicles has been left largely to the private sector and their technological appropriateness unquestioned to the extent that the type of vehicle is not a variable in road design. The result has been high road construction costs, slow network development, and the neglect of the movement needs of small scale farmers and of traditional forms of transport.

An essential element of any strategy for improving the transport capabilities of rural populations must be to provide a graduated choice of vehicles whose performance matches need and whose cost is in sensible relation to income. A range of *basic vehicles* is described - from aids to goods movement by man through to cheap motorised forms of transport - whose technology is shown to be more appropriate to the needs of many rural developing communities. The present status of basic vehicles is that much good technology already exists and which could be widely applied, but whose use is at present very localised. Where information on such technologies exists it is obscure, uncollated and unknown to those who could make use of it. Other basic vehicles remain technically primitive, but their efficiency could be radically improved using existing technology.

It is recognised that the ideas outlined in this report do not, as yet, enjoy wide currency and the application of more appropriate transport technology will require major changes in policy. The most fundamental change required in policy is to ensure that rural transport planning explicitly includes an appraisal of the needs of the small farmer and the constraints within which his choice must be made. The implication is that the most appropriate type of vehicle, and the "track" it requires, will be issued to be decided by local circumstances rather than to be externally imposed by the assumed use of conventional motor vehicles.

Throughout the report various actions to promote more appropriate rural transport are identified. These are summarised into three categories: information; research and development; and production and marketing.

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"They must be cheap enough for jobs to be provided in very large numbers and simple enough to be used and maintained by rural and small town populations without sophisticated technical or organisational skills and with very low incomes. It follows that equipment of this kind will have to be provided largely from indigenous resources and employed largely to meet local needs".

E.F. Schumacher (defining Intermediate Technologies).

1. INTRODUCTION

It isincreasingly being recognised that much of the technology applied to the problems of developing countries has been inappropriate, and that there are alternative strategies which better meet the needs of these nations. The purpose of this paper is to present the growing body of evidence which affirms:

i) that the technologies applied in the past have been inappropriate to, and ineffective in meeting many of the *transport* needs of the rural sector; and

ii) that there are alternative and more appropriate *transport* technologies which can better meet many of these needs.

The figures between brackets in the text refer to the works listed in the references.

The approach is first to define in general terms criteria for an appropriate technology. It will be evident that to apply these in any practical way it is necessary to specify the characteristics of the recipients of that technology. Thus, a large and important segment of developing countries - the rural poor - is characterised and used to show, in conjunction with a discussion of their movement needs and an outline of the traditional approach to the provision of rural transport for developing societies, why past policies are increasingly regarded as inappropriate. Consideration is then given to what alternative transport technologies could be adopted and the actions necessary for them to be implemented.

Discusssion is limited to road transport since this is the most important means of movement in rural developing societies. In a few countries water transport plays a major role but, with notable exceptions, both it and the railways are in decline relative to road transport.

1.1 Appropriate technology

The choice of technologies is one of the most important collective decisions facing a developing country. It is a choice which affects the whole pattern of income distribution and the fabric of the economic and social structure. It determines who works and who does not; where work is done, and therefore the urban/rural balance; what is produced; and for whose benefit resources are used. Thus the choice of technologies is, or should be, a consequence of the development objectives and priorities of the country.

In developing countries there is a need for technologies which are appropriate to rural conditions, since this is where the large majority of the population live, and which suit the mix of resourses locally available.

The criteria necessary for a technology to be considered 'appropriate' for developing countries are contained within the quotation at the start of this paper. Most other attempts to define 'appropriate technology' agree broadly with these: the obvious, but difficult to identify, necessity of meeting 'local needs' and the requirements that it be employment generating, compatible with incomes, and capable of manufacture and maintenance using indigenous skills and resources. Clearly to apply these in practice it is necessary to define the nature of the population being considered since by definition the very concept of appropriate only has meaning in local terms. We do this in terms of the rural poor, in order to identify the discussion of appropriate facilities with those people in developing countries towards whom a major development effort should be directed. However strict the definition used, the least privileged represent a *very substantial* proportion of the population of developing countries, and are not a distinct and separate disadvantaged minority, but the less fortunate of a wider majority of the rural population whose conditions of life are not radically better.

1.2 Characteristics of the rural poor

As the ILO have noted "it is very difficult to determine just how many people in the developing countries are poor" (1). It is even more difficult to describe the characteristics of that poverty in factual terms as the problem is complicated by differences in basic definitions and the years for which

estimates are made, but it must be attempted if the discussion of appropriate transport technology is to progress beyond the qualitative.

The number of persons suffering the most extreme poverty and subject to severe malnutrition has been estimated at about 700 million[1] Of these, 71 per cent are in Asia, 19 per cent in Africa and the remaining 10 per cent in Latin America. The poverty line of the destitute is estimated (1975) to be equivalent to an annual income *per head* of US $50 in Asia, US $59 in Africa and US $90 in Latin America (the equivalent figure for Western Europe is US $250).[2] (1) The majority of those suffering extreme poverty live in rural areas. Of the total number of destitute the proportions living in rural areas are 78, 78 and 40 per cent for Asia, Africa and Latin America respectively. (4) The most difficult circumstances are those in which extensive rural poverty is combined with low levels of natural resources. Countries in this situation include all the South Asian nations, those of the Sahelian region, many of the larger African countries such as Ethiopia, Sudan and the United Republic of Tanzania, and a few Latin American and Caribbean countries like Bolivia and Haiti.

The figures quoted above give a clear indication of the magnitude of the problem of poverty in the world. However, the most important and disturbing fact is that the *number* of

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1 These figures have been derived from ILO and World Bank sources (1) (2).

2 These are highly generalised figures and individual rural income surveys. (e.g. ILO surveys in Kenya: 1972) have indicated conditions worse than this. In Kenya there were some 600,000 households at the subsistence level with an annual *household* income of US $50 or less i.e. approximately US $8 per head. (3)

impoverished *has increased steadily* in the last two decades *and it is expected that it will continue to do so*(1).

Agriculture is the principal occupation for an estimated four-fifths of the rural poor who are usually small-scale farmers, tenants, sharecroppers, landless workers and their families. According to the 1960 World Census of Agriculture (5) there were 80 million small holdings of less than two hectares many of them comprising several small fragments of land. Table 1.1 shows the distribution of holdings of 1 hectare or more in size in different regions of the world. Obviously, this is not a complete coverage, since it excludes holdings of less than 1 hectare.[1] However, it does provide an insight into the patterns of distribution of holdings within the major regions.

TABLE 1.1 : Distribution of holdings by size and area

	1 - 5 hectares		5 - 50 hecatares		50 hectares or more	
	% holdings	% area	% holdings	% area	% holdings	% area
Asia	78.2	40.7	21.6	50.2	0.2	9.1
Africa		50+[2]				
South America	36.4	1.0	45.5	8.5	17.8	90.5
Europe	50.0	13.0	47.4	52.3	2.4	34.7
North and Central America	23.4	0.5	39.4	8.0	37.2	91.5
Oceania	5.5	-	27.7	0.5	66.0	99.5

Source: FAO Report on the 1960 World Census of Agriculture.

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[1] Current estimates suggest some 50 million small holdings of less then 1 hectare. (6)

[2] This is an estimated figure to allow for a bias in the original source data which was heavily oriented towards European holdings (6).

The analysis indicates the importance of small-scale agriculture in Asia and Africa, both in terms of the number of holdings under 5 hectares and the total area of land which they occupy. A recent survey by ESCAP has indicated that 88 per cent of the holdings in Asia are estimated to be less than 5 hectares and nearly 46 per cent belong to the predominant class of under 1 hectare. (7)

Incomes at the farm level are determined by a host of factors that include the quantity and quality of inputs such as land, labour and water, the technology used, the prices received for outputs, and the prices paid for inputs. Thus, an irrigated farm of one hectare using high-yielding varieties of rice and fertilizer can generate at least double the income of the same area farmed by traditional methods. One hectare devoted to tea can yield an income seven times as great as when it is used for maize. However, studies show that most of the small

holdings in Asia, Africa and Latin America are used for traditional low-yielding subsistence production. These studies also indicate that very few farms of less than two hectares of arable land, producing traditional crops, generate income above the poverty line of the destitute. (8)

The statistics quoted so far conceal very considerable differences among individual countries and regions of countries. Some of the more obvious differences are in population densities, land tenure relationships, social customs and attitudes, but their effect on rural poverty is often contrary to popular expectation. For example, the rural poor are found in roughly equal proportions in densely populated zones (over 300 persons per square kilometre) and sparsely populated zones (less than 150 persons per square kilometre). Thus, poverty is found in the highly productive irrigated areas of Asia, as well as in the adverse conditions of the Sahel, north-east Brazil, the Andean Altiplano and the dry zones of India.

characteristic attitude of the rural poor is an understandable reluctance to make any change that involves risk. A recent study in Nepal listed among the dominant reasons for the non-response by peasant farmers to new

opportunities provided by improved communications the scarcity of resources under current farming technology. "There is little slack in terms of land, animal-power, local manure and even labour at peak periods which can be utilised to introduce new production. Innovations compete for the same resources as those utilised by low productivity subsistence food production" (9) (i.e. there is an inherent and well founded inertia to change based on the needs of survival). The converse of this was that "the new opportunities were taken up predominantly by the already advantaged, and particularly by those successful in business and with capital to invest".

All the evidence implies that the transport facilities available to the rural poor are few and primitive. There are large numbers of people living far from the motor vehicle road system much of whose travel takes place on earth tracks and footpaths, and who are largely dependent upon human and animal powered means of transport. The evidence for, and implications of, these statements will be discussed subsequently.

Whilst there have been few precise studies of the problem, the effects of inadequate coverage of health and education facilities among the rural poor (10) are exacerbated by poor communications.

In summary the available evidence suggests that:-

- the number of rural poor is significant in absolute terms and increasing
- their standard of life is static at best or declining
- they are generally engaged in agriculture working small plots of land either for themselves or as landless workers

- most are engaged in subsistence farming or generate only small marketable surpluses
- family cash income is unlikely to exceed more than a few tens of dollars a year
- they are mostly located in areas poorly served by almost all public amenities including transport
- among the rural poor there is generally considerable resistance to any change which involves financial risk.

It is against this background that discussion of appropriate transport facilities for rural communities must be conducted. First, it is necessary to attempt to define the transport needs of the rural poor.

2. TRANSPORT NEEDS OF THE RURAL POOR

Whilst 'public transport' is listed by the ILO as one of man's 'basic needs' (1), its importance is not something which can be grasped as readily as his need for food, water, shelter and clothing. The need[1] for transport has no absolute meaning but rather it arises from man's other needs *and the activities he has to engage in to satisfy them:* to fetch water from the river, harvest from the field and wood from the forest. In those terms transport is a *derived need.* The type and intensity of transport needed being dictated by the type and intensity of other needs.

2.1 Basic needs and development strategy

It seems reasonable to assume a continuing and increasing emphasis in rural development strategy on the satisfaction of 'basic needs' which comprise two elements. "First, they include certain minimum requirements of a family for private consumption: adequate food, shelter and clothing, as well as certain household equipment and furniture. Second, they include essential services *provided by and for the community at large,* such as safe drinking water, sanitation, public transport and health, educational and cultural facilities". (1). It is clear that the world's major development agencies are relying on an increase in the agricultural productivity, and thus income, of the rural poor as the prime means of satisfying the first of these elements and are adapting their

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[1]We are concerned in this discussion with fundamental movement needs and not simply apparent demands: in this context it is important to distinguish between travel desires which are visible and can be measured (*demands*) and those which are not evident (*latent demands* or *unfulfilled* needs) perhaps because potential users do not perceive the possibility of transport suitable to their circumstances.

policies accordingly.[1] The services included in the second element are fundamentally different in that they are, as stated, traditionally provided and administered on a community basis, usually by government. It is therefore, conceptually at least, much easier to implement changes in policy and to assess the consequences of doing so, including any necessary transport changes, since we are dealing with centrally planned and financed events, rather than mere stimuli to individual change. They are also fundamentally different in that they are services brought to the people. As far as the individual is concerned where these services are not conveniently located they must either be dispensed with altogether (sanitation, safe water, etc.), carried to the home (water) or he must transport himself or his family to them (health, education). Thus, to a considerable extent, the transport requirements generated by the secondary basic needs are dependent upon the ability of government to provide the services, and are outside the control of the individual. Without some statistical evidence on the differences between the current and desirable distribution of secondary basic needs or knowledge of the various strategies proposed for reducing these differences, no meaningful discussion of the related transport needs is possible.

However, the most significant transport needs as far as the rural poor are concerned are those which relate to agricultural activities, since it is through the generation of marketable surpluses (and thus income) that other goods and services become affordable. It is possible to discuss the agricultural transport needs of the rural poor in a meaningful way and these can conveniently be divided into two categories: on-farm and off-farm.

[1] The case for this as the major prospect for improving the worsening employment situation in developing countries was authoritatively stated by the OECD in 1971 (2) : see also the recent statement of the World Bank (3).

2.2 On-farm transport

In most developing countries the small farmer's dwelling and storage facilities are located away from his land holding, which often consists of a number of separate plots. On-farm transport is required for a variety of tasks related to crop production and household needs. Movement of seeds or plants, fodder, fertilizer, insecticides, agricultural implements and other inputs, as well as movement of harvested crops, is required each season as a part of normal farming operations; also, firewood and water must be gathered from areas surrounding the farm for household and crop production use. The FAO has in fact stated that "the farmer is above all a carrier" (4), and a survey in Malaysia which showed that something of the order of 70 per cent of agricultural activity involved transport (5), supports this view. Somewhat surprisingly, however, on-farm transport needs have been almost totally neglected by those concerned with the planning of transport systems to the extent that we know very little about them.[1] One of the few known studies was carried out in Kenya by the World Bank in 1976 from which the results in Table 2.1 were obtained (6) (7).

It is clear that many of the results are based on judgement rather than statistically reliable surveys. However, they confirm, as expected, that most transport needs can be characterised as the movement of relatively small loads (15-150kg units) over relatively small distances (1-13km).

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[1] The underestimation of the importance of transport to the farmer is not a situation peculiar to developing countries. A study in the U.K. of transport requirements in agriculture has led a British company to develop a tractor better suited to transporting, because tractors spend so much of their time performing this function.

TABLE 2.1 : On-farm transport requirements of small farmers in Kenya

Group Involved	Trip Purpose	Frequency	Load	Distance	Conditions
all small farmers	on-farm transport connected with subsistence: transport of food products from plot to dwelling	daily	very small	very short	off-road
all small farmers above subsistence level	on-farm transport connected with commercial farming: transport of products and inputs from fields to storage area	follows agricultural schedule; varies with crops	depends on yields, increases with acreage under cultivation or grazing: (15-150 kg)	increases with acreage: 1 - 2 km	off-road
all small farmers	gathering of water and fuel from areas near farm	probably daily	50 kg water and 30 kg firewood	depends on available supplies: 2-13 km quoted	primarily off-road

Source : World Bank: Investigative Survey on Appropriate Transport and Farm Mechanisation Systems for Small Farmers in Kenya: 1976.

The amounts of water and wood required for household use are noteworthy (50 and 30kg respectively), since it was estimated that their collection occupied between 3-6 hours per day. The latter figures are significant for a number of reasons. Firstly, the transport of water and wood is normally carried out by the women, and to a lesser extent children.
In Africa, women are estimated to form 60-70 per cent of the agricultural labour force (8) responsible for clearing, preparation, planting and weeding, in addition to being involved in harvesting. Clearly, the more time spent on the essential household tasks the less can be devoted to proper farm husbandry. This problem can be exacerbated by attempts at agricultural development, as exemplified in the following quote (8). "Little or no progress has been made in making the tasks of women less burdensome and more productive. In fact, modern equipment which has been introduced has, almost invariably, been aimed at men and resulted in more, rather than less, work for the women. For example, partial mechanization helps the men to clear larger areas of land with less effort, but the women are left to weed and harvest the enlarged area with traditional implements".

Another reason why time spent on the transport of water and wood is significant is that it intensifies the effects of seasonal shortages of labour. In Malawi, as in many countries, there are peak labour requirements at certain times of the year, particularly at harvest time. A study has shown that there are often labour deficits at this time, which probably means that some of the crop is harvested late (and is therefore of lower value) or is lost completely. "In the worst situation, the farmer will have to spend about six days on crop transport from the garden to the household. With head porterage as the main transport method, transporting accounts for a large

proportion of the total harvesting labour requirements". (9)

Since in general the farmer must follow a fairly rigid schedule to obtain desired yields, it is important that on-farm transport needed for crop production *and* household needs should not be so time-consuming as to delay important operations. For example, if some crops are not sprayed on time the results may be disastrous. The spraying of cotton with insecticide to prevent disease and loss of crop requires about 200-300 litres of water/hectare under cultivation. For a four hectare plot this is 800-1200 litres and between 7-10 sprayings are normally recommended, i.e. between 6-12 tonnes of water, a formidable amount if headloading is the only available means of transport (6).

It is reasonably clear that on-farm transport requirements are already burdensome if not an outright constraint on small farm activities. For these reasons alone efforts *should* be made to provide more effective means of transport. However, if efforts to increase agricultural productivity - with increased requirements for seeds, agricultural implements, fertilisers, pesticides, water, etc- are to be successful then improvements to on-farm transport *must* be made. The World Bank study in Kenya found that although traditional methods of transport such as headloading and donkey had in some areas been adequate in the past for on-farm transport, introduction of new inputs and high-yielding seed varieties was beginning to strain the available transport capacity. (6).

2.3 Off-farm transport

'Off-farm' transport is conventionally understood to mean movements between farm and market. However, it has already been noted in the previous section that many small farmers live remote from the motor vehicle road system, Therefore, more precisely, 'off-farm' transport comprises

two elements: between farm and roadside, and between roadside and collection point/market.[1]

Few of the many studies of peasant farming systems have been oriented towards understanding the nature of their transport demands *using the farm as the study unit*. Roadside surveys of the commodities carried by motor vehicles, whilst relatively common, are a poor substitute since (i) they are too far along the marketing chain to be able to isolate individual consignments and the distance over which they are being moved, and (ii) none of the studies have been sufficiently extensive as to give any adequate measure of seasonal fluctuations in travel demands.

Manifestly the farmer needs prompt, cheap and secure means of obtaining the necessary inputs, such as seeds and fertiliser, and the same type of service for marketing surpluses. However, in order to quantify this general statement we need to know more about the magnitude, frequency and duration of the small farmer's movement needs. Clearly these will depend upon many factors including farm size, farming system, crops grown and accessibility of markets.

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[1] An example of how large these elements can be in difficult terrain poorly served by roads is given by the definition in a study of Nepalese peasant agriculture (10) of the terms 'on road' to mean at the roadside or within a few hundred metres, 'near road' to mean up to half a day's walk from the road, and 'off-road' to mean more than half a day's walk.

Table 2.2 gives details of the movement demands of small farmers in Kenya and identifies the different off-farm transport activities (6). The range of loads is much the same as for on-farm movements (15-150 kg) but, as would be expected, the typical distances are longer (1-25 km). Its limitation is that it is concerned only with present demands and does not identify situations where the farmer's ability to improve his conditions is constrained by (amongst other things) lack of suitable transport facilities. In order to obtain a better understanding of the transport needs of the rural farmer we consider the limited evidence concerning three inter-related 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?

2.3.1 Quantity of goods to be moved

It does not necessarily follow that because a farmer is operating at or below the subsistence level he does not market any of his produce. Surveys in Bangladesh (11) showed that farmers with holdings of less than 1.6ha market on average 300kg of paddy each year (out of a harvest of 1,700kg). During the course of the year they also purchase (in the form of paddy and rice) the equivalent of 430kg of paddy. Thus although their paddy production is below subsistence level, they market a part of their crop. The reasons for this are first the need to raise cash after the harvest in order to repay debts, and second because, even if they had the capital to hold stock they lack storage facilities.

Taking into account paddy marketed (300kg), paddy and rice purchase (360kg) and fertiliser purchased (200kg) these small subsistence farmers need to move nearly a ton of agricultural goods each year. However, their transport needs could change

TABLE 2.2 : Off-farm transport requirements of small farmers in Kenya

Group Involved	Trip Purpose	Frequency	Load	Distance	Conditions
all small farmers above subsistence level	Trips to local market: transport of surplus products from farm to market and purchased products back from market to farm	daily, twice a week or weekly; depending on market schedule	depends on yield, acreage, transport, capacity: 15-150 kg.	up to 25km: average 5-15 km	part off-road, part on-roa
all small farmers producing cotton, coffee, tea or pyrethrum	Transport of cash crops to collection points, depots or buying centres	depends on harvesting schedule, perishability of product	depends on yields, acreage, transport capacity	5-10 km average	part off-road, part on-road
all small farmers producing milk, maize and food crops not sold at farmgate	Transport of surplus food products to collection points, depots, or cooling centres	depends on harvesting schedule, perishability of product; daily for milk	depends on yield; acreage transport capacity	5-25 km average	part off-road, part on-road
all small farmers using purchased inputs such as fertilizers, chemicals, special seeds	Transport of inputs from buying centre or stores	follows agricultural schedule; varies with crops	increases with acreage; minimum 50 kg bag	5-25 km average	part off-road, part on-road
most small farmers	Trips to major towns for special goods or services	probably once a month on average	usually small: 30 kg	up to 50 km	primarily on-road

Source: World Bank: Investigative Survey on Appropriate Transport and Farm Mechanisation Systems for Small Farmers in Kenya: 1976.

significantly as a result of improvements such as elimination of indebtedness or provision of storage. It is also worth noting that these farmers need to move a substantial quantity of fertiliser (in another area surveyed fertiliser usage by small farmers was 25% higher than that quoted previously).

Where farmers are engaged in the production of cash crops the transport requirements can be substantial, even when only small areas are planted. Table 2.3 presents data from Malawi on the yields and inputs per hectare for different crops (9). The yields represent the weight of produce to be transported to market assuming that none is retained for family consumption and that initial processing of the crop is carried out prior to marketing.

TABLE 2.3 : Quantities to be transported (kg/hectare) for different crops in Malawi

Item	Maize	Tobacco	Groundnuts	Cotton	Rice		Coffee	Pulses
					Rainfed	Paddy		
Inputs								
Seeds	45		80	30	65			35
Fertiliser	250	250			620	400		
Yield								
Av.	1009	560	449	1120	1234	3362	335	449
Best	2804	2241	963	1881	3362	4708	1007	560

Improvements in agricultural practices can significantly increase quantities of goods to be transported. In South-East Asia introduction of a new rice variety increased yields by 5 tonnes/hectare (12). Thus, assuming that three quarters of this increase was marketed, a farmer growing 2 hectares of paddy would have 7½ tonnes of additional produce to move to market. This does not take account of the additional fertiliser needed to produce the increased yield.

2.3.2 Frequency and timing of movement needs

The above discussion was concerned with the aggregate quantity of goods to be moved. Of equal importance is the quantity to be moved on a single journey, which is obviously dependent upon the desired frequency of movement. It can be misleading to look for evidence of these needs in terms of current frequency of visits, and loads carried, to market since this pattern may be dictated by reliance on headloading,[1] which limits the load.

A major factor in determining the frequency and timing of the marketing of produce is the perishability of the crop. Certain crops need to be consumed soon after harvesting. For example, pineapples grown in certain parts of Bangladesh have to be at the point of consumption (usually the major cities of that country) within two days of harvesting (11). Thus the farmer has to get his crop to the point of sale within a few hours of harvesting. Certain agricultural products require specialised storage facilities which the individual small farmer is unlikely to be able to provide. For example, milk has to reach a cooler very quickly. In parts of Kenya where there is surplus milk production only the morning yield is marketed, the evening yield being used for home consumption, feed for calves, or wasted because there is no evening collection (7). Thus, for perishable crops the farmer needs prompt transport on a regular basis, either for the duration of the harvesting period or throughout the year, dependent on the type of produce.

However, for durable crops there are often advantages in

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[1] It is suggested (6) that this is often the case in Kenya.

not marketing immediately after harvest since at this time there is a glut of produce and prices are at their lowest. If the crop can be stored and marketed over a period of months a better price can be obtained.

In the example quoted previously from Bangladesh the small farmer sells paddy immediately after harvest and buys at other times of the year and therefore "sells at times of surplus and low price, and buys at times of shortage and high price".

The need for farm inputs is tied to the agricultural schedule. The correct timing of inputs often fundamentally affects yields.

2.3.3 Distance moved

In the Malawi survey the average distance which crops were transported to market was 6.5km (9). In Kenya it was estimated at 5-15km, though distances were thought to be greater in areas of lower potential or low population density (6).

However, there is evidence[1] to suggest that, because of limited availability of transport facilities, some small farmers have no option but to trade at the nearest market, and that if they had the means of travelling to more distant markets, they could obtain higher prices for their produce. For example, in

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[1] "In the absence of modern transport facilities which have reached only a small fraction of the cultivating class in Rajasthan, most of the peasants at harvest time have hardly any option but to offer their produce to the local merchants on such terms at the latter may dictate" (13).

Bangladesh "...a lack of vehicles....ties the small farmer to the local primary hats (markets) where he is in the hands of a very limited number of traders and receives a low price for his paddy". (11).

Inevitably the discussion of transport needs above is limited by the nature of the data available. However, some further insight can be gained by considering the *responses* to those needs open to the small farmer, and how these might be influenced. Hypothetically the small farmer is faced with four means by which he can respond to the need to transport farm inputs and outputs. These means are descriptively separate but in practice two or more may be combined to effect a particular movement. Also it is evident that to many farmers they are not 'options' or 'choices' since in most instances the decision as to which to employ is dictated by circumstances. The means are:-

i) Personal transport by the farmer, using his own means of transport.

ii) Hire of space on a bus, truck or pick-up, with the farmer usually accompanying his goods.

iii) Sale to or purchase from itinerant traders.

iv) Participation in a co-operative or marketing organisation which arranges collection and delivery of goods.

2.3.4 Personal transport

There is little doubt that, where personal transport is a feasible option it is preferred. The desire for personal means of transport is evident in the sacrifices people make world-wide in order to obtain cars, motorcycles and bicycles. At the farmer level it ensures control and

availability of transport as and when it is needed so that crops can be marketed on time, and with security from pilferage, deterioration due to delays, and loss of income through having to sell at dictated prices.

However, at present the only form of personal transport available to many small farmers is head or back loading. This form of transport is both slow and arduous and the carrying capacity is limited. This dictates that journeys should be short and loads small. Furthermore, this form of transport is very time consuming, which limits its availability at times of peak agricultural activity.

2.3.5 Transport by bus, truck or pick-up

In areas where motor vehicles are available they are widely used. However, they are dependent upon the existence of a system of roads, and of commercial vehicles operating for hire on these routes. (In practice journeys by these means also involve personal transport between farm and roadside). Availability of transport is lower than if the farmer uses his own means.

The cost to the farmer of these transport services can vary widely. Charges are often settled by negotiation and depend on (a) the weight of goods (b) the space occupied and (c) the competition for business on the particular route. The transport charge to the farmer will often be very different from the cost to the operator. In Kenya, charges on rural buses and matatus[1] range from 1-80 Kenya

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[1] share-taxis

shillings/tonne km and "for short distance trips which, for most smallholders must be considered the norm, charges can exceed costs by a factor of ten or more if bus, matatu or ox-cart is used" (7). The Kenyan study concluded that "for journeys from the roadside to market, whole hire matatu or pick-up transport is probably the most expensive form of transport for the smallholder."

2.3.6 Farm-gate trade with itinerant merchants

In dealing with itinerant merchants the farmer delegates responsibility for transport. However, because of the generally poor roads traders are not always willing to operate in the more distant and remote locations.

The selling of produce in this way is often linked to credit advances by the trader, who is likely to be literate, businesswise, able to move and sell goods in bulk and to obtain the best price for produce. However, where the farmer is dependent on the trader for marketing, the trader can dictate terms and depress the price which the farmer receives. In Kenya, "there are many reports that prices offered by traders are extremely low and many smallholders would like to seek alternative market outlets, but have no transport alternatives". (6).

In one area of Bangladesh most paddy sales are at the farm-gate to non-local traders who provide a cash advance to the farmer prior to harvest and hand over the remainder of the agreed payment on receipt of an agreed amount of paddy. "Therefore the contract involves two elements, one an ordinary sale and the other a loan by the trader to the farmer. The interest on this loan is represented by the lower than market price

accepted by the farmer for the sale of his paddy. The rates of interest being charged for these loans were apparently extremely high" (equivalent to an annual rate of interest of up to 400 per cent (11).

2.3.7 Marketing and co-operative services

The ILO World Employment Conference, in considering policies for the achievement of basic needs, recommended the promotion and extension of co-operatives in the fields of transportation, storage, marketing and distribution, processing and services generally, and that these co-operatives should be implemented so as to involve the lowest income groups through their own organisations. (1).

Whether organised by government or independent farmer groups, marketing and co-operative services offer in principle significant advantages. They remove from the farmer the individual burden of storage, transport and marketing while giving him a share in an organisation with credit worthiness and the resources to purchase, collect, store and market in bulk, and offer him a secure price for his produce without the fear of exploitation by merchants.

Organised services concerned with exported cash crops have proved quite successful, their function usually being limited to the procurement for further processing or export of crops at prices fixed by marketing boards. However, the record of co-operatives concerned with domestic crops is poor, so much so that Lele (14) questions whether they can be successful even in the long run.

Co-operatives concerned with domestic food crops must compete with the private traders in their ability to speculate and operate at low costs in highly fragmented markets. They require organisation, leadership and entrepreneurial skills. Farmer co-operatives tend to lack personnel with the necessary educational standards, management and business skills, and to be short of financial resources. Government organised schemes can generally employ highly educated people, but they tend to be short of practical trading skills and experience, and lack incentive because there is no personal financial involvement.

From the small farmer's point of view, the private trader has advantages because he will pay cash on receipt of the crop and in some cases provide credit advances. When the farmer sells his crops through a co-operative or trading organisation there is frequently a delay before he is paid. For example, in Nepal farmers supplying sugar cane to a mill are presented with a receipt promising payment at a fixed price *within three years*. (10) Payment is usually made before the end of the stipulated period but delays of one year or more have occurred.

There is also evidence that co-operatives do not necessarily benefit the poorest. Lele, reviewing African evidence, states that "where traditional authority and power are unequally distributed, co-operatives become an instrument in the hands of the few relatively large farmers and provide little assistance to subsistence farmers". (14)

Finally, the existence of a co-operative does not necessarily imply collection from the farm-gate. Farmers often have to transport their produce a considerable distance to a collection point.

Thus it is hard to disagree with Lele's conclusion that "the performance of both the formally administered marketing components and the co-operatives suggests that a simple transplant of modern marketing organisations into the traditional sector is unlikely to be viable".(14).

2.4 Summary of transport needs

The previous discussion shows that:

- although it is not an intrinsic need, the availability of appropriate transport facilities is necessary if other basic needs are to be met
- the most important transport needs for the rural poor are those relating to agricultural activities; these needs can be divided into two categories: on-farm and off-farm
- on-farm transport needs have been totally neglected by transport planners yet they are already a burden if not an outright constraint on small farm activities
- even subsistence farmers may need to market substantial amounts of produce: small plots of 1-2 hectares are capable of generating transport demands of several tons
- the cost and scarcity of hired motor vehicles, the poor terms offered by itinerant traders and the relative lack of success of organised marketing services indicates the need for transport that is under the control of the small farmer
- the transport available to the farmer should not be so

slow, burdensome and time-consuming as to limit the amount carried and the distance that can be moved because of the effort or time involved.

The next section analyses trends in the provision of rural transport over the past few decades and considers the consequences of these for the movement needs of the rural poor.

3. TRENDS IN RURAL TRANSPORT

3.1 Transport trends

A major feature of investment in developing countries since the Second World War has been the importance accredited to transport. The figures in Table 3.1 show that transport has accounted for almost one quarter of IBRD loans and one fifth of IDA credit, ranking first and second in their respective lending operations. This emphasis has been reflected in the allocation of public funds by the developing countries themselves as is apparent from Table 3.2. For most countries transport is the largest single sector for investment and for all countries it ranks in the first two most important sectors. Recent figures suggest that both the IBRD and IDA might be reducing the funds allocated to transport with a proportionate increase in those for agriculture and rural development, but this is not certain since information is only available for the major purpose for which finance is provided and many projects include activity in more than one sector.

The figures in Table 3.3 show that in the transport sector it is highways that have dominated investments accounting for approximately a half of all loans and credits. Again priority for investments by international aid agencies has been reflected and endorsed by the developing countries, as is apparent from the figures in Table 3.4 where investment in highways is dominant. Indeed in nearly all developing countries the most noticeable transport development of the past three decades has been the growth of motor transport and the construction of roads.

TABLE 3.1 : Approved IBRD and IDA cumulative lending operations (to June 30, 1977)

Sector	Bank Loans US $ millions	%	IDA Credits US $ millions	%
Agriculture & Rural Development	6780	17.6	3644	32.0
Development Finance Companies	4012	10.4	302	2.7
Education	1224	3.2	648	5.7
Electric Power	8455	21.9	949	8.3
Industry	3653	9.4	495	4.3
Non-Project	1855	4.8	2011	17.6
Population	120	0.3	76	0.7
Technical Assistance	31	0.1	55	0.5
Telecommunications	934	2.4	470	4.1
Tourism	247	0.6	40	0.4
TRANSPORTATION	9588	24.8	2251	19.7
Urban Development	368	1.0	128	1.1
Water Supply and Sewerage	1344	3.5	329	2.9

Source : WORLD BANK Annual Report 1977

TABLE 3.2 : Planned public sector investments (%)

	Barbados + 1973 - 77	Botswana + 1973 - 78	India 1974 - 78	Kenya + 1974 - 78	Malawi 1971 - 80	Nigeria 1975 - 80	Pakistan 1970 - 75	Philippines 1971 - 74
Agriculture	5.4	7.7	20.1	22.2	19.3	6.5	13.7	21.7
Natural Resources		4.2		1.8				
Mining			24.0			7.0	1.2	
Industry	6.1	5.6		3.0		19.0	9.0	
Commerce	1.2		0.8					
Tourism	0.7			2.9				
TRANSPORT	28.6	26.2	19.2	40.6	34.8	27.5	16.1	57.5
Power		35.4	16.3		7.5	5.0	11.9	9.7
Water	8.4		2.8		3.7		20.7	
Housing	18.9		1.6	5.9	4.0		7.7	3.3
Construction	4.7		0.1	2.2	13.4			
Education	15.0	9.4	4.6	3.2	5.3	7.5	7.6	3.4
Health	1.8	3.9	4.6	4.9	5.3	2.0	6.4	1.9
Social Services	0.4		2.0					
Public Administration	4.0	7.8	0.3	5.8		15.0		
Economic Services				5.8				
Urban Development			1.5					
Rural Development								
Other	4.8		2.1	1.7	6.7	10.5	5.7	2.5

Source : Various Development Plans + Government Ministries Only

Contd.....

TABLE 3.2 : Planned public sector investments (%)

	Senegal 1973 - 77	Sierra Leone 1973 - 78	Sri Lanka 1972 - 76	Sudan 1970 - 75	Tanzania 1969 - 74	Thailand 1972 - 76	Uganda 1971 - 75	Zambia 1972 - 76
Agriculture	21.0	25.6	26.0	38.3	10.5	13.7	22.2	9.6
Natural Resources	6.0							
Mining		3.8			0.1	1.5	11.1	3.2
Industry	2.0	7.2	19.0	13.2	13.4			8.4
Commerce	3.4	0.7			1.3	0.9	1.7	3.5
Tourism	9.0	0.9			4.4		1.6	1.2
TRANSPORT	17.5	21.3	25.0	14.8	28.9	19.5	28.2	29.7
Power	4.9	12.5	10.0	6.4	7.8	7.9		15.6
Water	7.8	1.7		6.5	4.1		5.2	
Housing		2.5	3.1		6.8		1.2	11.5
Construction		0.4	0.9					
Education	8.0	4.9	8.4	7.3	7.0	32.8	8.1	9.0
Health	2.8	5.4		4.2	1.5	6.3	6.0	2.9
Social Services		6.9			2.9	2.5	3.4	
Public Administration	1.9	3.0			2.9		9.8	
Economic Services	7.3	3.2						
Urban Development	8.3					15.1		
Rural Development								
Other			7.6	9.3	8.4		2.6	5.4

Source : Various Development Plans. + Government Ministries Only

TABLE 3.3 : Approved IBRD and IDA cumulative lending operations in the transport sector (to June 30, 1977).

Transport Mode	Bank Loans US $million	%	IDA Credits US $ million	%
Airlines and Airports	173	1.8	16	0.7
Highways[1]	4371	45.6	1171	52.0
Pipelines	357	3.7	-	-
Ports and Shipping	1597	16.7	300	13.3
Railways	2994	31.2	764	34.0
Other	95	1.0	-	-
	9587		2251	

Source : WORLD BANK Annual Report 1977

[1] includes major highways and minor roads.

TABLE 3.4 : Distribution of public sector transport investment (%)

	Botswana 1973 - 78	India 1974 - 78	Kenya 1974 - 78	Mauritania 1970 - 73	Nigeria 1975 - 80	Pakistan 1970 - 75	Philippines 1971 - 74	Sierra Leone 1973 - 78	Swaziland 1973 - 77	Tanzania 1969 - 74	Thailand 1972 - 76	Togo 1971 - 75	Uganda 1971 - 75	Upper Volta 1972 - 76
Roads : Main	60.5		21.5	29.5					34.7	29.9	34.7	22.6	20.6	38.5
Secondary	23.6		7.3	30.2						7.7	27.5		12.2	
Minor	3.3		8.4						10.4	2.7		6.1	2.6	
Urban										0.3	5.1	2.6	1.7	35.9
Other										6.1		7.1	0.3	
Total	87.5	25.8	37.2	59.7	73.1	24.2	80.3	61.2	45.1	46.7	67.3	38.4	37.4	74.4
Road Transport Industry		4.1				3.5		3.7			1.5			
Railways		37.1	25.0		12.1	21.4	3.6		1.6	40.0	8.0	7.7	19.1	7.6
Ports		5.1	7.1	20.1	4.4	6.7	4.5	13.0			3.7	40.9		
Shipping		3.8			1.7	4.9		1.2		0.6				
Other Water Transport		1.0		3.4	1.3									
Civil Aviation	5.1		10.1	10.4	6.5	16.7	6.6	6.1	26.8	5.2	3.4	4.1	13.1	3.4
Airlines		5.7			0.7	5.5		0.2					13.8	
Other Transport		0.9	6.0							4.0	0.3		4.4	
Posts and Telecommunications	7.4	17.1	14.7	6.5		17.1	5.1	14.8	26.6	3.6	15.9	7.1	12.2	14.6

Source : Various Development Plans

Goods movement by truck, and passenger movement by bus and taxi have become major new elements in the transport system. Most railways too are carrying more than ever before, but they are losing short-haul business and much of the higher-valued manufactured goods to road transport. The result is that with the exception of those used exclusively for mineral extraction, railways are in a state of decline. (2) Many railways are caught in a vicious circle of financial deficits, under-investment, declining service, loss of traffic and still larger deficits.

3.2 Road trends

The scale of investment over the past three decades has produced considerable changes in the road systems of most developing countries. For example, in Africa since 1945 the length of the road network has increased at a rate of about 3 per cent annually, and paved roads at almost 9 per cent (3). This trend is illustrated for specific countries by the first column of figures in Table 3.5. Yet, with one or two exceptions,[1] the figures in Table 3.5 show that most developing countries still lag far behind the rest of the world in terms of both the density and quality of their road networks.

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[1] There are anomalies in Table 3.5 that need explaining. In particular the high density figures for Sri Lanka and India in comparison with those of Norway, Spain and Sweden, expose the weakness of road density as a *precise* indicator of 'development': allowance must be made for the effects of topography and the density and distribution of population.
However, it may still be said that poor countries tend to have relatively sparse road networks. This aspect may be more apparent if one examines the relative 'quality' of road networks. For example, in Africa the density of 'all-weather' roads is, at approximately 1.2km/100km^2, less than 1 per cent of that in major European countries and 2 per cent of that in North America (4).

TABLE 3.5 : Road statistics for selected developing and developed countries

	Change in length of road* network 1950-75 (per cent)	Percent paved[1] 1975	Density in km/100 km^2**	GNP per capita $
Angola	110	11	6	370
India	200	35	37	140
Indonesia	40	25	4	220
Kenya	50	8	8	220
Malawi	70	14	11	130
Mozambique	40	9	5	180
Nigeria	140	17	10	340
Sierra Leone	130	17	10	200
Sri Lanka	110	70	48	190
Thailand	460	48	7	350
Tunisia	-	52	12	730
Uganda	70	-	8	230
Upper Volta	-	9	2	110
Zambia	140	11	5	420
Germany	260	95	187	6670
France	80	-	144	5950
Italy	50	93	96	2810
Norway	-	21	24	6760
Spain	-	80	28	2750
Sweden	-	51	30	8150
Poland	-	57	95	2600
U.K.	20	96	150	3780
U.S.A.	20	80	66	7120

Source: International Road Federation : World Road Statistics 1976

* these figures must be treated with caution since some of the changes are due to alterations in the classification of what is a 'road'.

[1] roads with an all-weather surface of bitumen or concrete.

** to obtain approximate average road spacing divide 200 km by the figures in this column.

The figures in Table 3.4 confirm that past road investments have favoured the construction or improvement of major rural highways rather than urban or minor roads. The IBRD too has recently stated that until about 1970 its overall lending for road and highway construction was disproportionately oriented to major roads, but claims that "in terms of kilometres to be built (present policy) is somewhat the other way (5) ..... Increasingly, emphasis is being given to rural roads[1], by which we mean low volume, low cost feeder or tertiary roads. This trend is very much in line with the focal shift in Bank lending policies and priorities towards projects benefitting the relatively poorer sectors and regions of our borrowing countries" (6); statistics support these statements. The proportion of 'rural roads' in the total *length* of rural roads and inter-urban highways expected to be built under Bank projects has gone up from 38 per cent for those approved in 1965 to 52 per cent in 1969/71 and 93 per cent in 1975/77. (5)

The Bank's policy change is, however, less radical than it sounds since, in many developing countries, the end of the 1960's saw the completion of a basic trunk road network and attention naturally turned to the provision of more extensive secondary and feeder road networks. Moreover, Class 1 and, to a lesser extent, Class 11 rural roads are still relatively expensive. Most important is the future balance of expenditure between road classes since, arguably, it is Class 111 which are most likely to affect the poor. In the period 1974-1977 Bank lending for the construction of the different categories of

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[1]The Bank now recognises three classes of 'rural roads':

Class 111: farm-to-market roads representing the lowest class of roads available for transport and normally linking a number of farms to the closest market/administrative centre or transport artery. Approximate costs: $5,000-$25,000 per kilometre for major construction, not minor upgrading.

Class 11: feeder roads connecting villages and small markets with larger regional centres and/or major transport arteries. Approximate costs: $10,000-$100,000 per km.

Class 1: major roads which also fulfil principally a rural access (as opposed to inter-urban) function but which cannot be classified as feeder roads because of their regional importance. Approximate costs: $20,000-$350,000 per km.

Classes 11 and 111 are sometimes referred to as 'minor rural roads'.

rural roads was, as a percentage of the total *length* built, 10.9, 36.8 and 52.4 for Classes I, II and III respectively. (Cost proportions would obviously be very different).

While there has been increasing emphasis on the construction of 'rural roads', only 43 per cent of annual average World Bank road and highway lending in the period 1974/77 was allocated to them. If Class I lending is excluded the proportion falls to 27 per cent.

It seems likely that this sort of balance will be maintained in the future since the Bank has recently stated "that a centrally directed shift of transportation lending to further increase the proportion devoted to rural roads beyond current trends would not seem desirable at this time". (5)

Despite the shift away from major highway construction, given present trends it is unlikely that the density of roads directly serving the rural poor will increase very rapidly in the future.[1] This is because of the (still) high cost of road construction and the limited resources at the disposal of the poorer countries.

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[1] It has been estimated that to provide a (recommended) minimum all-weather road density of 3.3 km/100km^2 in Africa (4) compared to a present world average of 8.4 km/100 km^2, will require an additional 613,700 km at a rough (1971) pre-oil crisis cost of $31,000 million.* The task is estimated to take 45 years and it would still leave the density of all-weather roads at only 40 per cent of present world levels!

* The 3.3 km/100 km^2 is an arbitrary figure as no one really knows precisely what the optimum spacing of roads is at a given stage of development: studies (7) have shown that in Japan, the United States and Western Europe there is in excess of 200 km of farm-to-market roads for every 100 km^2 of cultivated land.

3.2.1 Road construction costs

Despite years of research and discussion it is debatable whether many of the roads built in developing countries have been truly 'low-cost': more often merely 'less expensive'. Comparing the figures in Table 3.6 with the construction costs for rural roads given previously, it is apparent that many of the poorer countries can afford only relatively insignificant additions to existing road systems. For example, consider the case of Sierra Leone. If *all* the current annual expenditure on highways were concentrated on IBRD Class 1 rural roads then it could afford between 5 and 80 km of road per year, depending on construction costs, which would add between 0.2 to 2.6 per cent to the length of the present system. (At Class 111 construction costs the figures would be between 64 and 320km and 2.1 to 10.3 per cent respectively). Such action would of course be unlikely and some (more expensive) primary or urban highways would probably be built thereby reducing the overall length added to the system.

Table 3.6 Annual expenditure on road construction

Country	Year	Amount US $ (millions) at 1976 values	US $ per head
Benin	1973	4.8	1.5
Botswana	1975	7.4*	11.0
India	1974	64.8	0.1
Malawi	1975	9.0	1.8
Mali	1974	1.4	0.3
Mauritania	1971	4.9	3.7
Niger	1974	15.6	3.4
Sierra Leone	1975	1.6	0.5
Sri Lanka	1975	5.8	0.4
Thailand	1975	4.1	0.1

Source: IRF World Statistics 1976

* including maintenance expenditure

3.2.2 Access to road system

Despite past emphasis on investment in roads, there are still large numbers of people living far from the motor vehicle road system. Even in a relatively wealthy country like Mexico, at the end of 1970, there was permanent access by land to only 15,000 of the almost 100,000 centres of population, in a country of 50 million inhabitants. Those communities already served by the highway network accounted for the greater part of the population, but there were still more than 12 million people without permanent access. (8) A study of Rajasthan, one of the poorest states in India, showed that only 10 per cent of villages were connected to a 'metalled'[1] road (i.e. 90 per cent have no direct access) and some 44 per cent of the villages were located 10 or more kilometres away (9).

People living remote from the road system still travel, usually on foot, carrying their loads with them, along a network of tracks and paths whose total length is often much greater than that of the acknowledged system. These tracks are an important and frequently overlooked component of the true transport infrastructure, yet as far as is known they have received little recognition in development plans or actions in the past few decades.[2]

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[1] This term is used to describe a 'road' surface to which gravel or stone has been added: it is broadly synonymous with the more general description 'all weather'.

[2] Mosher (7) shows a photograph of a concrete farm 'road' in the New Territories of Hong Kong, which is 'designed' for bicycles, motorcycles and handcarts.

Unless the cost of 'road' building can be drastically lowered, then for most of the poorest countries road network development will be extremely slow.

At least since the Second World War the 'rural transport problem' in developing countries has been seen as one of providing or improving the quality of *access*. The term *access* has meant almost exclusively 'road access'. The only concession to the possibility that developing countries might have special rural transport problems has been the effort devoted to 'low-cost roads'. Since 1951 the Permanent International Association of Road Congresses (PIARC) has held four-yearly conferences on 'low-cost roads'. Until 1976 there were no parallel internationally organised discussions of 'low-cost vehicles' or indeed any other type of road vehicle particular to developing country needs. (10) (11) One of the main reasons why even so-called 'low-cost' roads are so expensive to construct is that they are designed to meet the requirements of *conventional motor vehicles*.

The most obvious and influential element underlying rural transport trends has been the increasing commitment to conventional motor vehicles. It is useful therefore to consider the trends revealed by the statistics on these vehicles.

3.3 Vehicle trends

Although, as is shown in Table 3.7, the stock of motor vehicles in developing countries has increased substantially since the Second World War, the current absolute level per head of population is still extremely low in relation to the developed countries[1].

The expectation is that the numbers of motor vehicles per head is unlikely to increase very rapidly in the future. A UNIDO study of 93 developing countries (12) showed that in 1968 average motor vehicle density, excluding motorcycles, was 9.2 units/1000 population. By 1980 it was forecast that this will have risen to only 11.8 units/1000 population, assuming existing population growth rates and an annual growth in GNP of 6 per cent, which is higher than most developing countries have achieved in the recent past.

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[1] The rural situation in developing countries is worse than the figures in Table 3.7 suggest, since the majority of private vehicles are owned by the relatively small urban population.

TABLE 3.7 ; Road vehicle statistics for selected countries (1975)

	Passenger cars 000's A	Commercial Vehicles 000's B	Increase 1953 - 1975 per cent A	Increase 1953 - 1975 per cent B	Motor vehicles per 1000 persons	Commercial motor vehicles per 1000 persons
Botswana	3.4[1]	6.8[1]	610	920	15.2	10.1
Burma	36.3[1]	39.3[1]	210	320	2.3	1.2
Chad	5.8[2]	6.3[2]	1500	230	3.0	1.6
Ecuador	43.6[1]	68.4[1]	870	520	15.8	9.7
Ethiopia	41.0[3]	12.7[3]	680	330	1.9	0.4
Ghana	55.5[1]	43.9[1]	440	250	10.1	4.4
India	756.5	434.4	350	220	2.0	0.7
Indonesia	383.1	231.5	540	350	4.6	1.8
Kenya	130.9[1]	23.8[1]	350	160	11.6	1.8
Malagasy	55.0[1]	51.0[1]	480	320	12.0	5.8
Malawi	11.2[1]	9.5[1]	300	350	4.1	1.9
Mozambique	89.3[3]	21.5[3]	710	610	1.2	2.3
Sierra Leone	14.8	6.7	490	740	7.2	2.2
Somalia	8.0[3]	8.0[3]	670	230	5.0	2.5
Sri Lanka	91.7	48.6	80	150	10.3	3.6
Sudan	29.2[3]	21.2[3]	440	240	3.2	1.4
U. R. of Tanzania	39.1[1]	42.3[1]	270	550	5.5	2.9
Thailand	286.2[1]	264.3[1]	1220	1020	13.1	6.3
Australia	5012	1200	350	110	460	89
Sweden	2760	171	540	50	357	21
U.K.	13949	1872	400	70	282	33
U.S.A.	106712	24837	130	170	616	116

Source: U.N. Statistical Yearbook 1976

[1] 1974, [2] 1973, [3] 1972.

Thus the availability of conventional motorised vehicles in rural areas of developing countries is limited and will remain so in the foreseeable future. It should also be apparent that the price of motor vehicles is such that they can only be purchased by the affluent, and are quite beyond the means of the rural poor.

A feature of past *institutional* and *public* investment in highway transport in all developing countries, which is only partly confirmed by the 'Road Transport Industry' figures in Table 3.4, is that it has been almost wholly concerned with infrastructure i.e. the building or maintenance of roads. Investments in the vehicles to use those roads, other than those necessary for their maintenance or the occasional publicly owned bus service, have been by comparison negligible.

"The (World Bank) Group has made no loans for the direct financing of bus or trucking companies. There has been some indirect involvement in vehicle manufacture and assembly, however, via the general industrial import credits to India and in truck and bus company operations through financing of development finance companies. In addition, there was a specific IDA credit to Pakistan for truck assembly and import of buses and spares, and the International Finance Corporation ..... has made loans to and equity investments in vehicle manufacturing firms in Brazil and Yugoslavia".

"The Bank does not propose to become active in motor vehicle or road transport industry financing before a great deal more thought is given to the problems entailed". (13)

Government involvement in the provision of motor vehicles has by and large been regulatory : either permitting reasonably free import or making it very difficult where foreign exchange has been an acute and continual problem (e.g. Burma, Bangladesh, Sri Lanka and Tanzania); although some have participated in capitalizing production ventures the bulk of the capital has come from the international motor vehicle suppliers. By 1972 some 47 developing countries had already established motor vehicle industries, although:-

(a) most had not progressed far beyond the assembly of kits of parts imported from the licenser's parent factory;

(b) they were concentrated in the wealthier developing countries : of the 28 countries with a per capita annual GDP of less than $200 only 1 (India) had progressed to full manufacture and just 5 had varying forms of vehicle assembly. (12)

3.4 Roads, vehicles and the rural poor

All the evidence implies that the net result of past growth is that the transport facilities available to the rural poor remain few and primitive. There are still large numbers of people in developing countries living far from the road system and with very limited access to motor vehicles. These people are dependent upon traditional means of transport as illustrated by the data in Table 3.8.

For most of the rural poor the predominant method of goods movement is head or backloading with the shoulder pole as a less common alternative. Bicycles, hand-carts, wheelbarrows, animals and animal-carts are used to a lesser extent. Although all these means of transport are used in rural areas their existence, and indeed importance, is yet to be acknowledged in the statistics of most developing countries[1]. Surveys of non-motorised forms of transport are rare, but two are noteworthy. In 1966 estimates were produced for the State of Rajasthan in India of the relative distribution of goods transport among different modes, as shown in Table 3.9 (8

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[1] Vehicle statistics compiled by UN organisations do not normally extend beyond cars, vans, buses and trucks. Private organisations such as the 'International Road Federation' and the French 'Chambre Syndicate Nationale du Cycle et du Motor Cycle' provide limited information on motorcycles and bicycles, which will be discussed subsequently but there are no regular international surveys of the use of animal or human powered means of transport.

TABLE 3.8: Prevailing transport-modes in selected ESCAP countries

	Area Connected By		
	All weather road	Fair-weather road	No road at all
Afghanistan	Truck	Truck Tractor Animal-drawn vehicle	Camel Horse Donkey
Bangladesh	Truck Rickshaw Headload Pushcart Animal-drawn vehicle	Animal-drawn vehicle Headload Rickshaw Pack animal	Shoulderload Headload Pack animal
Indonesia	Truck Jeep Pick-up Delivery van Animal-drawn vehicle	Jeep Delivery van Animal-drawn vehicle	Bicycle Pack animal Human transport
Sri Lanka	Truck Tractor Cart	Tractor Cart	Pack animal
Thailand	Motor vehicle Motor cycle Tractor	Motor vehicle Tractor Animal-drawn cart	Bicycle Manual carriage Animal-drawn cart

Source: Questionnaire circulated by ESCAP Secretariat

TABLE 3.9 : Relative position of different modes of conveyance in road transport in rural areas (12)

Mode of Conveyance	% of volume of goods handled. (tons)				
	Dry Area	Plains	Hills	Plateau	Total
Man	9.0	6.9	12.3	14.7	10
Animal	28.3	26.1	8.0	2.0	19
Bullock-Cart	50.3	55.0	26.5	54.0	48
Truck	12.4	12.0	53.2	29.3	23

The figures show that even in an area with a long tradition of animal and bullock-cart use, man still provides 10 per cent of the transport needs. Trucks are little used except where the terrain gives them a decided advantage over the bullock cart. The study confirmed that ownership of animals and bullock carts was confined to 'villages where the marketed surplus per household is large or where the percentage of sales made outside the village is high or where the cultivator is generally prosperous'. A similar survey in five areas of Bangladesh (14) produced the results given in Table 3.10. In this case usage of trucks is minimal with headloading and country boats as the dominant transport modes.

TABLE 3.10 : Transport facilities and use

Area	Mode of transport (%)					
	Head/Shoulder Loading	Cycle	Pedal Rickshaw	Bullock Carts	Country Boats	Truck
Malchiti	30.0	2.0	-		68.0	-
Chandina	83.0	-	13.0		-	4.0
Ranisankail	57.7	2.8	-	39.5	-	-
Rangamati	28.2	-	-		65.2	6.4
Sulla	44.5	6.5	-		49.0	-

Source: Bangladesh Rural Transport Study: August 1977.

3.5 Discussion of trends

For all its evident importance there are surpringly few statements of what strategy is being, or should be, pursued in the improvement of rural transport. There are few statements of objectives and the means by which they are to be reached; few discussions of alternative tactics and their relative merits and de-merits; and few analyses of how successful past policies have been other than those dealing with fairly narrow topics such as appraisal methods for feeder roads (15).[1] Thus, of necessity, transport strategy has to be inferred from the trends described previously.

The elements of past rural transport strategy that can be inferred from these trends are:-

(i) a belief in a positive relationship between transport and economic development;

(ii) a concentration on major highway construction and improvement; and

(iii) a concern in the design of roads with the requirements of conventional motor vehicles as a result of the assumptions:

  a. that conventional motor vehicles provide the most efficient means of movement;

  b. that government resources should concentrate on road building to the exclusion of vehicles.

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[1] the blame for this situation rarely lies only with the transport sector since, as the World Bank has pointed out, a major problem in planning transport in developing countries is that "the overall national priorities on which transport has a direct bearing - economic, social, strategic - are rarely made explicit, which means that from the outset the goals of planning are often vague". (13)

It should be re-iterated that in most developing countries transport has generally received more resources than any other sector of the economy, yet it is accepted that the rural poor have increased in number and their conditions of life have deteriorated. Clearly, past transport strategy has not prevented this worsening of the level of poverty. The implication is that *a continuation of past strategies is unlikely to alleviate or improve the conditions of the rural poor:* most probably they will continue to worsen. For this reason it is important to examine each element of past strategy to determine how it might be modified to better serve the needs of the rural poor.

4. RURAL TRANSPORT STRATEGY

Perhaps the key to understanding past policies lies in appreciating the changing interpretation of the word 'development'. For many years 'development' has been synonymous with *economic* growth. Despite misgivings as to their appropriateness terms like Gross Domestic or National Product have been the most widely quoted measures of the level, and alterations in level, of development. Equally, in the appraisal of individual development projects, the quantification of the 'economic benefits' they were expected to give rise to has been paramount. Concern with the distribution of the benefits of growth and the extent to which investment possibilities will contribute to the satisfaction of 'basic needs' are comparative newcomers as criteria of development.

4.1 Transport and development

The continuing importance accredited to transport investments in almost all national plans is the clearest possible indication of the strength of the belief in transport's ability to foster development. As recently as 1972 the World Bank stated: that: "Experience shows, and in a rather dramatic fashion, that promotional transportation investments can be the agent of important economic developments"(1).

Statements similar to this are still common, indicating a widespread belief in the critical 'catalytic' role occupied by transport in the development process. However in 1966 Wilson, architect of the largest study to date into the impact of transport investments on development, had said "transport investment is no more an initiator of growth than any other form of investment or deliberate policy. Under some conditions, it may turn out to be strategic but the same can be said about any specific investment or policy". (2)

Behind this statement lay the evidence from numerous case studies : some had shown rapid economic growth following improvements in transport, but there were others in which no such change had occurred.

More recent research has gone still further and suggested that under some circumstances transport investments in isolation may in fact be *harmful* to certain sections of the community : "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 agricultural 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). Agricultural improvements of all sorts have, in the past, encouraged concentration of land holding in fewer hands and an increase in the number of share croppers and landless labourers. Improvement of transport facility alone is likely to accelerate this trend by providing further advantages to bigger farmers". (3)

The study quoted and others (4) have shown that whilst there are usually appreciable benefits resulting from transport improvements, they tend to accrue to the already advantaged. Often there are also appreciable dis-benefits which are usually overlooked and, invariably, affect the poorest groups. Examples found include:

- reductions in labour demands following the replacement of traditional movement methods by motor vehicles;
- concentration of capital as cottage industries are bankrupted by the increased competition from larger-scale industries in the towns leading to the partial collapse of the wider rural economy and migration to the towns;
- changes in agricultural production towards transport-intensive products which do not necessarily benefit the poor;
- concentration of land holdings.

If these results hold generally, which seems likely, they would explain why past transport investments have had so little effect on the well-being of the rural poor.

Institutional reaction to "the typically disappointing response of the productive structure to the opportunities opened by road investment" (5) has been a change in road investment policy. Increasingly, particularly in respect of the minor classes of road, investments are being subsumed within 'integrated rural development' or 'agricultural development' packages. However, as a result of a recent study on the effects of roads in Nepal doubt has been cast as to whether this alone will make transport investments any more effective : "There is a real danger that the proposition 'roads equals development' now increasingly regarded as misleading or simply wrong, will be replaced by 'roads and expenditure on agricultural extension equals development' which holds little more universal applicability than the first proposition". (4)

Appraisal methods used to assess transport improvements need to be broadened considerably. Although the World Bank's most recent advice on this subject (6) does suggest consideration of the 'distribution of benefits', 'producer's response' and 'non-transport constraints' the enquiries, in the view of the critics, are still far too narrow in focussing purely on 'economic benefits', particularly those expected from increased agricultural production (7),(8). It is argued instead that the likely effects of roads, and thus a proper assessment of their justification, can only be understood within the context of an analysis of *social* changes in the rural areas.

An alternative approach is to reject precise quantitive methods altogether and use simple indices and ranking procedures to measure the likely social

and economic impact of investment in roads. Under the current Kenya Rural Access Roads programme (9) some 12,000 kms of road are being built, to very modest standards of construction, without any elaborate economic justification. Instead priorities are being decided by a much broader based ranking procedure that takes into account social needs as expressed through local leaders ie by a more overtly political process.[1]

Whilst these changes may make the appraisal procedures for feeder roads less economically biased, by themselves they will do very little to prevent the dis-benefits of road construction. The whole package of rural investments must be more appropriate to the needs, including transport needs, of the poor.

4.2 Major road development

Although there has been some shift away from expenditure on major highways, it still dominates road investment.

Yet the high cost of modern highway construction is one of the main reasons why road networks in developing countries are, and seem likely to remain, sparse.

A concentration on major highway improvement is understandable in the early stages of developing a country's road network. The elements of a road network are complementary not competitive Tertiary roads feed into secondary routes, which in turn connect with the primary network. Concentration on the lower orders of the system to the exclusion of the upper level network would be impractical. Moreover, for most countries

[1]These methods are not new, they have been employed in India since 1945 and, to a lesser extent, in a number of other developing countries (10).

the first communications priority must be to provide *reliable* connections between the capital and the main ports, regional administrative centres and productive areas for a variety of strategic, political, economic and social reasons.

However the critical decisions are to determine the standard of road which is judged 'reliable', and the balance which should be struck between providing a few routes of high quality and the need to open up new areas to the possibilities of development by means of a large network of lower standard routes.

For many countries both of these decisions have been determined by (a) the need to borrow the funds required from foreign sources, and (b) the necessity of 'justifying' the investment of these funds.

It is perhaps understandable that the influential international lending agencies, with their traditional "banking" outlook, exhibit a predilection for "properly" designed and executed projects. Often these require expatriate engineers and contractors who naturally introduce their own design and construction practices.

In common with many other sectors the 'success' or 'worthiness' of past road investments has been measured by the 'economic' benefits produced. This emphasis on the expected economic results of transport improvements has has a number of consequences, the most important of which is that it has biased investment towards projects with quantifiable benefits, such as savings in vehicle operating costs and road maintenance expenditures. Since both of these are related to the amount of traffic, existing and expected, the process has naturally worked in favour of main roads and led to a tendency to opt for major route improvements - which can usually be credited with user and maintenance savings - rather than new road construction . It is arguable that these factors have unnecessarily increased the *cost* of road construction through their effect on the quality of the facilities provided, as embodied in their road design standards.

4.2.1 Road design standards

It is important to realise that these are a product of western ideas of need and safety. Concepts such as the "safe stopping sight distance" and many others that underlie the geometric design of modern highways have never been satisfactorily translated for developing countries (in the latter respect it is significant that one of the few recognised text-books on roaddesign for developing countries recommends essentially US standards - probably the most generous ever developed - for the geometric elements of highways) (11). Moreover, the design, and hence cost, of a modern road ispredicated upon the performance characteristics of the privte car and goods lorry: the assumed speed that car drivers "desire" dictates the standards of horizontal and vertical curvature, and the expected axle load of goods lorries dictates the road's structural strength. Yet neither of these vehicles has ever been shown to be essential, much less optimum, for rural developing regions. It is probable that other simpler and probably cheaper vehicles would suffice. Slower and lighter vehicles would allow alignment constraints on roads to be relaxed and their strength and width reduced giving a considerable saving in costs.

The usual argument against building simple roads for simple vehicles is that such a combination gives high user costs and thus a high total cost of transportation. Indeed even when "feeder", "penetration" or "development" roads have been provided, the standard of construction has been such as to provide low motor vehicle user-costs. However, the appeal of this argument is superficial. It has merit only because we are unable to account fully for the consequences of road improvements, a situation which artificially exaggerates the importance of those benefits we can quantify. Time savings are not taken into account with current techniques for the economic appraisal of road improvements, (12) and by general admission the so-called "secondary" or developmental and social benefits are as yet unquantifiable.

The bias in favour of "quality" may be justifiable for the small proportion of heavily trafficked primary highways, but for roads whose primary function is to assist in the process of development it does not seem defensible. Research has shown that in promoting development, of first importance is the *existence* of a "route", its quality is a secondary consideration (ie the likely development effect of a new route, where none previously existed, is much greater than that due to the improvement of existing facilities). (2)

4.3 The role of conventional motor vehicles

For many years a belief has been fostered in what might be termed the 'economies of modernity'. (This is a technological equivalent of the well-known economies of scale). The figures in Tables 4.1 and 4.2 illustrate the foundations of this belief for which it would be possible to quote many other examples going back several decades (13), (14).

The clear implication of these figures is that 'primitive is slow and expensive' and 'modern is fast and cheap'. One of the authors concludes from the figures that "a road will lead to a better life for a community as a whole" (13). But of course, the figures cannot be taken at face value, since they are true only with the caveat 'other things being equal', which they almost never are. The comparisons assume either full loads or equal load factors, (i.e. similar degress of

TABLE 4.1 : Cost of transport by various means (Ethiopia)

Mode	Cost of Transport $ per 100kg/10km
Mule (on a track)	1.00 - 3.00
Landrover (on a trail)	1.00
Tractor (with trailer on an earth road)	0.50
Truck - on gravel road	0.25
- on asphalted road	0.10

TABLE 4.2 : Cost of transport by various means (Asia)

Method and Terrain	Length of journey (km)	Transport cost expressed as kg grain equivalent per ton. km.
Porterage		
Flat	21	45
Undulating	8	50
Steep Escarpment	5	65
Ox Cart		
Flat	8	7
Flat	21	11
Rugged	21	30
Bicycle		
Flat, undulating in places	16	12
where no motor vehicles competing	16	20
Motor Vehicle		
(5 ton truck on main highways)		
Flat	14	7
Undulating	96	1.3

utilisation) not just in the short term, but over long periods of a year or more. It is not always clear if the figures are costs or charges to the user. If they are costs, are they based on market or economic prices? Has any allowance been made for the fact that it costs society almost nothing for the track over which loads are carried on the head, by mule or bicycle, but a road suitable for motor vehicles will cost several thousand dollars per kilometre to build and several hundred a year to maintain? What, if anything, are the employment consequences of substitution among different modes of transport? (This crucial aspect does not even appear in formal appraisal methodologies). Are all modes of transport equally possible: will the terrain, length of journey, size of consignment, etc. allow a free choice between them? Most important are they equally available and affordable to *all* would-be users?

In reality different modes of transport serve characteristically different movement demands and they are infrequently in direct competition.[1] It is physically impossible for motor vehicles to traverse terrain that a donkey or bullock-cart would do with ease. It is frequently overlooked that modern vehicles need modern roads: suspension systems, ground clearances, tyres and many other vehicle components presume a reasonably flat, obstruction-free surface. Without such a surface operation may be impossible, or possible but only at very much higher than normal costs. No-one seriously suggests using headloading or an animal-drawn cart for journeys of 50kms or more, equally a lorry is hardly likely to be used for a trip of a few

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[1] "It was once thought that the use of antiquated carts which had survived centuries of changes might not continue long in the era of motor transport. This expectation has not materialised because motor lorries can operate successfully only around industrial areas. Due to insufficient loads, time taken in loading and unloading, long waiting at the market or the time spent looking for a return load at the market, the cost is so high that motor transport cannot as yet compete with the bullock cart. For conditions existing in the developing countries, the animal-drawn vehicle is cheap for short hauls". (15)

hundred metres. Despite the obvious nature of the situations described, supposed unit costs are the most common basis of comparison in analyses of the suitability of of transport modes.[1] This has given motor transport the appearance of 'indispensability' and consequently, it has resulted in the neglect of indigenous forms of transport, which have tended to remain primitive.

Undoubtedly the increasing dominance of the motor vehicle has been assisted by the preoccupation of governments and international lending institutions with the provision of roads to the exclusion of concern for the vehicles that use them.

4.4 Government and institutional involvement in the development of road transport

Considering their assumed importance, the apparent lack of attention paid by governments and international lending institutions to the *supply* of motor vehicles is surprising. In the development of road transport the implicit assumption appears to have been that the private sector would supply whatever vehicles were necessary to make efficient use of the roads provided by the government. That this supply would appear has been taken for granted and that it might not be appropriate to needs hardly considered. It is not difficult to find countries that have simultaneously pursued policies of significant (public) investment in highway construction and improvement, combined with severe restrictions on the (private) import of vehicles

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[1] A preoccupation with the unit costs of operation has resulted in the use of larger and larger goods vehicles in the UK and many other developed countries. Notwithstanding any reservations about the safety and environmental aspects of this policy, it has recently been pointed out that this has given little real gain to the customer. Large vehicles have led to a concentration of distribution centres leading to increased journey lengths for goods delivery. Thus the cost per ton of goods movement, which is what dictates the price to the customer, has *increased* whilst costs per ton km have continued to decline. (16)

through foreign exchange regulations, quotas or steep customs duties : the latter restrictions clearly reduce the possibility of receiving benefits from the former investments. (In retrospect it seems hardly surprising that the 'development' impact of some road construction programmes has disappointed their backers : the supply of vehicles may offer an explanation).

It is only recently that some of the drawbacks of this ambivalent policy in respect of vehicle supply have been recognised.

In Papua New Guinea between 1969 and 1974, 117 makes and 436 different make/size/body-type combinations of car and truck were imported. This led to severe shortage of spare parts, and exposed the lack of suitable maintenance skills. Government concern about this situation led to a Commission of Inquiry (1974) which, among other things, recommended that:

- imports be limited to a few types of motorised vehicle and the private car be phased out completely over a 10 year period;
- encouragement be given to bicycles and pedal-driven cargo vehicles, including the experimental construction for evaluation purposes of a bicycle path system in the capital Port Moresby;
- investigation be made of simpler motor-cycle-based vehicles and the Asian Utility Vehicle (AUV) used in the Philippines.(17

Whether these recommendations will ever be implemented remains to be seen, but they indicate the **alarm felt about** allowing unrestricted use of conventional (developed country) motor vehicles.

Apart from Papua New Guinea, very few developing countries - China and India are notable exceptions - have attempted to restrict the number and type of vehicles to those considered most appropriate to their stage of development. Restrictions because of foreign-exchange considerations or the desire for local manufacture are common : but restrictions because of alleged technological inappropriateness are rare.

4.5 Discussion of strategies

Perhaps the most striking feature of recent rural transport strategy in developing countries has been the rigidity with which the system has been regarded. Fundamental to this has been the implicity assumed superiority of conventional motor vehicles for every transport situation. From this assumption the essential characteristics of 'roads' follow: their planning, priorities for construction or improvement, location, regulation and their design to match a rigid and limited number of motor vehicle parameters; 'design speed' and, to a lesser extent, 'axle load'. It is not easy to offer any rational explanation as to why in most countries the provision of roads has largely been considered independently of any questions pertaining to the supply or type, of vehicles. Concentration of government resources on roads and lack of governmentinvolvement with vehicles means that a crucial part of the transport needs of the rural poor is not being met. Most developing countries lack low-cost private vehicles widely disseminated among the majority of the population of industrial workers, small businessmen, and in particular, rural farmers. This fact is particularly stark in Africa. Between headloading or walking, and movement by conventional car, bus or lorry, very few alternatives are used.

Whilst pursued independently, there has been a common element to the development policies concerning roads and vehicles in that both (paraphrasing Muller (18) "by and large build upon development inputs not only from above, but also, from abroad. Although adapted to some extent to the local conditions, the knowledge, organisation, techniques and products, i.e. the technology, transferred to the rural scene

are essentially 'modern'. As such transfers are prohibitively costly for repetition all over the country, their effects are limited to relatively few locations. And it is not only the transfers themselves which are costly. The required adaptations of the local conditions to the technology is also costly. By this we mean that the relatively high and essential infrastructural service demands of the technology are expensive to establish and to maintain." This is precisely what has happened with roads and vehicles: development from the top downwards using developed country technology. That is, a progression from major engineered primary, to secondary and only latterly to tertiary highways all built on the basis of design philosophies imported from the developed countries. Equally a reliance on developed country motor-vehicles with only very recently a small step in the direction of lower cost, but still motorised, vehicles and the complete neglect of traditional forms of transport. The result is skeletal road networks that in the poorer countries plainly do not serve effectively the majority of the population and vehicles so expensive that they are beyond the means of all but the affluent.

For the rural poor it would be difficult to conceive of a more inappropriate technology : often unrelated to basic movement needs, inaccessible, scarce, unimaginably expensive, difficult to use and maintain, and frequently wholly dependent on foreign resources in terms of manufacture, energy, spare parts and operating skills. Hence the need for a more appropriate transport technology is clear. In order to define this appropriate *transport* technology it is necessary to ask the question: 'What are the appropriate *vehicles* for rural areas of developing countries'?

5. APPROPRIATE VEHICLE TECHNOLOGY

Given the variations in incomes, topography, roads, farming and social systems, in local resources and capabilities, there cannot be a *'a universal vehicle'* appropriate to all the rural transport needs of developing countries. *An essential element of any strategy for improving the transport capabilities of rural populations must be to provide a graduated choice of vehicles whose performance matches need and whose cost is in sensible relation to income.* Consideration of the characteristics of the rural poor, their transport needs and the criteria of an appropriate technology leads to vehicles radically different in concept from conventional motor vehicles. The latter are disqualified on the basis of cost, complexity, dependence on foreign resources and inability to meet needs. The wide variations in local circumstances require the availability of a progression of human, animal and, at the extreme, simple motorised means of movement. We term these collectively as *basic vehicles*, which may be defined as:

> the range of devices from aids to goods movement by man himself up to, but excluding, conventional cars, vans, buses and trucks.

Many such basic vehicles already exist in different parts of the developing world, though often their use is localised. Some are primitive, being traditional devices which have remained effectively unchanged for many years, others are used for purposes quite different from those for which they were originally designed and for which they are unsuited. Almost all are capable of improvement,

using contemporary technical knowledge, so as to increase significantly their efficiency and usefulness.

Basic vehicles have been largely ignored by those responsible for the planning and development of rural transport systems in developing countries. That, as will be shown, so many basic vehicles are already used-despite the neglect of policy makers, planners and technologists, and despite technical shortcomings which frequently render their operation very difficult-implies a strong underlying need for such simple forms of transport. Furthermore, it suggests that there is considerable potential for their wider and more effective application if skilled attention is directed towards their development and use.

This section discusses the characteristics, current use of, and desirable technical improvements to, the different types of basic vehicle. Consideration of the appropriate vehicle for a particular situation inherently involves consideration of the track requirements of that vehicle. For example, some of the basic vehicles discussed may be described as 'two-dimensional' in that they have height and length but no significant width. This makes them suitable for use on the many footpaths and tracks which for the overwhelming majority of the rural poor are, effectively, the 'road' system. *All the vehicles described* could be operated on roads of a lower standard, and hence cost, than that prescribed by the requirements of conventional motor vehicles.

5.1 Head, shoulder and back loading

These forms of transport, described collectively as 'human porterage' are still the most common methods of load-carrying in rural areas. Loads can be carried over steep, hilly or rocky terrain on any surface on which it is possible to walk; a specially prepared track is not essential. Aids to human porterage can usually be made at token cost by local people using available materials.

Human porterage is, however, arduous physical work as the carrier has to support the whole of the load, in addition to propelling it forward. It is also slow, and therefore time consuming. The consequences of these two factors are that the loads which can be carried are limited, and in practice can only be moved short distances.[1] Although no hard evidence has been found there is widespread concern that the habitual carrying of very heavy loads on the head, shoulders or back can cause physical disabilities and injuries. In Eastern Africa the use of the head strap (from which loads are suspended onto the back) is thought, because of the very stooped posture induced under heavy loads to induce spinal and pelvic disorders. However, it must be stressed that the validity of these concerns is, as far as we know, unproven.

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[1] It is impossible to put a precise figure on the effective range of human porterage. This will depend on the importance that is attached to moving the load and the willingness of the individual to undertake the arduous work involved, in addition to the more obvious factors such as the terrain and magnitude of the load.

The choice between the different modes of human porterage tends to be dictated by local custom as much as by the loads themselves. Furthermore in some countries custom decrees that men do not carry loads - although these taboos are less common among the really poor - whereas in others they move only the heaviest of loads.

5.1.1 Head loading

Loads are usually limited to about 40 per cent of bodyweight (25-35kg) (1) though this decreases as the distance of travel increases or if the terrain is difficult.

The load which can be carried is greater than that which the carrier can lift unaided onto his head (2). Thus the load is further limited if the carrier has no-one to assist in loading. In some parts of the world a combination of head and back loading is employed using a head-strap from which the load is suspended. Although this considerably increases the load that can be carried and eases the raising and lowering problem it also imposes considerable strain on the skull, neck and back.

5.1.2 Shoulder loading

This form of human porterage is widely used in Asia. The most common method of shoulder loading is by means of a *carrying pole* (3). This is a long, flexible member carried on one shoulder with the load suspended in containers at each end. The usual construction is from bamboo, split longitudinally to give a semi-circular cross section of large radius to spread the load on the shoulder. It is flexible

enough to provide springiness which, with the load normally carried, gives a natural frequency of oscillation related to the frequency of trotting in such a way as to minimise the expenditure of energy. The loads that can be carried are similar to those for head loading, but the process of loading can be carried out unaided. A less common form of shoulder loading is the *yoke* which is a rigid member resting on both shoulders simultaneously with a shaped cut-out to accommodate the neck and carrying roughly equal loads on either side. It is particularly useful for carrying and distributing water to crops. A third form of shoulder loading is what might be designated a *strongback*, in which a pole is carried by two or more people with the load suspended between them.

5.1.3 Back loading

This method can be used with or without a carrying frame of which there are a variety of different types. In Korea and Nepal loads of 60-80kg are common (4) (5). This implies that backloads suspended from the shoulder are the largest which humans are capable of carrying. However, the evidence is very limited and it is not clear whether the greater loads result from the efficiency of the method used or the physical condition and the attitude of the people involved.

5.1.4 Research and innovation

Human porterage is arduous, time consuming, and it seems likely that it can cause injury or deformity. Yet for the foreseeable future it is likely to remain an important means of rural transport. Therefore, despite its inherent limitations efforts should be made to improve its efficiency and minimise, if they are real, its harmful effects. While

the choice of method is at present based largely on custom, there is potential for change if significant benefits can be demonstrated. An appraisal of conventional transport literature suggests that there have been few attempts to investigate the physical side-effects associated with human porterage, or to study (or improve) this means of transport. Such studies have been made (1) in the developed countries in relation to the design of backpacks for military and sporting purposes Efforts should be made to collate this information and determine its usefulness, if any, for the improvement of 'traditional' methods of human porterage.

One notable attempt at innovation is the joint work of the Georgia Institute of Technology (USA) and Soong Jun University (Korea) on the Korean Chee-ke (4). The Chee-ke is a traditional form of back loading frame and "is very inefficient, difficult to handle, and very heavy when it is fully loaded. Nevertheless, in light of Korea's hilly and rocky terrain, this piece of equipment can hardly be discarded" (4). Through a programme of research and development involving farmers, rural blacksmiths, traditional chee-ke makers, specialists in farm equipment and engineers an improved chee-ke was produced. Six successive models were evolved before a satisfactory design was achieved The improved chee-ke converts easily from a back-frame to a wheeled carrier. This is because on good terrain it is easier to place the load on wheels and push or pull it, while in more difficult conditions it is better to carry the load.

It is particularly noteworthy that the combined talents of three professors from different disciplines were needed to improve one of the (apparently) simplest means of transport. This illustrates the need to apply the best technological skills to the improvement of basic, and superficially simple, devices.

5.2 Handcarts and wheelbarrows

The effective utilisation of human power for transport can be increased by supporting the load on a wheel or wheels. Power is then devoted to propelling the load forward rather than supporting it, allowing greater loads to be moved at about the same speed as human porterage. If the weight of cargo to be moved is greater than can be carried by one person in a single load, there is a considerable time saving in using a handcart or wheelbarrow. Because of the lower effort involved it is likely that a person would be prepared to move a given load further on wheels than by carrying it. Handcarts and wheelbarrows are not suitable for use on steep gradients since the weight of the cargo then has to be supported by the operator and this, rather than resistance to motion determines the maximum load.

It is important to distinguish between the handcart and the wheelbarrow since the two devices have different track requirements.

> A *wheelbarrow* is a single wheeled load carrier pushed, under normal circumstances, by one person.
>
> A *handcart* is a two-wheeled load carrier pushed and/or pulled by one or more person(s).

On a *smooth* surfaced track of sufficient width the handcart is preferred since, having two wheels it is balanced against

sideways tipping. However, on a rough track a handcart is difficult to use since each time one wheel hits a bump the cart is diverted from its direction of travel. Thus, in rural areas, the wheelbarrow, which can be used on narrow footpaths, is likely to find wider application.

5.2.1 Handcarts

Handcarts are fairly widely used in Asian countries, although more so in urban than rural areas. They are predominantly of wooden construction, locally manufactured in small workshops and use a variety of different wheels: traditional, large diameter wooden spoked wheels; discarded truck or car wheels; crude welded steel spoked wheels; and bicycle or cycle rickshaw wheels. In Bangladesh 'push carts', operated by up to four men, are used to move loads of up to 1 ton in urban areas, albeit slowly, over short distances, and at great effort (6).

5.2.2 Wheelbarrows

With the notable exception of China the wheelbarrow does not appear to be widely used for rural goods movement, its major application being in civil construction. However, there is evidence from Africa of a number of attempts to use barrows for rural transport. Extremely crude barrows, made entirely from wood, having very small wheels, primitive bearings and poor weight distribution, have been observed in a number of countries. In Tanzania a wheelbarrow has been developed suitable for manufacture in a village workshop using only timber, nails and rubber from discarded motor tyres (7). This is certainly more effective than human porterage for many applications but its efficiency is limited by its small wheel and the type of bearings used.

In general the efficiency of all these devices must be limited by their crude design and manufacture. However, the most important aspect is the fact that they exist at all. Clearly,their use is preferable to human porterage, however seemingly ineffficient, and is the best possible indication of the need for such means of movement.

The one country where the wheelbarrow is widely used is China (8). The Chinese wheelbarrow is of quite different design from that found in other parts of the world, which we refer to as the Western wheelbarrow.

The Western wheelbarrow has a relatively small diameter (up to 400mm) wheel positioned partly below the sloping front of the load tray. The centre of gravity of the load is well behind the line of the wheel axle.

The Chinese wheelbarrow uses a larger diameter wheel (about 700mm) with the load placed directly above it on a horizontal platform so that the centre of gravity is just behind the wheel axle. The operator wears a strap which passes across his shoulders and is attached to the handles of the barrow.

Consideration of the design of the Chinese wheelbarrow indicates that it is a more effective device than the Western type. Because the load is placed close to the wheel axle the operator only has to support a small proportion of the load, sufficient to maintain control of the barrow. Thus more of his energy can be devoted to propelling the barrow forward. The large diameter wheel reduces rolling resistance. The disadvantage of the Chinese design is that the load is carried very high so that the barrow tends to tip sideways. However this is mitigated by the use of the shoulder strap.

There is practical evidence of the superiority of the Chinese

design. Studies carried out by the World Bank as part of its programme of work on labour intensive methods in civil construction showed that the maximum load for a Chinese barrow was about 180kg, compared with about 120kg for the Western configuration (9). Thus, it would appear that the greatest potential for wheelbarrow transport lies in the development and wider application of the Chinese wheelbarrow type [1].

5.2.3 Development

Only a limited amount of information about the Chinese wheelbarrow is available outside its country of origin. While the general principles are understood there is a need for investigations to determine the optimum disposition of the load [2] and the diameter, width and type of tyre to minimise rolling resistance. Such studies would provide the data needed to develop simple designs for Chinese wheelbarrows using locally available materials. Frame and load tray designs can be evolved relatively easily, but the major need is for the development of strong, light, large

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1 It is worth noting that two British manufacturers of crop spraying equipment use the 'Chinese wheelbarrow' configuration for their manually propelled sprayers.

2 Some pioneering preliminary work on this subject was carried out by ILO in 1963 (10) but apparently this has never been followed up.

diameter wheels that can be manufactured in developing countries. Motor cycle wheels could be used, but are expensive, not always readily available, and not necessarily the optimum size. Traditional wooden spoked wheels are another possibility, but in many countries the necessary manufacturing skills are not available.

5.3 Pedal driven vehicles

Pedalling is a highly efficient means of utilising human energy (11). Wilson has shown that movement by bicycle is four times as efficient (in terms of energy consumption per kilometre) as walking (12).

It has not proved possible to locate any estimate of the world stock of bicycles. Table 5.1 gives statistics for those countries for which information is available, and shows that in them bicycles generally outnumber motor vehicles. The best estimate of world bicycle production is that it has increased by approximately 31 per cent since 1970 to an annual total of some 43 million in 1976. (Table 5.2). In comparison, production of all motor vehicles has increased by 16 per cent in the same period to an annual total of 33 million in 1976. This supports the intuitive conclusion that the bicycle is probably the most widely used wheeled vehicle in the world. Given that this is the case, it is surprising that data about bicycles is so rarely included in official transport statistics. Table 5.2 shows that world production of bicycles is concentrated in the developed countries. Although

TABLE 5.1 : Bicycle statistics for selected countries (1975)

	Bicycle stock 000's	Bicycles per 1000 persons	Motor vehicles per 1000 persons	Commercial motor vehicles per 1000 persons	$ GNP per capita
Argentina	4,000[1]	156	117	35	1,550
People's Republic of China	100,000[1]	120	n.a.	n.a.	380
Colombia	500	21	20	5	580
India	30,000	49	2	1	140
Ireland	700[1]	22	181	18	2,390
Israel	80	23	117	35	3,790
Norway	1,830[1]	453	273	36	6,760
Portugal	314	33	125	27	1,570
Sweden	5,000[1]	607	357	21	8,150
Syria	10[2]	1	12	5	720

Source : Bilan de l'Industrie du Cycle et du Motocycle en 1976
UN Statistical Year Book 1976
World Bank Atlas 1977.

[1] 1976

[2] 1974

TABLE 5.2 : World production of bicycles : 1976

United States	8,100,000	Czechoslovakia	500,000*
Japan	6,299,205	Thailand	300,000*
People's Republic of China	6,250,000*	Hungary	256,000*
USSR	4,500,000*	Mexico	250,000*
Germany	2,854,236	Norway	230,000*
India	2,250,000	Australia	187,581
Italy	2,000,000	Portugal	101,328*
France	1,941,601	Turkey	84,143
U.K.	1,821,618	Ireland	80,000
Brazil	1,450,000	Colombia	75,000
Poland	1,258,800	Iraq	50,000
Argentina	700,000	Chile	50,000*
Holland	668,827	Morocco	25,000
Spain	538,829	TOTAL	42,822,168[1]

Source : Bilan de l'Industrie du Cycle et du Motocycle en 1976.

* estimated from 1975 or part-year returns.

[1] There are a number of other countries who have not submitted returns for several years and it is not certain if they are all still in production. Crudely a further 2,465,340 could be added to this total made up as follows. Denmark : 225,000 (1974); Israel : 2,000 (1974); Sweden : 238,340 (1973); **Another S. E. Asian country: 2,000,000** (1972) It is known that bicycles are produced in a number of other countries, including Bangladesh, South Africa, Malaysiaand Kenya.

the data is not complete the number of countries producing or assembling bicycles - with local content - is almost certainly less than those carrying out the same operations in respect of motor vehicles.

5.3.1 The bicycle in developing countries

The data in Table 5.3 taken from a recent UNIDO report gives details of the distribution of vehicle ownership in India. As the report noted "The bicycle is the nearest thing to a mass vehicle, with one being owned by approximately one in four of the close to 100 million Indian households. The $24 - $35 cost (1975 prices) of a standard cycle is, needless to say, still substantial in an economy where the *per capita* annual income is only about $100. In proportion to that income, the bicycle appears in approximately the same relationship as a conventional car does to incomes in the United States or in some Western European countries". other notable feature of the results is that both cars and motor-cycles are

TABLE 5.3 : Vehicle ownership in India according to household : 1967/68

Annual disposable income (US $)	Number of households (million)	Percentage of households owning			Number of vehicles (thousands)		
		Motor cars	Motor cycles or scooters	Bicycles	Motor cars	Motorcycles or scooters	Bicycles
URBAN							
below 395	12.1	-	-	25.1	1	-	3048
395-658	3.8	-	0.6	58.8	-	24	2219
658-1316	2.2	0.4	3.2	48.2	10	72	1082
1316-1974	0.6	5.9	12.9	68.1	36	78	410
above 1974	0.4	38.6	22.9	51.2	155	92	206
	19.1				202	266	6965
RURAL							
below 395	54.5	-	-	12.4	-	4	6740
395-658	9.7	-	-	41.8	-	-	4044
658-1316	7.1	-	0.5	62.9	-	37	4446
1316-1974	1.4	0.8	2.0	73.4	11	29	1055
above 1974	0.5	5.7	11.5	75.8	27	54	351
	73.2				38	124	16636
ALL							
below 395	66.6	-	-	14.7	1	4	9788
395-658	13.5	-	0.2	46.4	-	24	6263
658-1316	9.3	0.1	1.2	59.4	10	109	5528
1316-1974	2.0	2.4	5.4	73.2	47	107	1465
above 1974	0.9	20.2	16.2	61.8	182	146	557
	92.3				240	390	23601

Source: All-India Household Survey of Income, Saving and Consumer Expenditure. 1972.

predominantly urban vehicles whereas the converse is true of bicycles.

It is apparent that bicycles are used in significant numbers in many developing countries, in rural as well as urban areas. They are relatively cheap (US $60-100),[1] rugged and easy to use and maintain. They can be used to carry a passenger or cargo up to 80 kg., although they can be difficult to control under heavy loads, and can operate on narrow paths and tracks.

Bicycles are already used to meet some of the transport needs of small farmers. In Rajasthan the bicycle has "given opportunity to the village dairy man to bring his milk and dairy products to the cities and adjoining towns" (14). In Malawi, "feet, *bicycles* (our italics) ox-carts and buses provide the main methods of transport for smallholders" (15). In Kenya "for trips to marketing outlets, *bicycles* (our italics) donkeys and animal-drawn carts are used along with headloading in many areas" (16).

In the developed countries the bicycle has, in recent years, become steadily more complex, principally through the use of lighter alloy materials and advanced mass production techniques. The type of bicycle which at present predominates in developing countries is, by comparison, old-fashioned, and indeed is typical of the designs produced in Western countries thirty or forty years ago. It has a strong heavy frame and sturdy wheels,

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[1] It is not possible to give precise figures for the cost of particular vehicles since these vary from country to country. Figures are quoted in this section simply to indicate the *order of cost* of different vehicle types.

the brakes are operated by rods rather than cables, the chain drive is generally completely enclosed by a gear-case and a rack is fitted over the rear wheel.

This type of bicycle remains popular because of it robustness and longevity. Its popularity reflects the fact that bicycles are used in a very different way in developing countries. They are habitually used to carry passengers and/or heavy cargo loads, they are operated on rough, unsurfaced tracks and paths, and are expected to stand up to arduous use for many years. They are, in summary, a basic load carrier rather than a convenient means of short distance personal transport.

Yet no bicycle has ever been designed to meet the very different operational requirements of developing countries. Moreover existing bicycles are unsuitable to manufacture in most developing countries.

"The bike we are making today is very much the bike we made and sold 25 years ago..... The Indian bike made no adaption to the way it is used. In our country, very different loads are carried on a bike from those carried in other countries" (17).

The'conventional' type of bicycle is suited to large-scale manufacture using highly mechanised methods. This is exemplified by the lugs, joining the frame tubes, which are formed by a series of complex pressing operations. With a few notable exceptions (e.g. India and China), individual developing countries do not have a large enough market to allow bicycles to be locally manufactured at a competitive price. As a result, most existing cycle factories in developing countries are assembly plants, with the majority of the components imported from the parent company. One approach to the design of a bicycle suitable for small scale production is illustrated by the Oxtrike - to be discussed in more detail subsequently - and the moped developed at the Institut fur Produktionstechnik und Automatisierung (18) in Germany, both of which use a frame fabricated from folded sheet metal.

Much could be done to improve the load carrying capability of existing bicycles. Loads can be carried over the front wheel, above and/or on either side of the rear wheel, or on the crossbar. There do not appear to have been many serious attempts to optimise the design of carriers suitable for

use with standard bicycles. In China, bicycles equipped with wicker panniers perform a significant role in the marketing of grain crops (19). In Kenya, bicycle carriers are made from scrap materials (20) and observation indicates a number of other, individually designed, carriers for special consignments such as milk churns. Information on the most useful of these carriers ought to be collated and made more widely available. The U.K. 'carrier' bicycle is an effective way of carrying loads but does not seem to be used to any significant extent in developing countries.

5.3.2 Bicycle railer

The loads which can be moved on a bicycle are limited by the space available and the difficulty of balancing when carrying a heavy weight. However heavier and more voluminous loads can be moved by attaching a trailer (21). The trailer can be designed for rapid attachment and removal and for auxiliary use as a handcart for on-farm transport. It offers the possibility of increasing the cargo or passenger-carrying capability of the bicycle at low cost (US $30-50). Cycle trailers can be made in wood or in steel and are suitable for production in small workshops.

Cycle trailers are widely used in many rural parts of Europe and are one of the standard means used by the Swiss Postal Service for the delivery of letters and parcels. However, except in French-speaking countries of Africa and Indo-China their use in developing countries is uncommon.

It is estimated that there are 40-60,000 bicycles in the rural areas of Kenya (22) but as far as is known not a single bicycle trailer. This seems to be a case not of an inappropriate technology but of one that is *unknown*. There are however signs of increasing awareness of the potential of the cycle trailer. One interesting application which has been identified in designs evolved in Nigeria (23) and Malawi (21) is as a rural ambulance. A disadvantage of the conventional two-wheeled trailer is that it limits the type of route over which the bicycle can be used since the trailer is usually too wide to operate on narrow footpaths. Therefore there seems to be potential for a single wheeled trailer with the same 'two-dimensional' characteristics as the bicycle.

5.3.3 Tricycles

The utility of pedal power can be extended by the use of a tricycle (initial capital cost US $150-200) purpose-designed for load-carrying. The tricycle is inherently stable and can carry loads of 150-200 kg. but like all pedal-driven forms of transport, is only suitable for use on relatively flat terrain.

The tricycle is already widely used in Asian cities as a passenger carrier, commonly known as a cycle rickshaw or trishaw (24) (25). However, it appears to be virtually unknown in Africa. In some cities of Asia tricycle use is under pressure from authorities who wish to restrict them either because of their supposed 'effect on traffic congestion' or because they are considered 'inhumane'. Riding a fully loaded tricycle is certainly hard work, though we argue below that the effort involved can be significantly reduced by more efficient design. There is certainly no shortage of people wishing to ride tricycles and they are an important form of employment.

In Bangladesh the cycle rickshaw has become an important means of rural transport (26). They are operated on a hire basis, as in the cities, and are used to carry passengers and cargo. Many tricycles retain the same passenger bodywork used in the cities, though in some areas this has been replaced by a simple, flat cargo platform. The tricycles are used on earth tracks and on brick-soled roads, and often carry greater loads than in the city - it is not uncommon to see four passengers and their goods being carried. These more arduous operating conditions highlight the design deficiencies of the traditional tricycle.

The traditional tricycle has a single gear the same as, or slightly lower than, on a bicycle. This is quite inappropriate when its loaded all-up weight can be three times that of a bicycle. The construction is crude and excessively heavy. The wheels are basically the same as those used on a bicycle, and are not designed to withstand the side-loads encountered on tricycles. As a result the spokes break easily and the rims distort.

The 'Oxtrike' is an attempt to overcome the design deficiencies of traditional tricycles (27). It incorporates a three-speed cycle gearbox and a simple differential formed from two freewheels. In addition to the standard front brake there are foot-operated inboard band brakes on the rear wheels. A strong, light box section frame is used and the weight of the Oxtrike, without bodywork, is some 15 kg less than an Indian tricycle in the same condition. The Oxtrike is designed to be suitable for small-scale manufacture in developing countries. It utilises standard cycle components whenever possible, and the frame is formed from folded and welded 16 gauge (1.6 mm) sheet steel.

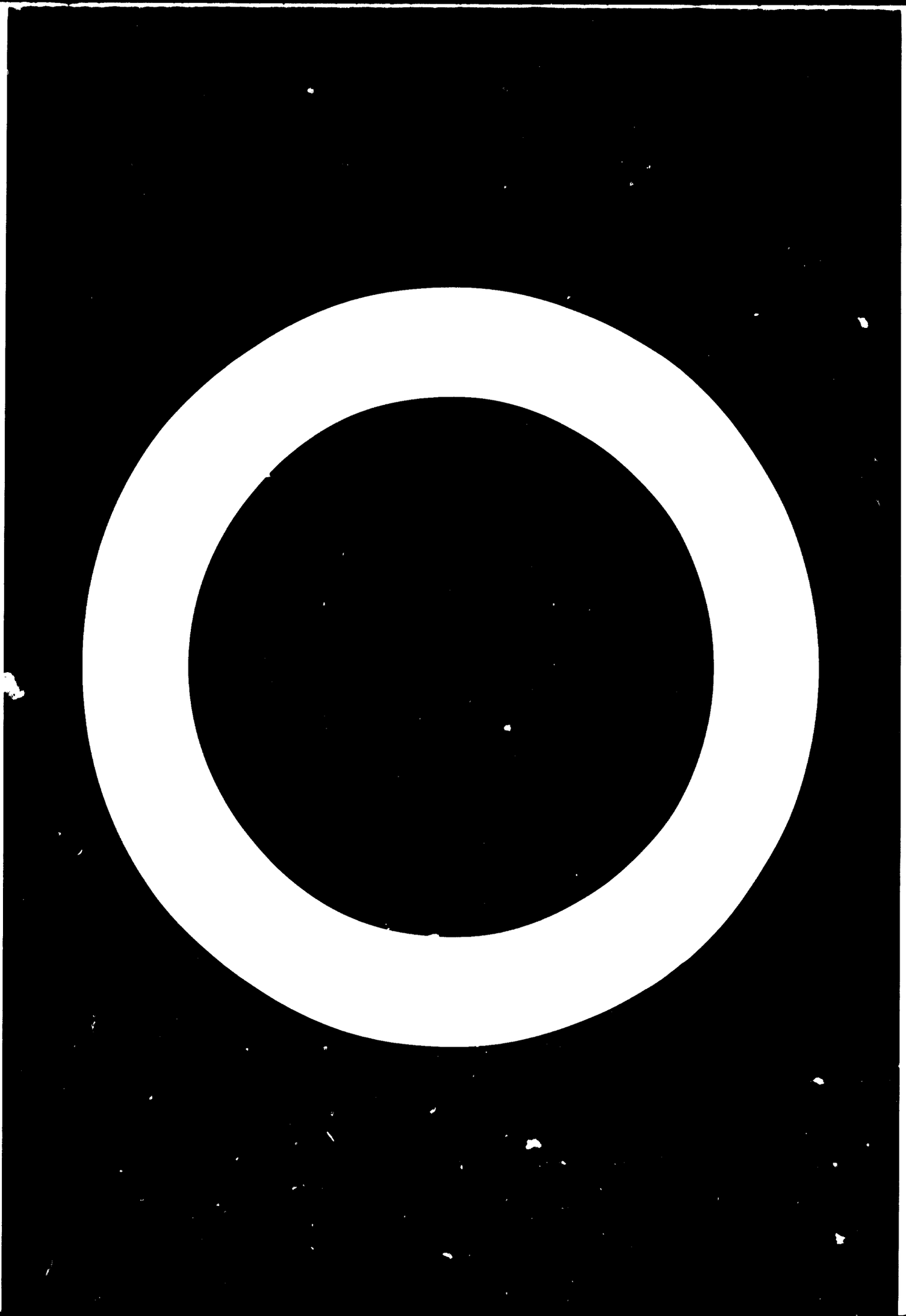
It could therefore be fabricated in a small workshop equipped with shearing, bending and welding facilities.

5.3.4 Other uses of pedal power

The discussion up to now has been concerned with existing forms of pedal driven transport. However, the principle can be applied in other ways. It is possible, for example, to envisage multi-person pedal driven vehicles which could carry greater loads and/or operate on more difficult terrain. Pedal power can be applied to agricultural functions such as crop-processing and cable ploughing. A design for a standard 'pedal power unit' which, with appropriate attachments could be used for both stationary and transport applications has been proposed (28).

5.4 Animal transport

The next stage in the progression of basic vehicles is the use of animals as the source of power rather than people. A number of animals are used for transport purposes, including the horse, mule, donkey, ox, buffalo and camel. The power output of the different animals varies according to breed, size and condition: typical figures are given in Table 5.4 In all cases the available power is much greater than that which can be generated by human beings. (for the latter typically 0.08 - 0.1kw). Thus the use of animals allows greater loads to be moved, though speeds are slow. It is not sensible to attempt to give figures for the cost of work animals, since this will vary with availability and demand, species, breed, age and condition.



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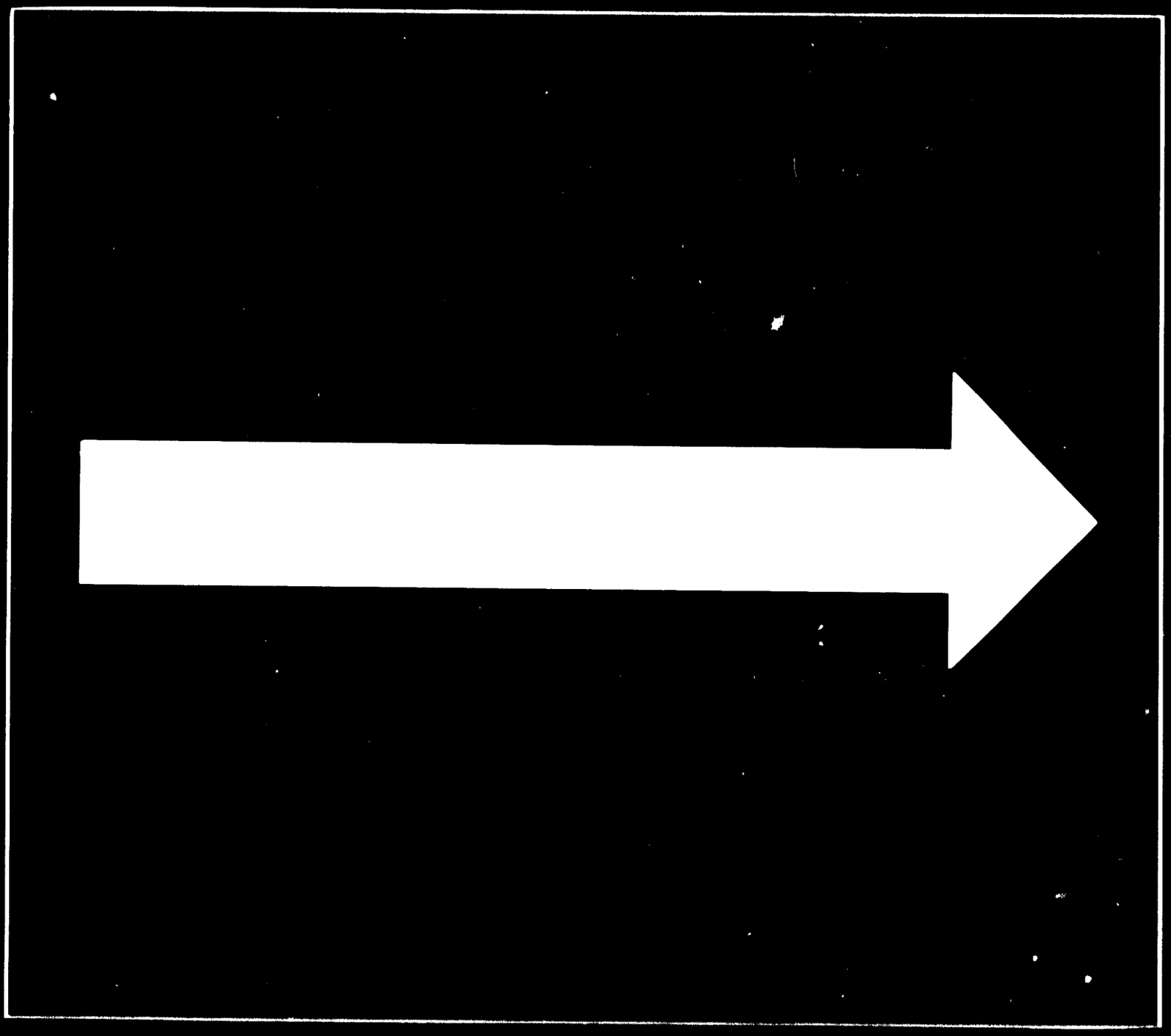

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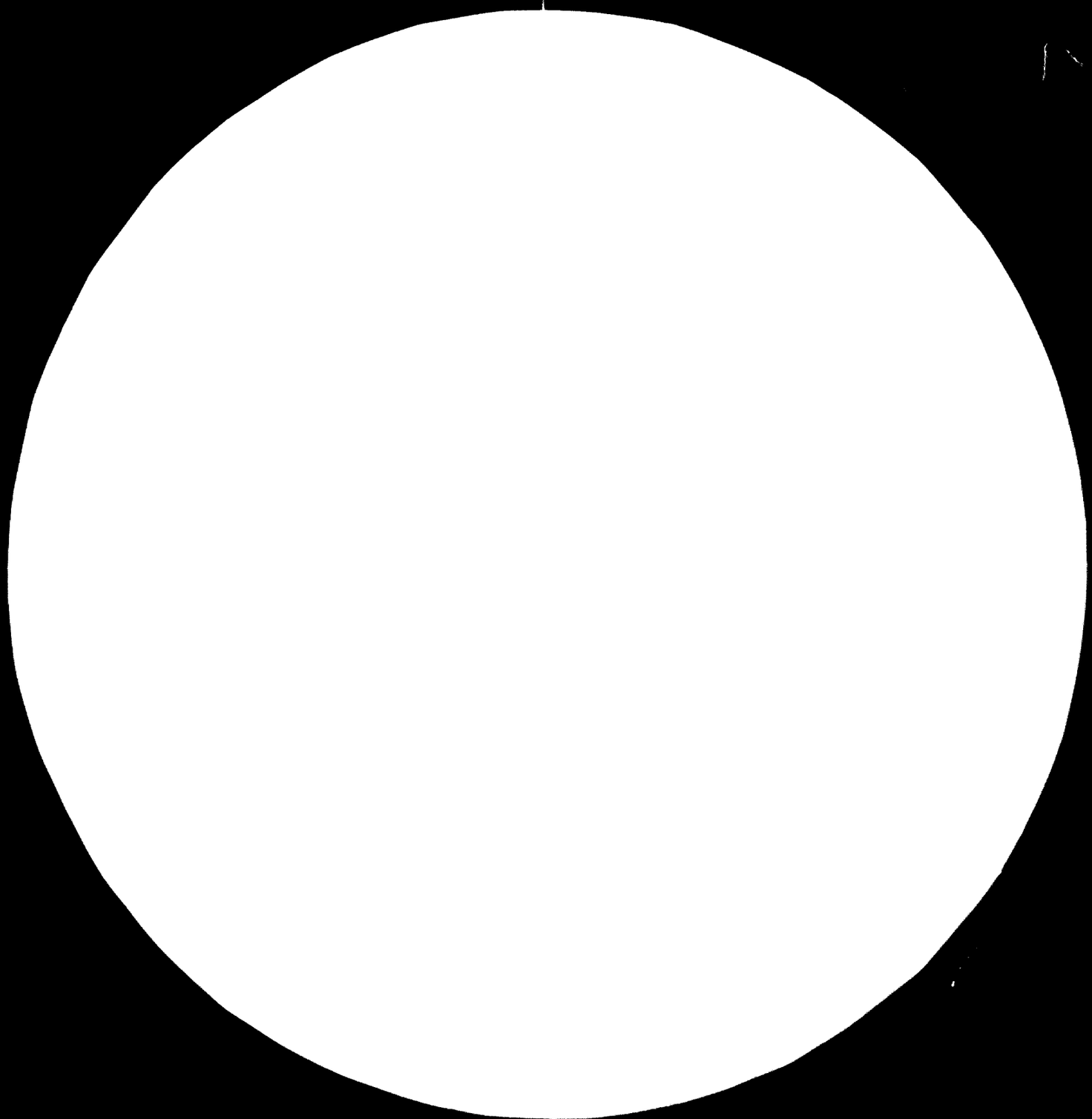

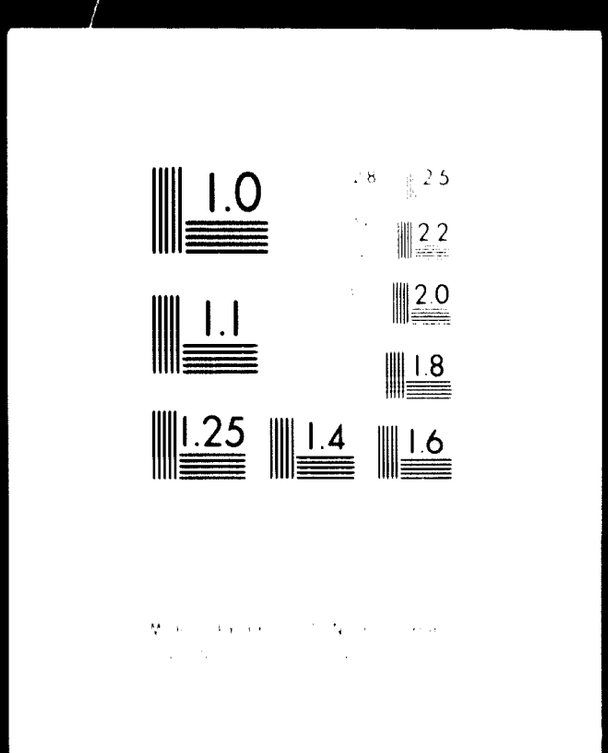

Table 5.4 Power output of work animals

Animal	Average Weight Kg.	Power Developed Kw
Bullock	500 - 900	0.55
Buffalo	400 - 900	0.55
Cow	400 - 600	0.35
Mule	350 - 500	0.50
Donkey	200 - 300	0.25
Light-Horse	400 - 700	0.75

Note: Power developed is an average figure. It will vary according to the weight of the animal.

Source: FAO (29).

Animals play an important role in the agricultural systems of most developing countries. This is particularly so in Asia where agriculture is predominantly animal powered,rather less so in Africa where animal draught cultivation methods have developed fairly recently. However, "there is considerable interest in animal draught cultivation" (30) which many African countries are now actively promoting.

It is sometimes suggested that efforts should be directed towards introducing mechanised, rather than animal-based, agriculture. However the successful introduction of mechanised methods is dependent on the farmers having the necessary financial resources, and upon the existence of technical support services. For the foreseeable future, many small farmers will simply not be able to afford mechanised equipment. Thus while there is likely to be a steady growth in mechanised agriculture, animal draught cultivation will also have a significant role. Given its continuing importance there are obvious advantages in using the same source of power for transport.

5.4.1 Pack animals

These are used in many different parts of the world, their major application being in steep, rocky or very sandy terrain where wheeled transport is impossible. Table 5.5 gives typical loads and speeds for pack animals.

Table 5.5 Performance of pack animals

	Load Kg	Speed km/hr
Pony	100-150	3-4.5
Mule	75-150	3-4.5
Donkey	70-120	2.5-3
Camel	120-680	3-5

Source: World Bank (31).

The load varies according to the route conditions and distance, the lower figure in the table being indicative of that which can be carried continuously for a full day.

The only equipment required for this form of transport is a carrying container or saddle . In some cases this consists of cord lashings, though often bags or wicker baskets are used which ensure better balancing of the load. The containers are usually made of local materials to traditional designs and the investment is small. However there is little information available about these containers and there is a need for a survey of the techniques used, so that they might be applied elsewhere.

The loads which can be carried by pack animals are limited, and, except in difficult conditions where wheeled transport is impossible, the animal cart is more efficient.

5.4.2 Animal carts

Animal drawn carts are a major form of rural transport in the Asian region. The prime example is India where it is estimated that they now number some 14,000,000. The Indian Institute of Management in Bangalore has estimated that at present over 60 per cent of all goods carried from farm to market are moved by bullock cart. (32) In rural areas most of these carts are owned by individual farmers, and the same animals are also used for agricultural activities. The farmer, in addition to using the cart for his own on- and off-farm transport requirements, may also hire it out to other local farmers.

The salient features of the traditional cart are common throughout the Asian region. It has two large diameter (1 - 1.75m) wooden, usually spoked, wheels, each enclosed in an iron rim. The wheels are mounted on a forged iron axle and run on very loose-fitting steel bushes. The axle is contained in a wooden block onto which is fitted a wooden platform. This runs forward to a simple yoke to which are harnessed a pair of bullocks or buffaloes. The typical cart costs US $100 - 180, has a maximum payload of about 1 tonne, and moves at 3.0 - 4.5 km/hr. These carts can operate on very muddy tracks though they cause damage to surfaced roads because of the very high contact pressure at the rim.

Because of the damage to surfaced roads caused by steel-rimmed wheels tyre manufacturers in India produce an alternative ADV (animal drawn vehicle) wheel. This is a pneumatic tyred run on ball bearings, the whole assembly being fitted to a specially fabricated steel axle. The cost of a cart with a steel axle and ADV tyres is approximately twice that of the traditional vehicle. (32) Such carts can, on good surfaces, carry loads of up to 2.5 tonnes, yet their penetration of the market has, up to now, been very limited and use is concentrated in urban areas and in the affluent agricultural regions with relatively good roads. Experts generally agree that in muddy conditions pneumatic tyres are less effective than traditional wooden wheels and there is some research evidence to support this. (33)

The use of animal carts is less widespread in Africa, even in areas where animals are used for draught cultivation. However, the use of wheels with pneumatic tyres appears to be more common in Africa than Asia (probably because wooden wheel building skills are not widely known). These wheels are usually used in conjunction with the discarded rear axle of a motor vehicle. These are excessively heavy since they normally include the useless brake drums and differential assembly and can be difficult to obtain. Maintenance problems are also encountered with the pneumatic tyres.

There are major deficiencies in the design of existing carts so that the available power of the animals is used very inefficiently.

(i) The carts are excessively heavy - the tare weight of a conventional Indian cart is around 400 kg, that of ADV tyred carts varies from 500 - 550 kg. (32). Obviously the heavier the cart the lower the useful load that can be carried.

(ii) Many existing carts are badly balanced so that a significant portion of the load bears down on the necks of the animals. This means that some of their energy must be devoted to

supporting the load rather than propelling it forward.

(iii) The yoke of bullock carts usually consists of a simple wooden beam resting on the necks of the animals with wooden attachments and ropes to keep the yoke in place. This type of yoke is inefficient since it transmits power from the animal through the relatively weak neck, rather than through the strong shoulders. Furthermore, the yoke rubs on the neck and frequently causes open sores which can become cancerous.

(iv) The traditional wooden wheel is effective in muddy conditions but is heavy, damages surfaced roads, and uses very inefficient bearings. The pneumatic tyred wheel is expensive, causes maintenance problems and does not perform well in muddy conditions.

There is thus a major need for a complete re-appraisal of cart design, leading to devices which utilise the energy of the animals efficiently. This would result in carts with increased carrying capacity and would offer the possibility of using only one animal instead of two. It is likely therefore that the cost of transport would be decreased and its speed increased. Because of the range of conditions under which animal carts are operated and manufactured the need is for a range of different designs.

In India there have, since 1944, been a number of investigations into the performance of carts. (34) (35) (36) Recently several organisations, including the Indian Institute of Management and the National Institute of Design, have made proposals for improved bullock carts. (37) The main reason for this spate of activity appears to be the recognition that the bullock cart is not going

to be replaced by the truck. "Thanks to the oil crisis people who used to talk about the mechanisation of rural transport are now conceding the key role the humble bullock cart plays in transporting men and materials from villages to towns". (38) However, none of these efforts over the past thirty years have yet had any significant effect on the carts actually in use in India. Recently efforts to develop improved animal cart designs have been made in a number of other developing countries, including Nigeria, Botswana, Malawi, Tanzania and Senegal. (39) (40) (41) (42)

5.5 Motor cycles

Data about motor cycles is more difficult to obtain than for larger motorised vehicles since many countries do not include them in official statistics. Table 5.6 presents

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[1]The three-pad collar harness has been proposed as a solution to bullock yoke problems. This harness was introduced in Europe in the 1930's and is based on the principles of the horse collar, but with no restriction across the front of the neck which would press on the windpipe. (29) It has been estimated that the use of the harness could *double* the useful work output of bullocks. (43)

TABLE 5.6 : Motorcycle* statistics for selected developing countries (1975)

	Motor cycles 000's	Motor cycles per 1000 persons	Motor vehicles per 1000 persons	Commercial motor vehicles per 1000 persons	$ GNP per capita
Chad	0.7[2]	0.2	3.1	1.6	120
Ethiopia	1.1[1]	0.1	2.0	0.4	100
India	1070.2[1]	1.8	2.2	0.9	140
Indonesia	719.4[2]	5.7	3.8	1.4	220
Malawi	5.4	1.1	3.8	1.7	130
Mali	33.8[1]	6.1	3.4	0.5	90
Mozambique	0.3[3]	0.1	11.3	1.5	180
Niger	0.9	0.2	4.0	0.7	130
Sierra Leone	1.1	0.4	5.5	1.7	200
Sri Lanka	22.8	1.7	10.2	3.5	190
Thailand	464.8	11.1	6.1	2.5	350
Uganda	7.2[1]	0.6	30.8	3.4	230
Upper Volta	1.8[1]	0.3	14.4	6.6	110
Zaire	8.0[3]	0.4	3.8	1.4	140
Zambia	9.0[1]	1.9	3.0	0.5	420

Source : International Road Federation : World Road Statistics 1976.

* includes mopeds, scooters.

1 1974
2 1973
3 1972

statistics for selected developing countries for 1975. These show that the use of the motorcycle is significant in relation to other motorised vehicles, though there are considerable variations in the ratio of motorcycles to private cars and commercial vehicles in different countries.

World production of motorcycles is estimated to have increased by approximately 23 per cent since 1970, to an annual total of some 8.3 million in 1976. As Table 5.7 shows, this has been dominated by the developed countries, Japan in particular: of the poorer developing countries only India and Thailand have produced motorcycles in significant numbers. (44) In the same period world private car and commercial vehicle production increased by an estimated 14 and 22 per cent to annual totals of 25 and 8 million respectively. (45) Thus, in absolute terms current world production of motorcycles is about the same as commercial vehicles and one-third that of private cars, although relatively production of motorcycles in the last half decade has grown at about the same rate as commercial vehicles and some 50 per cent faster than that of private cars.

While the role of the motorcycle in developing countries is significant, observation suggests that its use is predominantly urban. The same would also appear to be true of the three-wheeled passenger and cargo carriers based on motor-cycle technology, such as the Indian auto-rickshaw (24) and the Indonesian bemo (25). Yet there would appear to be considerable potential for the use of motorcycles in rural areas. Quite apart from its economy in relation to other forms of motorised transport, it is suitable for operation on narrow walking tracks and in hilly terrain. In Papua New Guinea the motorcycle is used by government officers to travel to the more remote areas, often in mountainous terrain, where the only access is by footpath (24). The machine used is a 90cc Honda with a transfer gearbox giving a high and low range of gears, the latter allowing the motorcycle to be ridden up very steep inclines.

TABLE 5.7 : World production of motorcycles : 1976

Japan	4,235,112
Italy	1,016,500
France	994,725
Germany	327,465
Poland	290,000*
Spain	241,455
India	240,000*
Thailand	230,000*
Czechoslovakia	229,554
Austria	200,786
Morocco	65,000*
Portugal	62,600*
Holland	61,200
Yugoslavia	57,376
Turkey	35,992
Switzerland	23,645
U.K.	21,500
Argentina	11,200*
Total	8,344,110[1]

Source : Bilan de l'Industrie du Cycle et du Motocycle en 1976.

* estimated from 1975 or part-year returns.

[1] There are a number of other countries who have not submitted returns for several years and it is not certain if they are all still in production. Crudely a further 91,000 could be added to this total made up as follows.

Brazil : 7,000 (1973); Belgium : 40,000 (1974); Denmark : 1,936 (1974); Greece : 6,633 (1973); Hungary : 34,383 (1974); Israel : 1,000 (1974). There are unknown numbers produced in China, USSR and a few other countries.

A major reason why motorcycles are not used in rural areas would appear to be that production is dominated by the developed countries. Trends in the design of their products make them increasingly irrelevant to the requirements of rural areas of developing countries. Motorcycles have become steadily more complex, and in all probability more expensive in real terms, with a shift away from kick-started single-cylinder 2-stroke engines to electric started multi-cylinder four-stroke engines; from cable-operated drum brakes to hydraulic disc brakes; and from spoked to exotic alloy machined wheels.[1]

For use in rural areas the present requirement for the motorcycle is analogous to that of the bicycle: it must be rugged, simple, easy to manufacture and maintain locally, suitable for continuous use on rough tracks and capable of being used as a cargo carrier rather than simply a means of personal transport. *As with the bicycle it is arguable that no motorcycle has yet been designed specifically to meet the needs of developing countries.*

Considerations of space and balance limit the load that can be carried on a motorcycle. However it can be adapted to increase its utility. In Vietnam and other parts of Indo-China moped trailers are used - "in certain country districts the honda[2] is used with a small, two-wheel trailer which can carry both passengers and freight. With the trailer, a 50cc Honda can move, albeit slowly, five adults or 200kg of produce". (25) The moped and trailer is also one of the methods used by the Swiss Postal Service for delivering parcels and letters.

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[1]An exception to this generalisation is India where, as a matter of deliberate policy the motorcycles produced are, in Western terms old-fashioned (the same is true of Indian cars). One Indian motorcycle, based on a post-war British Royal Enfield model is now exported, albeit in small numbers, to Europe to meet a specialised demand for a 'traditional' motorcycle.

[2]Generic Vietnamese term for a small motor-cycle.

In the Philippines some 90 per cent of motorcycles (168,000 in 1975) are fitted with sidecars. These combinations are based on Japanese motorcycles with power units in the range 80 - 125 cc, the complete vehicle being capable of carrying a payload of 250 - 400 kg or two passengers plus the driver. The side-cars are usually manufactured in small, independent work-shops using elementary metal-cutting and welding equipment. The vehicles are used extensively in both town and country. In the latter role they have been found particularly versatile and able to operate on quite simple tracks.

The cheapest device that falls within the motorcycle category is the motorised conversion of the bicycle. The simplest means of doing this is to fit a small motor above the front wheel, which it drives through a friction roller. This system is used by the French Velo-Solex company who have produced several million machines using this principle. In India there is a commercially available conversion kit which consists of a small (35cc) engine mounted in the bicycle frame and driving the rear wheel through an additional chain drive. This conversion has proved successful on bicycles, but problems have been encountered where it has been applied to cycle rickshaws. (46) These problems have arisen for two reasons. First the engine and transmission does not appear to be sufficiently robust to withstand the greater loads encountered on cycle rickshaws. Second the greater performance of the motorised version highlights the shortcomings of the basic rickshaw chassis design. However with an improved tricycle design such as the Oxtrike (27) there is no fundamental reason why an appropriate motorised conversion should not be successful.

Up to now it would seem that the potential of the motorcycle and it derivatives have been largely neglected. There are limitations as to what can be achieved by human and animal powered forms of transport. The extra power available when a motorised vehicle is used extends transport capability significantly. This extra power can be used to move

greater loads, to travel more quickly, and to operate on difficult or hilly terrain.

A motorised bicycle should sell for (US $150 -200), a moped for US $250 -350, a small motorcycle for about US $600. *The major need, if the potential of the motorcycle is to be exploited, is for the development of designs suited to the requirements of, and to small-scale manufacture in, developing countries.*

5.6 Basic motorised vehicles for the small farmer

The last few years have seen a growing interest by a number of international and national institutions, in basic motorised vehicles for the small farmer. . In some cases improved transport *per se* does not appear to have been the prime objective: it is a by-product of efforts to mechanise agriculture.

An example of this form of development is the 'single-axle' or ' 'two-wheeled' tractor. This type of tractor is used extensively in the People's Republic of China.

It has a 7.5 kw single-cylinder diesel engine and in addition to its agricultural functions it can be hitched to a trailer and haul a payload of 1200 kg at 15 km/hr.(47) A 4-5 kw petrol-engined single-axle tractor has been developed at the International Rice Research Institute (IRRI) in the Philippines specifically to meet the needs of the many small-scale Asian rice farmers. A range of attachments has been developed for cultivating upland and lowland crops, for transport, and for irrigation. The machine was designed to make maximum use of standard components, the engine, roller chains, sprockets, bearings and seals used in the power tiller being imported into most Asian countries for other uses.
countries for other uses. The remaining components of the power tiller are fairly simple and can be produced by small metalworking shops. The power tiller was introduced in 1972 and is now produced by 12 companies in six Asian countries: up to December 1974 a total of 6021 units had been produced commercially. (48) This single-axle tractor is marketed in the Philippines at a price (US $1000)

approximately half that of comparable imported machines from developed countries. Because the machine was developed to suit the low volume production technology that was readily available, no new equipment had to be acquired by the manufacturers in the Philippines. In the first two years of manufacture in that country some 700 new jobs were created in the manufacturing sector at a capital investment of about US $200 per workplace. (49)

The single-axle tractor has been successfully used for wetland agriculture in Asia but is not suited to the more arduous requirements of dryland cultivation. There have been many attempts since the war to develop 'simple', 'basic' or 'low-cost' tractors, most of which have had the capability to move on-board or trailed loads. These devices have been proposed as an alternative to the conventional tractor which is expensive, complex and quite beyond the means of the small farmer. Indeed a study in Pakistan has shown that the introduction of the conventional tractor worked to the disadvantage of the small farmer because of its adverse effect on farm employment. "Some of these jobs were compensated for by casual labor use on seasonal tasks at a rate which implies an overall net destruction of jobs of about five per tractor".(50) However, 'basic' tractors have met with only very limited commercial success. A major reason for this is that in simplifying the design and lowering the cost, power output, weight and wheel size have been reduced, thereby reducing the ploughing performance of the tractor. (51) An attempt to overcome these difficulties is the 'SNAIL' developed at the National College of Agricultural Engineering, UK. This is a winched, rather than towed, cultivation system, the SNAIL being, in essence a motorised winch. It can be simply adapted to tow a trailer for transport purposes.

There is also a group of purpose-design motorised transport vehicles suitable for use by the small farmer. IRRI have developed . a self-propelled cart, initially intended as a means of moving a thresher but now generating considerable interest as a general purpose vehicle. It is a three-wheeler with a single, driven and steered front wheel having a payload of 720 kg and a top speed of 15 km/hr. In Crete three-wheeled rigid chassis vehicles powered by single cylinder diesel engines have been developed in the

past few years. Their evolution appears to have resulted from the use of single-axle tractors and trailers for goods movement, leading to a demand for vehicles similar in concept but specifically designed for transport use. The vehicles are produced on the island by small-scale manufacturers (53). Vehicles very similar in concept to these 'basic three-wheelers' are used by many municipal authorities in Europe.

The machines described above exemplify the localised use of certain types of basic vehicle and indicate the need to make information about such devices more widely available It is evident that these basic farm vehicles will be more expensive than the non-motorised devices described earlier, and require more complex maintenance skills. There is a lack of information regarding the circumstances under which such motorised vehicles can be introduced successfully in a particular area. Much could be learnt from a case study of the situation in Crete, where the manufacture and marketing of such vehicles seems to have arisen spontaneously.

Lastly, mention should be made of attempts to produce simplified versions of conventional motor vehicles. Several major international manufacturers, including Ford, General Motors, Toyota, Datsun and Volkswagen are now producing Asian Utility Vehicles (AUV's) (13). All use major assemblies including engine, gearbox and rear axle taken from the manufacturer's existing ranges, built into a simple, sturdy light-truck chassis with a beam front axle. A cab made up of flat panels - which can be produced without using expensive tooling - is added, and a number of rear bodywork styles are available, including flat-deck, closed-van, and passenger-carrying The intention is that these vehicles should be cheap to produce with a significant local manufacturing content, durable, economical to run and simple to maintain. Since their introduction in the Philippines in 1972 the AUV's have grown rapidly in popularity, with 1975 production estimated at some 12,500 vehicles. AUV's are now produced in smaller numbers in other Asian countries, but have not yet penetrated into Africa to any significant extent. While AUV's undoubtedly have a valuable role to play they represent a 'top-downwards' approach to the

development of more appropriate forms of transport and their retail price is still somewhat above the level necessary. to achieve substantial market penetration (54).

Manufacture of motorised vehicles in developing countries

The evidence from the work of IRRI and from Crete demonstrates that basic motorised vehicles can be produced economically on a small scale in low-cost labour economies provided that the product and the production processes are suitably adapted for manufacture at this level.

In the examples cited, the approach has been to make use of standard (usually imported) components and assemblies - engine, chains, bearings etc - and to fabricate locally the chassis, bodywork and simpler components. Thus there is still a significant imported content in the final product, the major single item being the engine.[1]

The development and wider application of techniques for the low volume production of internal combustion engines would have important implications for the local manufacture of basic motorised vehicles, and for other applications such as power generation, water pumping and water transport.

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[1] There is one known example of an internal combustion engine being locally produced on a relatively small scale. The Thai Heng Long Co. Ltd. "is producing high speed air-cooled engines in Chachiengsao, a predominantly rural area of Thailand. The owner of the company is a highly innovative individual and he has adapted the engine design by incorporating ideas from many popular makes of imported engines. He then set about to develop simple production equipment for labor-intensive manufacture. This company now produces 1500 engines a month in the 10, 15 and 20 hp size, with very simple, non-automatic production machines and has started to export the engines to neighboring Southeast Asian countries." (49)

The Asian Utility Vehicles described earlier have been developed with the aim of reducing the minimum level of economic production and increasing local content. The Jeepney, the most distinctively Filipino means of transport, can be viewed as the forerunner of the AUV. When the American armed forces departed at the end of the war they left behind a large quantity of equipment, including many jeeps. Local mechanics converted a number of these jeeps, by extending the wheelbase and fitting seats onto the lengthened rear platform, to provide a basic means of motorised transport. From these origins the manufacture of jeepneys has developed into an important local industry in the Philippines. As original supplies of parts have been exhausted, so more and more components have been manufactured locally. (24) "Francisco Motors, the main Jeepney manufacturer, began as an automotive paint shop in 1947, undertook body building in 1951 and proceeded to assembly and progressive manufacture in 1955. Today - apart from the engine, transmission, drive train and wheels - the Jeepney is manufactured in the Philippines". (13)

A more comprehensive approach to the economic, low-volume production of complex motorised vehicles is embodied in the design of the Trantor. This is a new type of work vehicle[1] designed for manufacture by the 'Group Technology' production system. The engine and other standard components are bought-in but machined parts, including some gears, are made within the factory. All components are designed to be suitable for manufacture on standard machinery and no special purpose production equipment is used. The components are grouped into 'families' which have similar manufacturing operations. "It is then possible, because one is dealing with groups of similar components, to set up groups of machine-tools with associated jigs, tools and fixtures, so that the time taken to change from one family member to another is virtually the same as if they were the same components. As each family can

[1] The Trantor can carry out virtually all the tasks and operate with the same attachments as a conventional agricultural tractor, but can, on good road surfaces, be driven at speeds up to 90 km/hr and haul trailer loads of 8 tonnes safely at speeds of 55 km/hr.

contain anything up to fifty similar components it is soon possible to substantially increase the effective batch size and reduce the cost per component". (56). By use of this manufacturing concept the Trantor can be produced economically in low volume. A 'standard' Trantor factory is designed to have an annual output of 1000 units. The 'Group Technology' production concept can be applied to motor vehicles other than the Trantor. However the success of the system is critically dependent upon *the vehicle being designed specifically for production by this method.*

5.8 Discussion

We have demonstrated that there exists a range of 'basic vehicles from simple aids to goods movement by man through to cheap motorised forms of transport. The vehicles have operational characteristics which offer a wide choice for meeting transport needs under different conditions. *The technology can be related to basic movement needs and is accessible, available (or potentially so), in sensible relation to income, simple to use and maintain, and utilises local resources in terms of manufacture, energy, spare parts and operating skills.*

In discussing the characteristics of basic vehicles no mention has been made of operating costs, but as we have argued in Section 4.3, there are other factors which are equally important in analysing the suitability of transport modes. To the user, availability of transport at the time required is of great importance and can best be ensured by personal ownership. While it would be foolish to suggest that all of the rural poor will be able to own a vehicle which meets their transport needs, the introduction of cheaper vehicles will at least bring the level of ownership closer to the individual and hence increase availability. Comparisons of the operating costs of different vehicles take no account

of the cost to society of providing and maintaing the transport infrastructure. All basic vehicles can operate on routes of lower quality, and thus cost, than those prescribed by the use of conventional motor vehicles. They therefore offer the possibility of extending the availability of transport facilities in rural areas, (including those required to meet on-farm needs), perhaps accompanied by relatively minor upgrading of existing routes.

One of the major reason for arguing the appropriateness of basic vehicles is that they can be made to suit the consignment sizes, distances of travel and operational conditions typically encountered in rural transport.

There is much good basic vehicle technology which could be widely applied, but whose use is at present very localised. Where information on such technologies exists it is obscure, uncollated and unknown to those who could make use of it.

Few vehicles have ever been designed specifically to meet the needs of developing countries. Several of the basic vehicles discussed here have been designed to meet the requirements and production systems of developed countries and then marketed elsewhere. Their use in developing countries indicates not that they *best* meet transport needs but rather that they are better than anything else currently available. Vehicles designed for use in developing countries must also be suitable for local, low-volume production. The system of manufacture envisaged for the vehicle has to be taken into account throughout the design process if the product is to be commercially competitive.

While devices which meet the transport needs of the rural poor must be simple and low cost, this does not imply that their development is an easy task. Rather, experience suggests that *the development of effective basic vehicles requires the application of contemporary technical knowledge and the very best technological skills.* It is not difficult to specify the technical problems that need to be overcome, but the transport needs of the rural poor will only be satisfied if recognition is given to the necessity for policies that result in a balanced approach to transport provision.

6. POLICIES FOR MORE APPROPRIATE RURAL TRANSPORT

We have argued:-

(i) That the technologies applied in the past have been inappropriate to, and ineffective in meeting many of the transport needs of the rural sector; and

(ii) That there are alternative and more appropriate transport technologies which can better meet many of these needs.

However, the ideas outlined in this paper do not, as yet, enjoy wide currency. Therefore the likelihood of implementing such policies for the provision of more appropriate rural transport facilities is dependent upon substantial changes in present *attitudes*.

6.1 Attitudes towards 'appropriateness'

The existing government, institutional and commercial climate is heavily biased towards the construction of roads suitable for motor vehicles. If more appropriate transport technologies are to succeed there must be a change in the attitude of senior and middle management in government departments, and by those involved in research and education for the transport sector.

Present attitudes in developing countries are powerfully influenced by the developed world. The major international companies have the resources and incentive to exert considerable influence and pressure in promoting the transfer of capital-intensive technologies, such as motor vehicles,

There is, at present, no pressure group which is exerting a similar and counterbalancing influence to promote the use of more appropriate transport technologies. The bilateral and multilateral aid agencies influence attitudes through the provision of finance, expertise and equipment. They can thus play an important role in changing attitudes in developing countries by:-

(i) policies for the provision of finance and equipment which encourage the application of appropriate transport technologies;

(ii) according greater importance to appropriate transport technology in their research activities, thereby giving the subject greater visibility and status; and

(iii) taking care, in providing expert assistance, not to impose external standards and procedures which may be inappropriate.

Attitudes towards appropriate transport technology will be affected by the priorities accorded to the subject by individual governments. If the executive officials of government are to make the effort necessary to develop expertise in the subject, and to attempt to apply it in practice, then they must perceive that the topic is accorded some status and that their efforts are likely to be rewarded. If instead government priorities are oriented towards large-scale capital-intensive projects, then efforts to implement appropriate transport technology will be limited to a few 'committed' individuals.

Part of the process of changing attitudes will involve the development of expertise on appropriate technology by those currently responsible for the planning and provision of transport facilities. The concepts of appropriate transport technologies should be incorporated into educational courses, particularly those of universities, which will provide the decision makers of the future. The support, by donor agencies, of research institutions, training schemes for government employees and improved information services, all oriented towards more appropriate technologies, will assist in achieving this.

Necessary changes in attitude extend to the collection of information. At present official national and international statistics include only motorised vehicles and, in many cases even exclude motorised two-wheelers. Equally, existing statistics on road networks are based on an arbitrary definition of what constitutes a road and, for the most part, exclude footpaths and tracks not used by motor vehicles. The implication is that the characteristics of more 'basic' forms of transport are not sufficiently important to warrant official attention. For the rural poor nothing could be further from the truth: to them the basic forms may *be* the transport system.

Undoubtedly the fact that basic forms of transport, both vehicles and routes, have not been accorded any official recognition has contributed to their neglect. Correcting this situation will not be easy since many of the vehicle types do not have to fulfil any registration requirements and the routes are not part of public works maintenance inventories. However, information on basic transport is essential both to change current attitudes and to create a basis for planning improvements. It is vital that the surveys and presentation of results should be integral with

existing transport information so that basic facilities are seen to be a part, and an important part, of the total land transport system.

6.2 Policies for appropriate transport

The most fundamental change required in policy is to ensure that rural transport planning explicitly includes an appraisal of the needs of the small farmer and the constraints within which *his* choice must be made. Poorly understood as these needs are, the implication is that the most appropriate type of vehicle and the 'track' it requires will be *issues to be decided by local circumstances* rather than to be externally imposed by the assumed use of conventional motor vehicles. A transport planning process which includes the appraisal of the needs of the small farmer will be very different from that currently practised:

(i) The first step would be a small-farmer specific analysis of the magnitude, frequency and duration of transport needs and of the distances over which movements were required.

(ii) Cognizance would need to be taken of the proximity and structure (condition, degree of integration) of all existing routes (footpaths, tracks and roads) and motor vehicle services.

(iii) Consideration of (i) and (ii), existing incomes and/or credit facilities, and attitudes towards different forms of transport would indicate the likely range of functionally and economically appropriate vehicles.

(iv) The consequences of (iii) in terms of current availability, ease of manufacture and repair from local resources, and employment generation would then have to be evaluated.

(v) Finally a selection would be made of the vehicle(s)/ route(s) combination that would best meet local needs and consideration given to what forms of assistance were necessary for it to be provided.

Two crucial elements of this process are: (a) greater flexibility in the methods of route design, and (b) the direct participation of government and aid institutions in overcoming the problems associated with the provision of appropriate basic vehicles.

Present road design standards in the developing world are based largely on criteria originally laid down to meet the very different requirements of western countries. There is a need for developing countries to generate their own road design standards based on local conditions which would incorporate, as appropriate, the requirements imposed by basic vehicles. Road design has been based on the needs of motor vehicles for so long that there is little available experience of designing for anything else, at least in the developed countries.[1] However, some developing countries have experimented with the provision of routes for basic vehicles. Reference has previously been made to the concrete farm 'roads' in the New Territories of Hong Kong which are designed for bicycles, motorcycles and handcarts. In the People's Republic of China "the present (1962-64) effort at building roads aims at the opening of commercial routes to the villages, to facilitate the transport of locally produced goods as part of the policy of priority given to agriculture. ..... *they*

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[1] The recent revival in cycling in many developed countries has produced a rash of cycle route design manuals. Most of these are urban-oriented, but some studies have been made of the structural design of low-cost rural cycle routes.

are rarely fit for motor traffic: on the better roads horses and oxcarts may travel; on others handcarts ..... can be pushed or pulled by men ..... To this account should be added the fact that *rubber-tired wheelbarrows, improved carts and bicycles are now being mass-produced for peasant use* on the new highways and the better village roads". (italics not in the original). (1) A S. E. Asian country has recently adopted a pattern for rice reclamation schemes which includes 4 metre wide roads spaced about 400 metres apart, with 2.5 metre wide side-roads leading to every field. None of these roads is surfaced and whilst the larger ones could probably be used by cars and trucks, they appear to be intended for 'basic vehicles' (2). Lastly, in India road designs have been developed especially for traditional bullock carts with steel rimmed wheels (3). Other than the fact of their existence little is known about these designs or of operating experience with them: both aspects are worthy of study.

Despite the apparently public nature of track and private nature of vehicles, it is now necessary that governments and aid institutions should play as dynamic a role in the provision of basic vehicles as they have done in the provision of roads. *Indeed it seems irrational for them to do otherwise, given that the track and vehicle are complementary and mutually dependent parts of the road transport system.* If it is in the public interest for government to supply and maintain the 'track' why, especially under conditions of great need, should they not also supply vehicles?

The most compelling reason for arguing that governments and aid institutions should intervene in the supply of basic vehicles, is that without encouragement and assistance the private sector is unlikely to do so. Developed country manufacturers appear to be willing to play only a limited role in the development of appropriate basic vehicles (e.g. A.U.V's.) Most local manufacturers that might engage in the production of basic

vehicles lack the resources to carry out the necessary research and development. Ultimately to be successful, any product of appropriate technology must compete in the market place. However, before local 'basic vehicle' manufacturers can do so they will require assistance in the form of proven designs, and in initiating manufacture and marketing of the product. It is in these areas that specific *actions* by governments and aid institutions can assist the supply of basic vehicles.

6.3 Action

Throughout the paper we have identified the need for various actions to promote more appropriate rural transport. These are now summarised and classified into three categories: information; research and development; and production and marketing. Since there are institutions that are actively involved in the development of basic vehicles any programme of action ought to consider how their efforts can be assisted.

6.3.1 Information

"The solution to a technological problem often exists away from where the problem arises. Good information systems are therefore essential. If information about intermediate technologies is not widely disseminated, the bias in favour of sophisticated technologies, and the readiness of information about them, may lead people in developing countries to believe that sophisticated technologies are the only acceptable answer to their problems" (4).

There are two major aspects to any information system: the collection of data, and its dissemination. Because basic vehicles are a relatively new area of interest, the collection of information is particularly important. Information needs

to be collated on the design, manufacture, operation and effectiveness of the following existing devices:

1. head, shoulder and back-loading aids.
2. handcarts and wheelbarrows.
3. bicycle carriers.
4. bicycle and moped trailers.
5. tricycles.
6. carrying containers for pack animals.
7. animal drawn carts.
8. basic motorised vehicles.

Information also needs to be collated on experience with the design and operation of:-

9. routes for basic vehicles.

Many of these devices are the products of local artisans and therefore fall outside the scope of conventional information collection systems. As a result, information is difficult to acquire but may be particularly valuable. Good information on such devices can only be obtained by in-depth case studies which could best be carried out by local appropriate technology organisations with co-ordinating support from aid agencies.

A basic function of the international aid agencies should be to collate information on existing devices, on research and development programmes, and institutions and individuals with expertise in appropriate transport technology. This information can be disseminated where needed by means of publications on particular topics and by an enquiry service which responds to specific requests for information.

6.3.2 Research and development

The research and development requirements of appropriate transport technology can be classified into socio-economic aspects and hardware. The purpose of the socio-economic research is to clarify transport needs, and to supply the necessary background information and justification for planning the provision of more appropriate facilities. The socio-economic aspects requiring study are:

10. The magnitude, frequency and duration of small farmer transport needs at the farm level.

11. Other rural transport needs, particularly those associated with industry, and with health, education and other services provided by the community.

12. The direct and indirect employment characteristics of different modes of land transport. Of particular significance would be the employment created per unit of capital, and the likely proportion of local to foreign resources required per unit of employment.

13. The operational characteristics of *existing* basic vehicles. This should cover the capital, running and maintenance costs; proportion of foreign to local resources; loads and load factors; speeds; and movement capability (terrain, ground conditions).

14. The economics of basic vehicle operation in relation to loads, distance, short and long-term load factors, expected vehicle life and maintenance expenditures, terrain, and availability of alternatives.

15. The existing type and condition of the routes serving the rural communities. The focus of such a study should be to assess (i) the vehicular implications of the present route structure and (ii) the type, cost and benefit of practicable route improvements.

The items of hardware requiring research and development are:-

16. Chinese wheelbarrow.
17. Wheels and bearings for use on barrows, handcarts, cycle trailers etc.
18. Bicycle for local manufacture and use.
19. Bicycle carriers.
20. Single-wheeled cycle trailer.
21. Animal-drawn carts.
22. Motor cycle for local manufacture and use.
23. Motorised bicycle and tricycle.

Any programme of hardware research and development should, if it is to result in products which are commercially viable, be market-oriented and take account of the end-user's needs, the manufacturer's requirements, and the economic and industrial capabilities of the society. Ideally all such programmes should be executed in developing countries but at present many of these lack the capacity, expertise, resources and organisational knowledge to meet all their research and development requirements.

Thus, while some projects can be carried out in developing countries by national appropriate technology organisations or research and development centres, there will be a continuing and important role for the developed country institutions to play.

Basic vehicles evolved by developed country institutions must be specifically linked to needs and conditions in developing countries: There are a number of ways in which this can be achieved:-

i) Collaborative work by a developed and a developing country institution to meet a particular need. (e.g. the improved Chee-ke (5) developed jointly by the Georgia Institute of Technology (U.S.A.) and Soong Jun University (Korea).

ii) Work carried out in a developed country institution to meet needs in one or more locations with field testing and evaluation done in conjunction with local institutions.

iii) Work carried out by an international institution located in one developing country but aimed at meeting the needs of several (e.g. IRRI, based in the Philippines but serving the needs of all rice growing countries).

The method of carrying out the research and development work will be influenced by the capabilities and resources of the countries concerned, and the type of basic vehicle involved. Whatever method is used there is an important role for the aid agencies to play in providing technical and financial assistance. A significant part of this assistance should be directed towards increasing the research and development

6.3.3 Production and marketing

The successful conclusion of a hardware research and development project is usually marked by the satisfactory testing of a prototype. However, the successful transfer of the technology is only achieved when the product is available to the people who need it. Therefore after research and development is completed there remains the need for field testing and market evaluation in the place of intended use, and for the establishment of the production system including making the technology known, financing, marketing, training and servicing.

The developing country manufacturer may have a detailed knowledge of the market, and of the rules and regulations with which he must comply. However, his technological expertise may be limited and he is likely to need technical assistance in establishing manufacture of a new basic vehicle. The small manufacturer will probably have little spare capital and limited access to credit. He will tend to be reluctant to invest in the production of new basic vehicles since these will involve considerable risk on his part. He will therefore need financial support through the provision of credit, possibly at preferential rates of interest. Governments can assist manufacturers in the provision of credit and technical expertise through small industry development organisations, but there is also a role for aid agencies either by providing assistance to specific

projects or by re-inforcing the capabilities of government institutions.

The small maufacturer often has difficulty in obtaining materials and components of specified quality. He can normally only purchase in limited quantity because of his small production capacity and lack of capital to invest in stocks. He therefore has to pay higher prices, and has greater difficulty in obtaining supplies, than larger manufacturers. Government can assist here by intervening in the supply of materials and components.

The manufacturer may need both expert assistance in marketing his new product and, more important, some assurance and protection of his market, particularly in the initial period when his new product is being established. This can be provided by restricting competing imports by means of tariffs, quotas, or exclusion, through government taxation policy and by government purchasing procedures which give priority to the products of small, local manufacturers.

The successful introduction of basic vehicles will depend, in addition to the establishment of local manufacture, on the provision of an adequate supply and distribution system for spare parts, and the training of operators and mechanics. Past experience has shown that the provision of an adequate maintenance infrastructure is essential if a new technology is to become permanently established in rural areas of developing countries. This is particularly critical in the case of even simplified motorised vehicles. The adoption of these devices in place of human or animal powered forms of transport is a major technological step forward. The maintenance and servicing procedures are more complex, and very critical to the

performance, running costs and life of the vehicle.

A model of the type of research and development, and production and marketing process required for basic vehicles is provided by the Agricultural Machinery Development Program of IRRI (6) (7) (8). Their approach to the design of machinery for local manufacture was described in section 5.6. IRRI recognise, however, that even if the machines meet all social, economic and technical objectives they still do not help the farmer unless "they are commercialized and can be purchased and utilised". IRRI have evolved a structured programme to assist the process of commercialization:

(i) IRRI engineers advise the manufacturer which products best suit his marketing and manufacturing capabilities.

(ii) Design information is given to the manufacturer free of cost.

(iii) Technical back-up support is provided throughout the manufacturer's prototype fabrication and evaluation process.

(iv) IRRI staff advise the manufacturer on whether to go into commercial production.

The success of the IRRI programme suggests that a similar approach could significantly alter the appropriateness of the transport facilities available to many rural communities.

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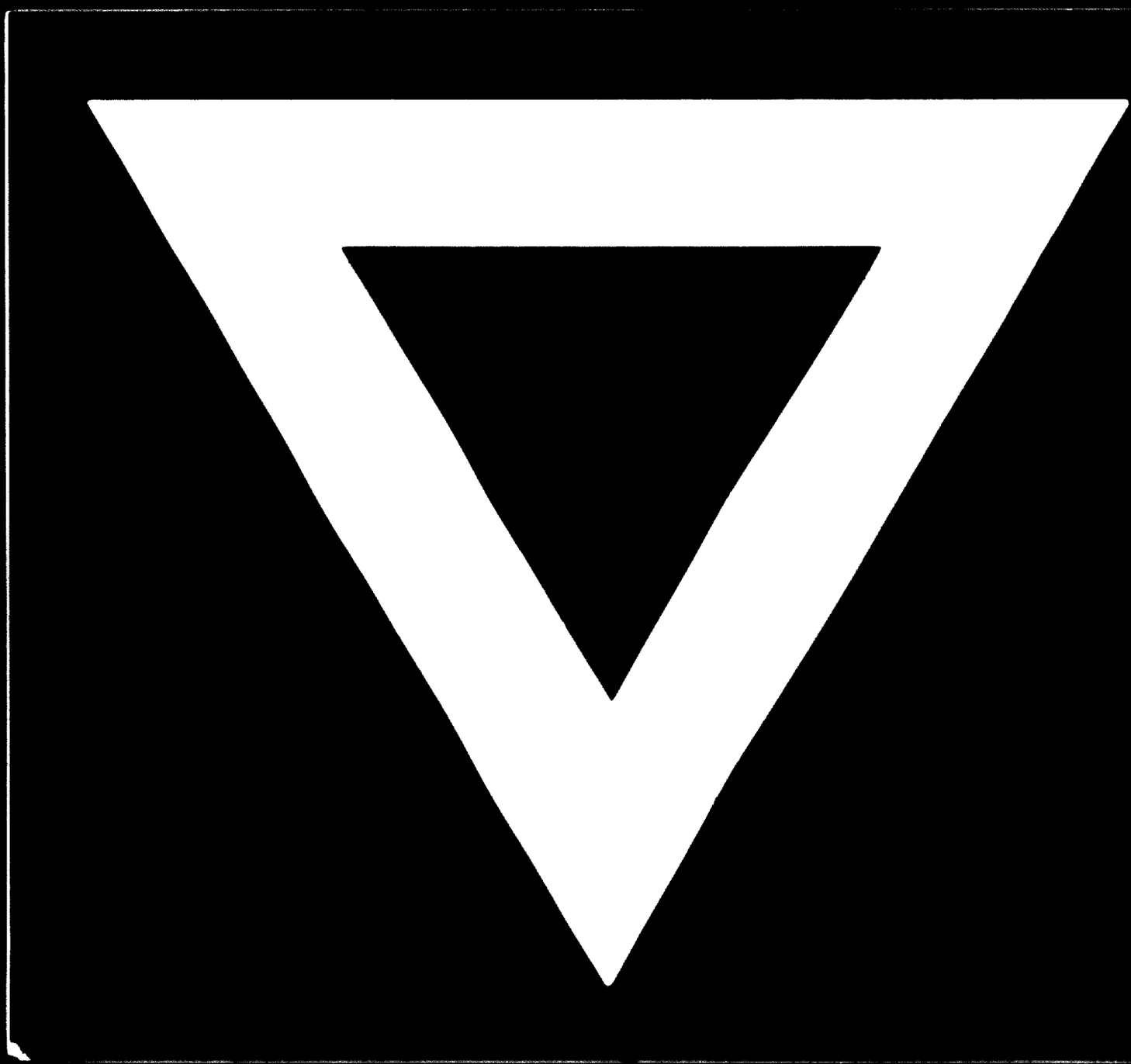

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