Fig. 12. Log Transport Cost as a Function of Distance under Alternative Methods.

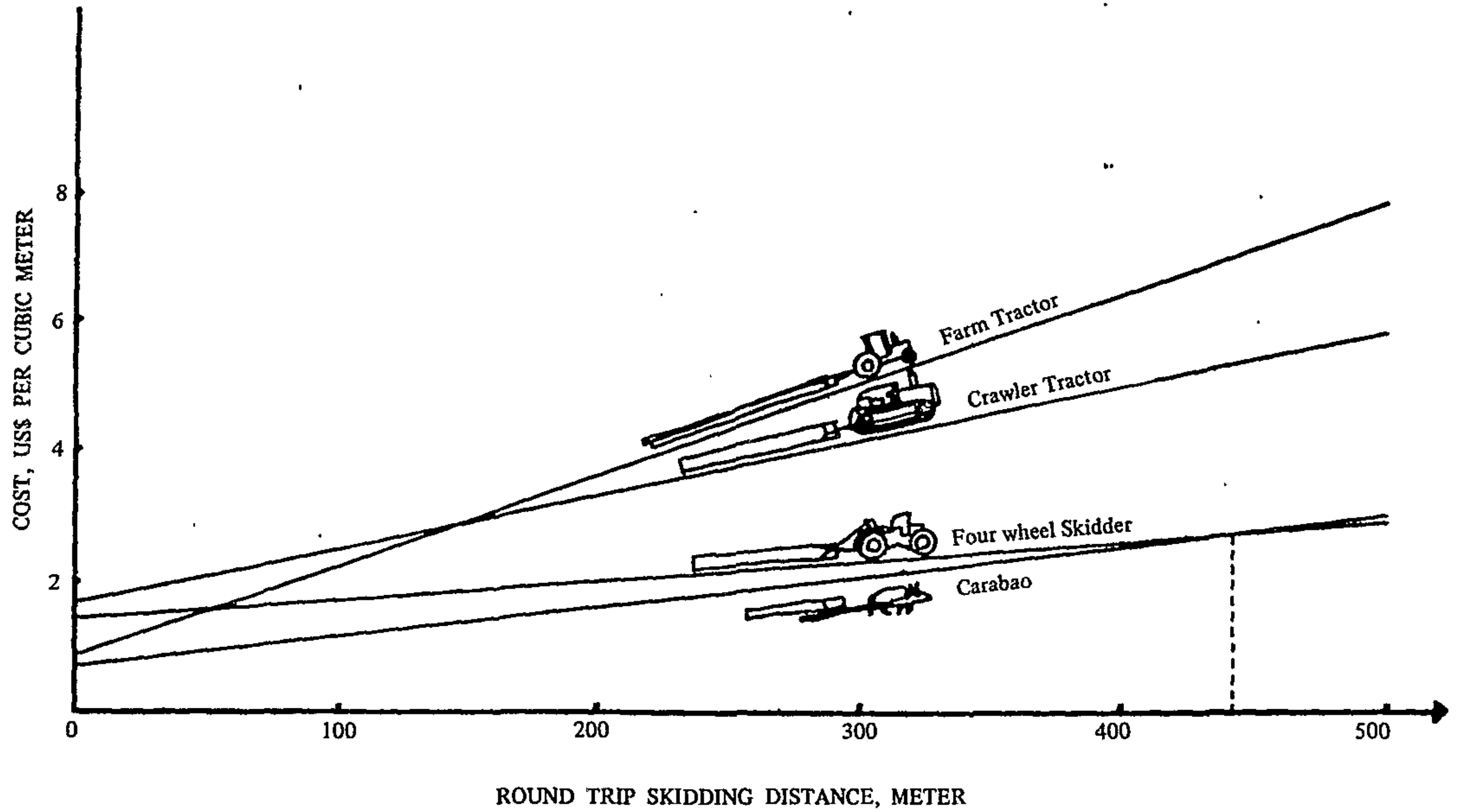
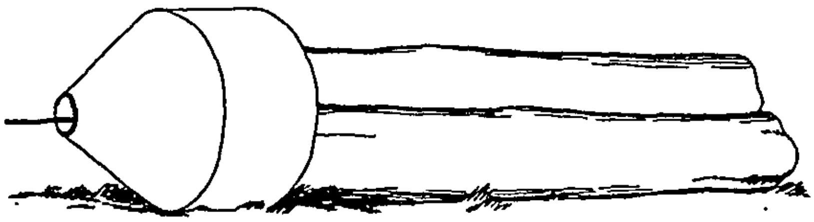
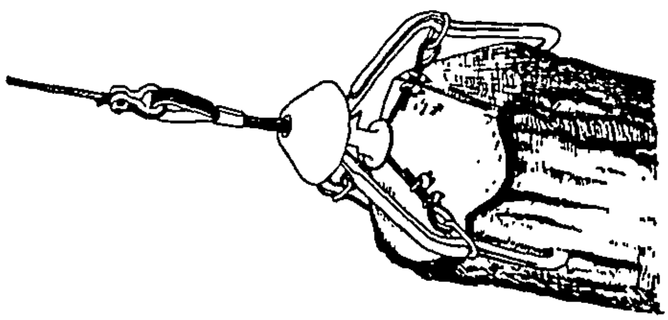


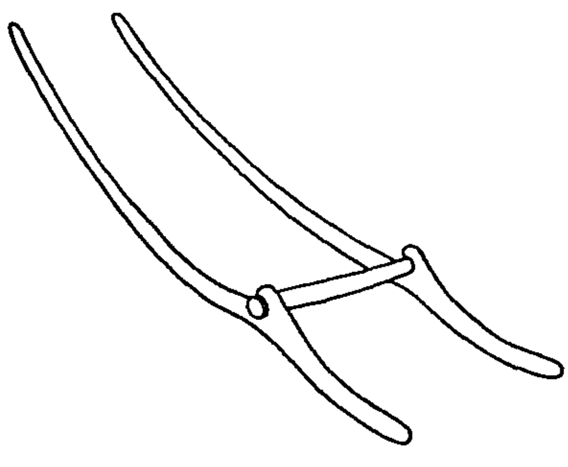
Fig. 13. Cone, Grapple, and Sledge to Assist Log Skidding by Carabao.



(a) Cone



(b) Grapple



(c) Sledge

ding distances of less than about 300m. In situations where longer distance skidding is unavoidable, carabaos and properly equipped farm tractors could be used to bunch logs for the larger skidders or forwarders.

2.3 Debarking

The investigation covered the debarking of Benguet pine (*Pinus kesiya*), falcata (*Albizia falcataria*), and gubas (*Endospermum peltatum*) by means of *bolos* on the one hand, and properly designed *debarking spuds* on the other (Fig. 14). Introduction of the spuds increased productivity by 129% for gubas, 62% for Benguet pine, and 33% for falcata. Compared with the bolo, the debarking spud allows the worker to maintain a semi-upright stance rather than a stooped position. Secondly, use of the spud reduces the risks that the worker will lacerate himself. When used to debark pine, the spud helps reduce bodily contact with the resinous wood.

Fig. 15 shows the man-hours required to debark the different species under the alternative methods, including one point representing mechanical debarking of mixed hardwood. The figure indicates that the spud is the improved labour-using method having productivity and labour absorption intermediate to the bolo at one extreme, and the mechanical debarker at the other. The point representing the mechanical debarking of mixed hardwood deserves special attention, since it is associated with intended manpower substitution that was not successful.

An imported ringe-type debarking machine introduced in1975, did not work well for the indigenous hardwood mix, because it had particular difficulty with pieces that had fibrous or stringy bar and the waste disposal capacity of the machine was not adequate to keep it from getting clogged. Cost levels were 72% higher than projected, and the mechanical debarking was discountinued.

The debarking machine will probably be perfectly suitable for thin-barked species like falcata and gubas, and is also known to work well for pine. It must be accepted that 20-30% of the native hardwood mix cannot be peeled mechanically.

2.4 Log Loading

Labour-intensive log loading is more feasible for industrial plantations, tree farms, and miscellaneous small-diameter timber than for virgin dipterocarps. As in so many other logging activities, log size plays the key role in determining the costs of the alternatives.

The work study compared pulpwood loading by purely manual methods with loading by a rubber-tired front-end loader (Fig. 16).

The manual method had a longer truck standing time waiting to be laded, and it incurred the cost of extra crosscutting to 2.5 meter lenghs for manual handling compared with mechanised loading even when these additional costs were taken into account, manual loading cost US$0.88 per cubic meter relative to US$0.91 for the mechanical loader.

Fig. 14. Debarking with Bolo and with Debarking Spud.

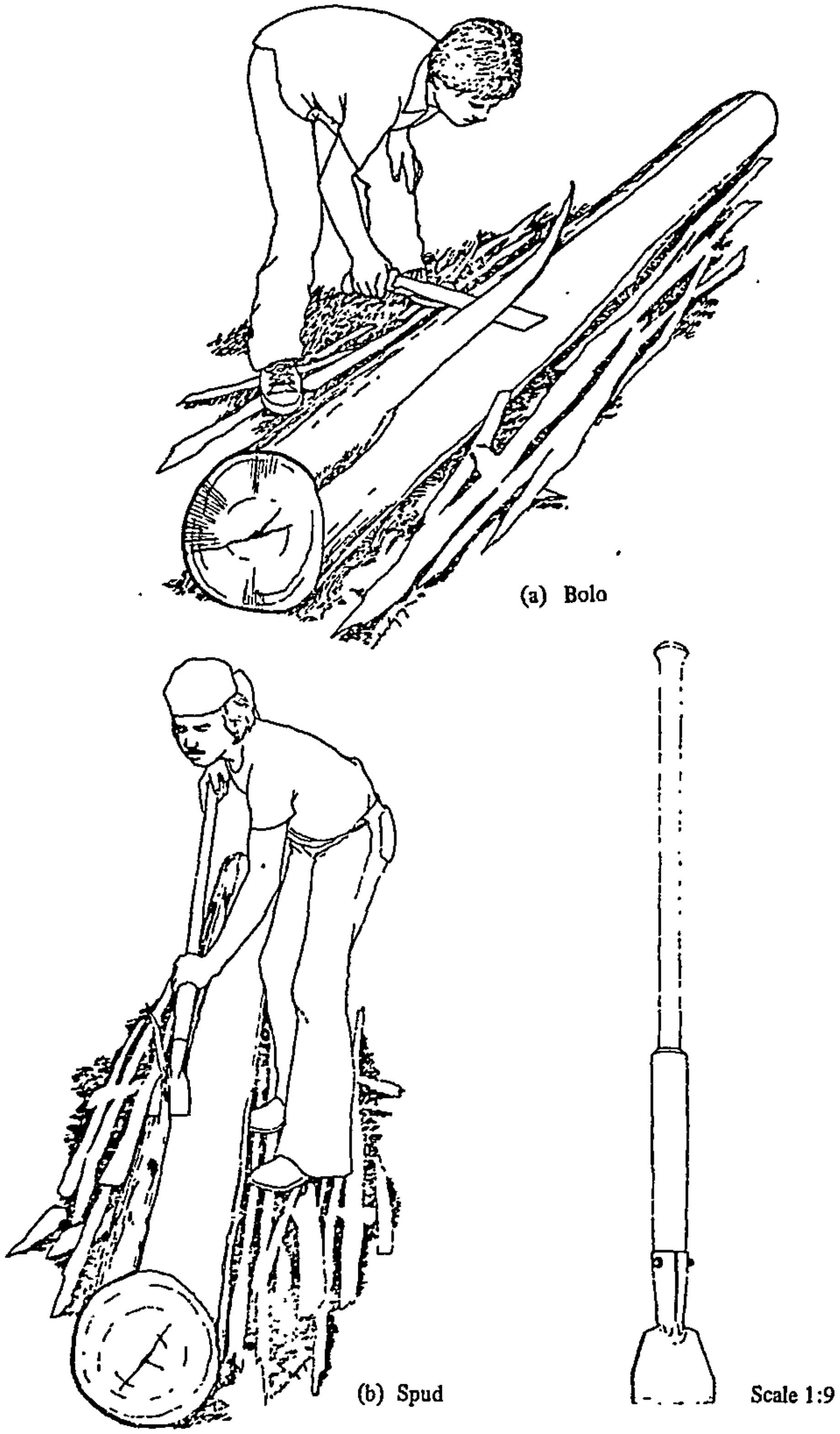
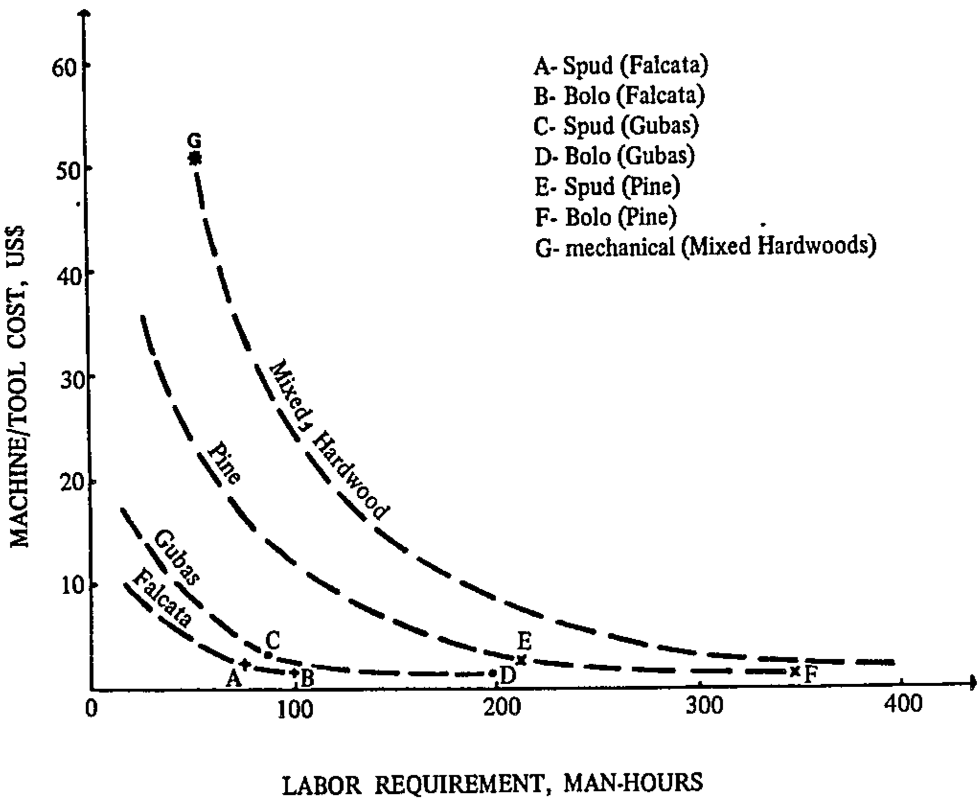
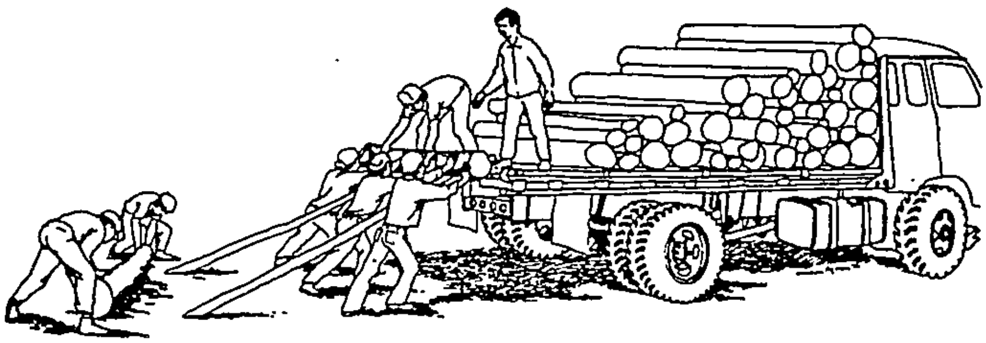


Fig. 15. Machine Cost and Labour Requirement to Debark 100 Cubic Meters of Small-Diameter Logs under Alternative Methods.

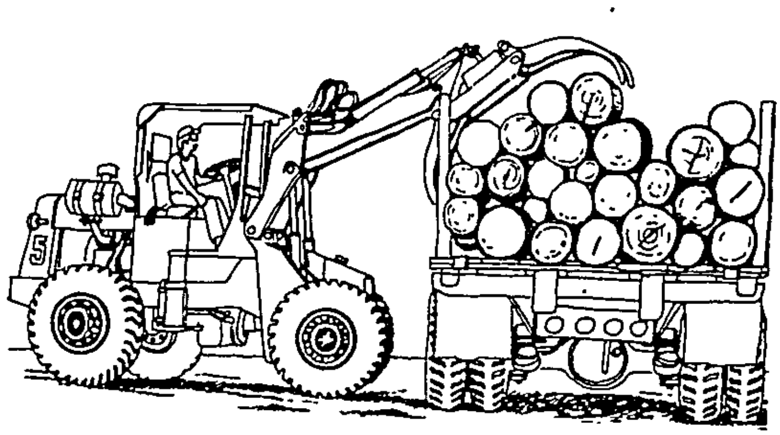


Note: (i) Data for mechanical debarker form large pulp and paper producer.
(ii) Machine cost for mechanical debarker covers depreciation, debarking knives, electricity, and repair and maintenance.

Fig. 16. Pulpwood Loading Manually and Mechanically



(a) Manual



(b) Mechanical with Front-End Loader

The manual loading did not benefit from helping devices other than wooden poples to serve as inclines, and the occasional use of ropes. Loading hand tools such as tongs, stacking claws, pulpwood picks, and ligting hooks (Fig. 17) were not available but their introduction could be expected to raise output by a factor of three, with a corresponding reduction in the labour requirement (Fig. 18). The improved labour-intensive method trebled productivity, but nevertheless retained approximately ten times the labour input of the mechanical alternative.

3. FACTORS AFFECTING THE CHOICE OF HARVESTING AND TRANSPORT TECHNOLOGY

Choosing the correct technology for harvesting and transport is a difficult and complex task because of the very large number of factors which must be taken into account. It is important that a choice be made only after a systematic and thorough evaluation of all the options. Before commencing the evaluation, it will be necessary to identify the options which

Fig. 17. Hooks, Picks, and Tongs for Handling Small Logs.

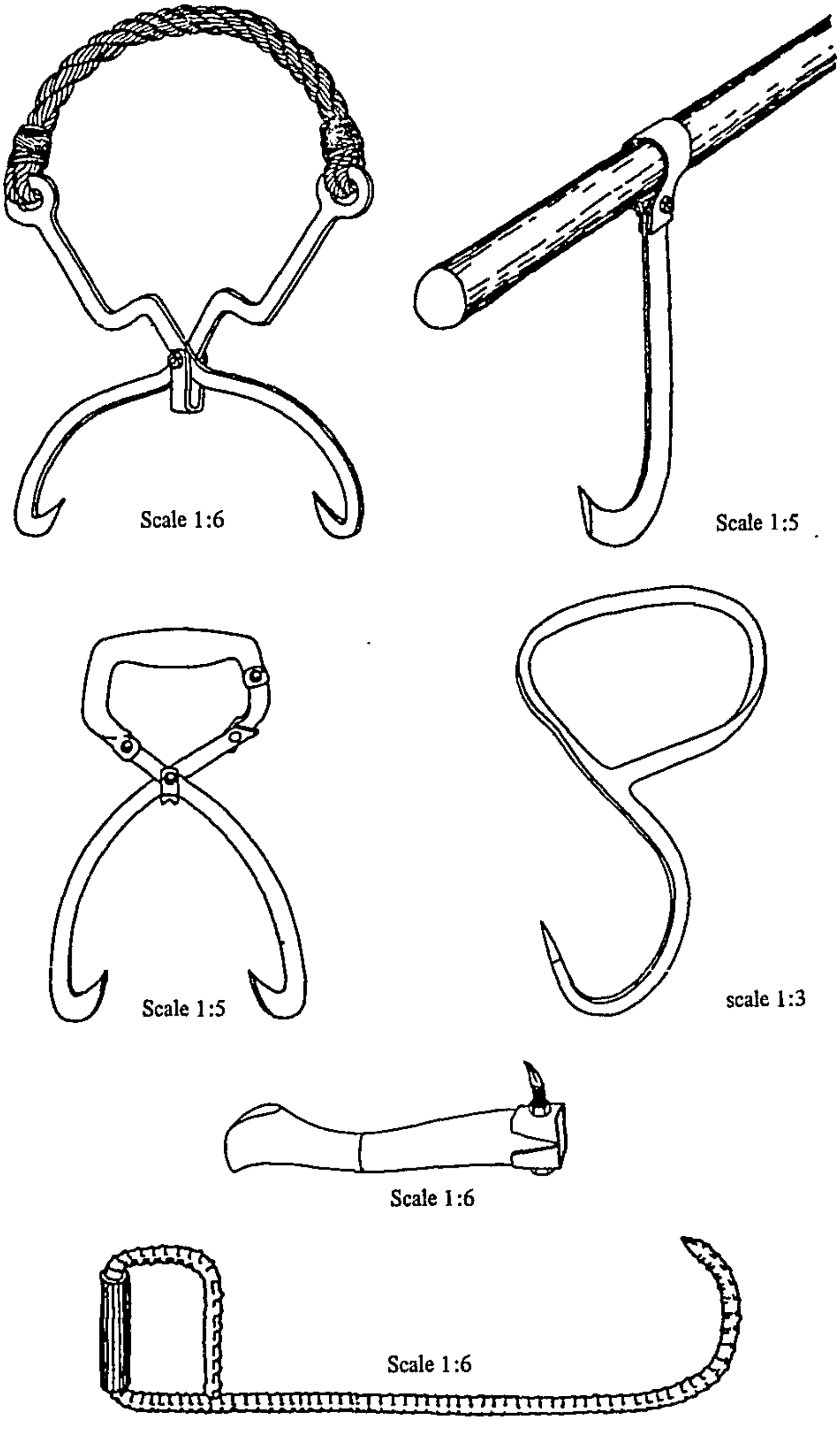
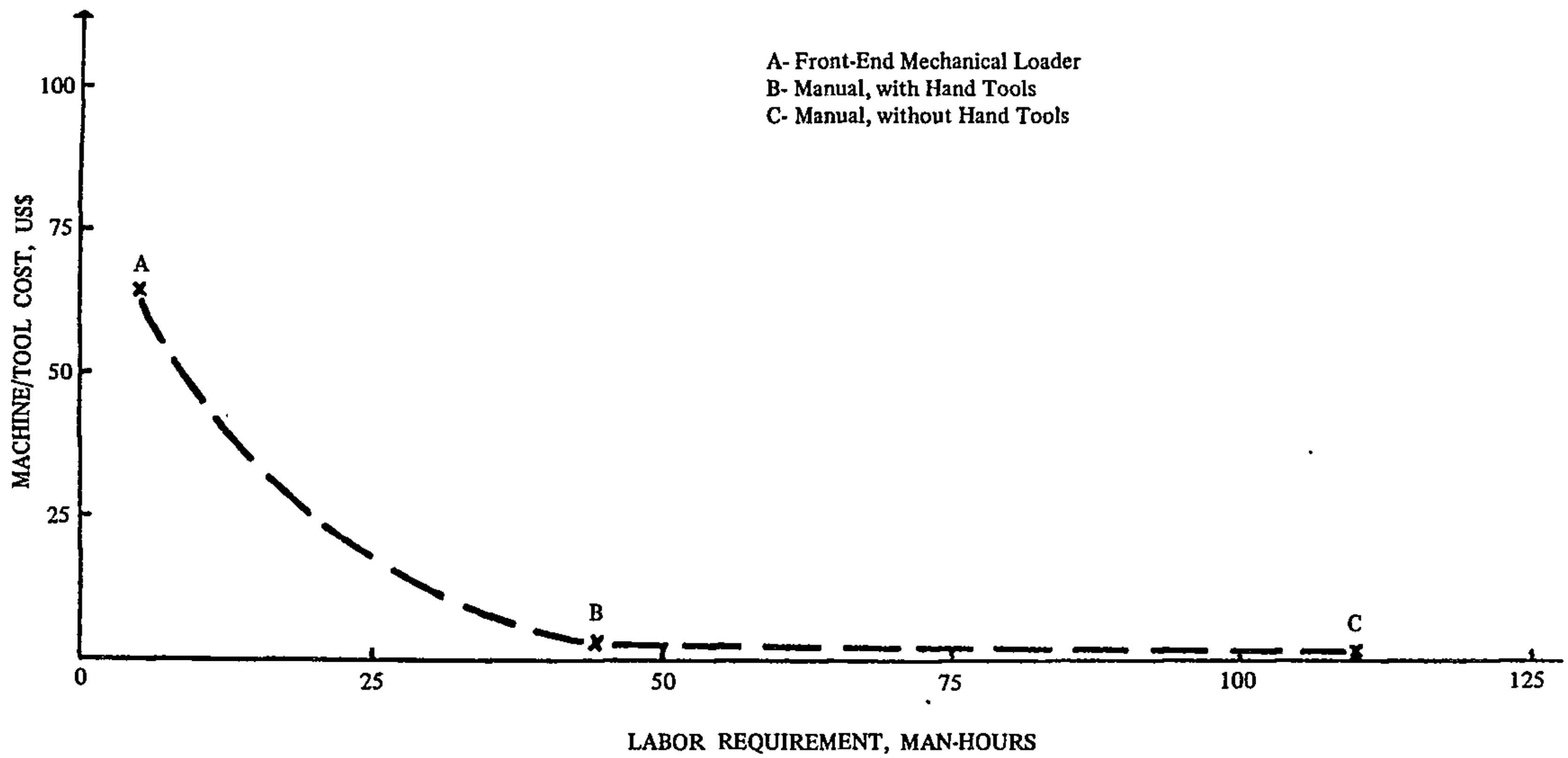


Fig. 18. Machine Cost and Labour Requirement to Load 100 Cubic Meters of Pulpwood under Alternative Methods.



Note:
(i) Machine cost for mechanical loader covers depreciation, interest, fuel, oil and repair and maintenance.
(ii) Data for mechanical loader include breakdown allowance.
(iii) Manual loading with hooks, tongs, and picks assumes previous training and well-organized pulpwood piles.

are available and to eliminate those which prove unviable for one or more reasons. The next chapter discusses briefly most of the options which are available, but below are listed the most important factors which will determine the viability of any particular option.

(a) Site conditions: terrain, soil conditions and climate are the three most important factors of the site to be considered.
Terrain determines the degree, length and frequency of slopes, as well as the accessibility of the area to be harvested, and the distances over which timber will have to be moved.

(b) Forest conditions: the type and sizes of tree, the stand density and the proportion of standing timber which will be harvested will all influence the relative cost and feasibility of operating with different types of equipment, as well as the required capacity of the equipment.

(c) Financial conditions: the capital cost, including tariffs or import duty, taxes, and the repair, maintenance and running costs of each piece of equipment considered must be taken into account. The latter will include fuel costs if relevant.

(d) Operationan scale: the anticipated output from a particular operational unit which may be determined by the end-use of the timber being harvested, or by the area of forest allocated must be taken into account. Large scale operations may justify a degree of mechanisation in order that production targets can be realised. There has been a tendency in the past to assume that there were economies associated with increased scale of operations. This is increasingly being shown to be an unrealistic assumption, as expensive equipment must have a high utilisation factor to dervive the benefits of high output. An intermediate scale of operation allows greater flexibility in adapting to changing conditions and is generally more efficient in the employment of scarce capital resources, than very large scale capital resources, than very large scale capital intensive technologies.
(For more detailed discussion see paper "Operational Scale in Appropriate Technology" by ADB.)

(e) Employment and socio-economic conditions: the local need for creative employment will be a principle determinant of the choice of technology, but it must be combined with the provision of a reasonable standard of living conditions for the workers and their families.

(f) Ergonomic considerations: stress, strain and safety of all the available machines and equipment.

(g) Technical considerations: the output of the various options, together with their physical capacity must be considered. It will also be necessary to assess likely reliability and the availability of spare parts. In this context local manufacture of either the original equipment or spare parts can be important.

(h) Environmental considerations: these have rarely been allowed for in practice, but should be given more attention, including physical damage to the environment such as soils, and the amount of waste generated.

A more detailed discussion of the qualitative and quantitative aspects of site, forest, financial and technical considerations can be found in the two F.A.O. manuals, dealing with Logging and Log Transport, in Tropical High Forest and in Man-made Forests in Developing countries. In view of the importance of the socio-economic, ergonomic and environmental considerations in arriving at a correct choice of appropriate technology, these factors are discussed here in a little more detail.

3.1 Employment and Socio-Economic Conditions

It is apparant from the earlier description of the Philippine studies, that the choice of technology will have a strong influence on the amount of employment created. In a majority of Asian countries the need to maximise the amount of productive employment will be of paramount importance in the choice of technology.

Technological choice which favours increased employment in the forestry sector however cannot be divorced from the context of living and working conditions. Forestry work must frequently be carried out in remote areas where living conditions and amenities are of a very low standard, often with workers separated from their families. Where families are present they frequently suffer badly from poor housing, lack of educational opportunities, and medical care, poor nutrition, and inadequate facilities for culture and recreation. Forestry sector employment as a result has a bad reputation and is often unstable, lacking in social security and workers' representation through trade unions or labour councils nonexistent.[1]

Technology which combines the characteristics of high labour input, with a reasonable level of productivity will help to minimise the cost of each job createdto the economy as a whole.

The fact that these poor conditions are prevalant among forestry workers at the present time is no justificaiton for the continuation of this situation. There are many forestry projects around the world, including several in Asia where housing, educational and cultural facilities provided by the agency (both governmental and private companies) carrying out the project, are as good as or better than those provided in Governmental resettlement schemes.

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[1] See ILO *Conditions of Work and Life in the Timber Industry*, Second Tripartite Technical Meeting for the Timber Industry Report II (Geneva, 1973).

The experience in these projects has generally been that labour turnover and absenteeism are lower and productivity higher than in projects where no special attention is paid to workers' living conditions. If the introduction of appropriate technology can increase productivity and improve worker health and safety, these benefits can be reinforced, and probably even paid for by the other indirect benefits associated with good living conditions.

3.2 Ergonomic Conditions

The principle factors to be borne in mind are stress, strain and safety. The subject of *heat stress* is dealt with at some length in the F.A.O. Publication on the subject. Strain is a more difficult topic to quantify, but relates to the adaptation of the tools and equipment to the human body, so that the most effective use can be made of its attributes, and there is a minimum amount of wasted energy. *Noise* and *vibration* are two further aspects of stress which are being given increasing attention in developed countries.

An extremely important aspect of working conditions of special relevance to developing countries is accidents. Compared with other industries work in the forestry sector, particularly in logging, exhibits high accident frequency and severity. Logging together with mining is the most hazardous occupation in a cross-section of industrialized countries, and the limited data vailable on accident frequency rates in developing countries, suggests that the situation is similar in most of them.

Injuries in logging are generally associated with the fact that the work is arduous, and it tends to take place in inclement weather and in difficult terrain. Accidents occur due to sliding, rolling, or falling timber; slippery ground conditions; lacerations with sharp tools; moving equipment and equipment parts. Power chain saws, heavy tractors and skidders have excessive levels of noise and vibration, which are among some of the hidden costs of capital-intensive methods.

The ergonomic problems of logging and other physically demanding forestry work are especially pronounced in tropical countries. Heat stress, small body size, unsatisfactory untrition, lack of skill and experience, long hours, and lax safety standards limit work capacity and increase vulnerability to accidents.[1]

In the Philippines the workers most frequently hurt are (i) chain saw operators and helpers, and (ii) riggers and choker setters. In Malaysia many accidents are associated with the use of winch lorries.

Most injuries result from the worker being struck by moving objects. Falling trees and falling branches are the principal instrument of injury.

Lacerations and punctures predominate, although they are not always the most important in terms of seriousness. Most accidents happen to the appendages, especially the

[1] See FAO, *Logging and Log Transport in Man-Made Forests in Developing Countires,* FAO/SWE/TF 116 (Rome, 1974), Chapter 7 and Appendix B.

fingers and hands. Again, however, frequency is a matter quite apart from seriousness.

Accidents tend to happen when workers are tired or no longer attentive, which is usually well into their work. This explains a first peak at 11:00 a.m.; a sharp decline at noon; and a subsequent build-up to a second but smaller peak at 3:00 p.m., which is already near the end of the day for many of the workers.

3.3 Environmental Conditions

The cost to the economy of environmental damage may be very high over a period of years, and it is frequently an insidious process, of which people can be unaware until a catastrophe occurs. When such a thing does happen the price often has to be paid by people who have not been involved in the cause.

Forest harvesting techniques are particularly prone to causing serious environmental damage, through damage to vegetative cover, exposure of the soil and blocking of natural watercourses. It is difficult when evaluating alternative harvesting technologies to know what the environmental costs might be, associated with the different options. Even when some assessment can be made of the damage that might be caused in quantitative terms, such as the percentage of vegetative cover removed, or exposed it can be very difficult to translate these into economic terms. It may be necessary to make a subjective judgement, and to *rank* the alternative technologies from least to most damaging in terms of different types of environmental damage. The latter might also include the amount of waste generated, since the logger generally does'nt pay for waste directly.

It may be possible to arrive at an estimate of the relative costs of restoring the damage as a means of arriving at a more quantitative comparison. Similarly it can be helpful also to try to estimate the probability of different types of damage arising and quantifying the cost of the losses associated with the expected damage. None of these techniques have been fully tried or developed in practice, but their use and value has been discussed at several workshops on Forestry Development Planning, organised by F.A.O.

4. CHOICES OF HARVESTING AND TRANSPORT TECHNOLOGY FOR EVALUATION IN ASIAN COUNTRIES

Over the past 10-15 years the rate of development of forest harvesting and transport technology has been very rapid, and there has been intense competition among manufacturers to produce new and better designs. The result is that for any particular system of harvesting there may be several models of equipment or machinery available with quite substantial differences between them in performance, reliability and ease of handling. To these recent developments must be added the very wide range of traditional tools and equipment which have been tried, tested and adapted over the years to suit particular conditions.

It is not possible within the scope of this paper to give a comprehensive list of all items of equipment available, or indeed to describe in much detail the alternative harvesting systems that are in use, but an attempt will be made to indicate the alternative types of tools and equipment which should be considered for each of the main types of tasks likely to be undertaken. These are listed below under operations, more or less in descending order of labour input relative to equipment input:

(a) Stump operations : axes - light to heavy bow saws
crosscut saws
crosscut saws
chain saws - small 2-4HP felling aids,
- large 10-11HP wedges etc.
mechanical tree fellers

(b) Bunching/
Short haul transport : manual - sulkies, tongs, grapples
animal - buffalo/carabao, elephant, mule, oxen
- sledges, cranes, grapples, sulkies, trailers
farm tractor - choker plates, tongs
- winch trailer
- tower and double drum winch
4 wheel drive skidder - small
- large
- conventional or hydrostatic transmission
forwarder - small
- large
- tractor/trailer
- 4/6 wheel drive articulated forwarder with crane
cable systems - ground skidding with small winch
- gravity skylines
- high lead logging - small
- large
- skyline logging

(c) Debarking : debarking spuds
adzes
rotary debarking machines - mobile
- fixed

(d) Loading and
Unloading : manual - lifting, rolling
- with tolls - pulleys, grapples, tongs
- with winch
lorry mounted lifting gear - winch and block or A frame
- hydraulic crane
mobile crane/heelboom loader - small
- large
front end hydraulic loader - small
- large

(e) Transport : tractor and trailer
small truck (2 axles up to 10 tonnes)
large truck (3-4 axles) 200HP + with trailor or semi trailer
railway - narrow gauge - conventional
water - rafts, barges, boats

(f) Road construction : manual - pick axes, spades, barrows
small machines - pedestrian operated dumpers and rollers
large machines - bulldozers, scrapers, rollers, graders.

Forest roads are an integral part of the timber transport system, but will not be referred to in more detail, as the use of "Appropriate Technology" for road construction has been the subject of a special ILO report based on the experience of a project in the Philippines.

5 CRITERIA FOR CHOOSING APPROPRIATE HARVESTING AND TRANSPORT TECHNOLOGY

There are very few references in the literature to criteria which have, or might be applied when choosing appropriate technology. However, it is essential to have criterial in deciding which of serveral options is the best, or which option is the "appropriate" one for the circumstances.

The ILO Wold Employment Conference recommended that appropriate "technologies should contribute to greater productive employment" and therefore the number of jobs created by the technology is clearly and important criteria.

In economic development theory, the benefit/cost ratios, is considered as one of the most important criteria, provided that all the costs and benefits can be quantified. In the case of choosing technology it is equally possible to examine the benefits and costs of the available options, and compare the results.

The benefits derived from a technology are:

- the productivity or output per unit of input
- the employment per unit of output
- the economic multiplier effects, including local manufacture and use of local resources
- the quality of the output
- the ergonomic benefits of reduced stress and strain, and improved safety
- the ecological benefits from reduced damage to the environment and waste

The costs are:

- the capital cost in economic terms
- the running costs for repair, maintenance and fuel
- the "hidden costs" of much technology in current use, which are the corollary of the ergonomic and ecological benefits.

The following table from Fraser (1975) gives some approximate figures for the capital requirements, employment and output for different typical logging and transport systems in Aisa. The basic figures have been used to calculate the *Capital per man employed ratio* (A), the *Capital per m^3 of daily output ratio* (B) and the *Employment per $100m^3$ of daily output ratio* (C) for each of the items. Items can be compared within the operational groupings but not between. The items have been listed in ascending order of Captital investment within operations, and the figures give a very good indication of the order of magnitude of the differences involved between technologies.

The table shows very clearly how capital replaces labour with the ratio of capital per man employed rising rapidly with the more expensive machines. For example, 10 simple mobile cranes, with tripods, as used in parts of Tahiland for loading, employs 15 yimes the number of peiople and can load twice the amount daily as one hydraulic loader costing the same total amount. If employment is considered in relation to output then it can be seen that the decline in potential employment is enormous as increasingly capital intensive equipment is used – see last column number of men employed per $100m^3$ per day of output–.

Not all the items can be directly compared as many of them are restricted to the conditions in which they can be used, e.g. the manual sledge (kuda kuda) is more or less only feasible in swamp forests.

The ratio of capital per man employed will not vary greatly from the figures quoted, except to reflect the inflation of prices of capital equipment. The ratio of capital per m^3 of daily output will vary greatly from place to place according to local conditions, as daily output can vary so greatly.

In commercial conditions, technology is generally choosen on the basis of "visible" cost effectiveness. That is, taking capital and operating costs into account, the criteria is the minimum cost per unit of output. As has already been stressed, when choosing "Appropriate Technology" it is important that the "hidden" costs and the social benefits also be taken into account.

6. POTENTIAL CONTRIBUTION AN AVAILABILITY OF APPROPRIATE HARVESTING AND TRANSPORT TECHNOLOGY IN ASIA

The Philippine study has shown that for many operations, the choice of an "Intermediate Technology" has resulted in reduced operating costs and increased employment at the same level of daily output compared with the highly capital intensive technology imported from Europe or N. America. These same intermediate technologies have also resulted in improved output and quality of work for the same employment as the most simple and primitive methods in current use.

In some Asian countries, where more or less virgin high forest is still being harvested, there are large local populations, and sometimes there is land hunger, with consequent pressure to clear forest to grow food for survival. In these circumstances it will be socially beneficial to maximise the employment creation potential of forestry, in order to provide a cash income to as many people as possible. The multiplier effects of an increased level of cash income should not be forgotten. The Philippine study confirms the gneral findings of Table 1 which shows that intermediate methods create much greater employment per 100m³ per day of output than more capital intensive methods. Table 2 is calculated from the Philippine data to show the average output per day from the four skidding systems studies, and the employemtn per 100m³ per day of output.

Table 2 COMPARISON OF OUTPUT AND EMPLOYMENT FOR FOUR SKIDDING METHODS STUDIED IN THE PHILIPPINESS

Method	Average output per day m^3	Man days/$100m^3$
Crawler Tractor	74	2.7
Four wheel skidder	62	3.2
Farm Tractor	29	7.1
Carabao	1	100.0

Table 1 and 2 both illustrate they very high employment potential with using animals for skidding, but their use is likely to become increasingly restricted, partly because of the need to increase production generally, and partly because of the difficulty of maintaining an adequate supply of animals.

In many parts of Asia, indigenous varieties of intermediate technologies have been developed over the years: these include the winch lorries used widely in Malaysia and Indonesia, and the tripod cranes for loading as used in Thailand.

In Indonesia a gravity skyline system has been developed for the estimation of logs in steep terrain. The normal span of the system is about 250m. and daily output is reported to be around 12-15m^3 per day, with a crew of 6 men. Employment is thus about 35-50 jobs per 100m^3 daily output, and is thus comarable with sledge skidding on flat terrain – see table 1 (ref. Duta Rimba 1978).

In India a variety of cable way and skyline systems have been developed which work very satisfactorily under the conditions for which they were designed. Trials have also been carried out in India to develop attachements for farm tractors to enable them to be used for skidding.

In Thailand two different log loading systems are used, which can be classed as appropriate technology, being relatively labour intensive, manufactured locally, and low cost.

The first of these is the self loading lorry, bassed on a standard 5 ton flat bed trusk. On the back of the truck a timebr framework, made up of 15 cm square timber pieces is constructed to form a cuboid the length of the truck and standing about 2.5m high on the tailboard. The lorry is fitted with a p.t.o. driven winch and two pulley blocks on the fornt and rear upper cross-members. The rope is passed over the rear pully block to lift one end of a log onto the

Table 1. AVERAGE CAPITAL REQUIREMENTS, EMPLOYMENT AND OUTPUT FOR DIFFERENT LOGGING AND TRANSPORT SYSTEM

Operation	Item	Approximate Capital Cost US$	Average Number of Men employed	Annual Average daily Output m^3/day	Capital per man employed A	Capital per m^3 daily output B	Employment per $100m^3$ daily output C
Stump Operations	Axe	10	1	3	10	33	30
	Cross out Saw	20	2	8	10	25	25
	Cahin Saw	400	2	60	200	66	3
Skidding	Sledge (manual)	10	8	15	12	1	50
”	Elephant	5,000	4	1	1,250	5,000	400
”	Winch Lorry	10,000	3	16	3,333	666	18
”	Wheel Skidder	30,000	2	50	15,000	600	4
”	Crawler	50,000	2	50	25,000	1,000	4
”	Mobile Yarder	250,000	7	80	35,000	3,125	8
Loading	Hand-poles	20	8	50	25	4	16
”	Mobile crane	5,000	3	40	1,666	125	7
”	Winch Lorry*	10,000	3	20	3,333	500	15
”	Hydraulic loader	50,000	2	200	25,000	250	1
Transport	Raft	100	5	50	20	2	10
	Truck (10 ton)	25,000	2	20	12,500	1,250	10
	Truck (+ winch)	30,000	3	20	10,000	1,500	15
	Light Railway +	40,000	2	80	20,000	500	2
	Truck (20 ton)	65,000	2	100	32,500	650	2
	Barges and Tugboart	100,000	3	160	33,300	625	2

* includes short haul transport – 3 km.

\+ average length 10 km.

tailboard, and then over the front pulley block to pull the log fully onto the desk. A total of five or six logs with a volume of 6-10m^3 can be loaded in less than an hour.

An alternative system also used in Thailand is the A-frame crane lorry. Here an olf truck is reduced to a bare chassis and a swivelling jib pole is mounted at the rear, which has two supporting poles in the form of an A attached to the end. The jib and A frame are long enough for the trailer of a logging truck to be reversed underneath, while a log is held in the air. A logging truck load of 15-20m^3 can be loaded in about one hour. Both these methods of loading are examples of intermediate technology. The cost of the equipment is substantially less than that of a purpose built crane or loader, and they can easily be manufactured locally. The output is less than that of a front end hydraulic loader, so that employment per unit of production is higher. On the other hand it is more productive, and therefore less wasteful of truck time than hand loading.

In Malaysia a different form of winch lorry (San Tai Wong) with an A frame on the chassis is used for short haul transport of log in the forest. Comparative studies between winch lorries and wheeled skidders carried out by FAO showed that for distances greater than about 1 km winch lorries were as productive as wheeled skidders though having a substantially lower purchase cost, and providing a similar level of employment per unit of production (ref. FAO Forest and Forest Industries Project Tech. Report No 6).

In addition to existing technology wthin the region there is the possibility of importing intermediate technology from other developing countries where a wide variety of systems have been developed to meet local needs. For example, in E. Africa a manual sulky has been developed for the short distance skidding of plantation thinnings, and in Brazil a very effective winch with continuous cable has been developed for Eucalyptus plantations.

The wider adoption of "Appropriate Technology" will bring important benefits, which include

increased employment in the forestry sector
increased output
improved quality of output
improved working conditions
increased opportunity for the local manufacuring sector
improved status of forestry work
reduced wastage of a valuable resource
reduced environmental damage.

Very little information is available at present on the availability and cost of intermediate technology either within the Asian region or elsewhere in the world. Very little attention has been paid to forest harvesting and transport, by any of the organisations concerned with "Appropriate Technology". The Forestry and Forest Industries Panel of the Intermediate Technology Development Group, has been investigating a variety of techniques, but does not at the present time have the resources to assemble a complete directory of forest harvesting technology.

As far as is known, the FRI Logging Branch at Dehra Dun India is the only organisation actively involved in the developement and testing of forest harvesting and transport equipment in Asia a the present time. Harvesting has tended to be the concern of commercial organisations, the majority of which find it cheaper to import technology rather than develop their own.

The existence of a substantial number of indigenous designs of intermediate technology within Asia, combined with the widespread scope for its application means that there are opportunities for Technical Cooperation among Developing Countires (TCDC) in the further development of existing designs to render them suitable for more extensive application. Once such cooperation has been initiated it would be relatively more easy to initiate R and D into completely new designs, and to have prototypes built. The cost of the development work can be very high, and has been sigled out by Hari Kant (1972) as one of the principal reasons for the lack of progress to date in the Asian countries.

It would therefore be valuable to identify technologies which could have widespread application in the region and draw up and R and D project, specifying the funds needed and the manpower required to reach pre-production stage, with an indication of the likely market for a successful item. In this way funds could be attracted either from Private, Government or International sources, to initiate a TCDC project in this very important field.

7. DISSEMINATION OF INFORMATION ON APPROPRIATE HARVESTING AND TRANSPORT TECHNOLOGY IN ASIA

The number of modes in existence for disseminating information about "Appropriate Technology" is very restricted, which probably explains the very uneven state of knowledge about harvesting and transport technology throughout the region.

If one considers potential recipients or users of information about appropriate forest harvesting technology there are the following broad groups:

Government Forestry Officials	
Managers of Private Companies	- locally owned
	- foreign owned
Contractors	
Investors in forestry enterprises	- local
	- international
Farmers and Forest Workers.	

If one considers modes of disseminating information about appropriate forest harvesting technology there are the following broad groups:

Professional Journals	- e.g. Indian Forester, Malayan Forester (etc.)
International Journals	- e.g. World Wood, Asian Forests (FAO)
Advertising	- in technical press and journals
	- manufacturers brochures

Exhibitions	- mainly national or regional trade fairs not specific to forest harvesting as yet
Technical Reports	- from national agencies
	- from international agencies ILO, FAO, ADB (etc.)
	- voluntary or charitable agencies ITDG, VITA, TOOL (etc.)
Consultants	- local
	- international
Training Establishments	- general
	- specific logging, e.g. logging training centres, India, Malaysia (etc.)

None of the modes of disseminating information, except for the charitable agencies such as ITDG and TOOL are concerned with appropriate technology, and so rarely include references, except when a special paper is prepared or an appropriate item is included or referred to by chance.

Two of the important groups of potential recipients, who are most likely to benefit directly from applyimg appropriate technology, namely contractors and farmers, are barely reached by any of the established modes of disseminating information.

Government Forestry Officials are the group on whom responsibility falls for ensuring that the forestry sector makes the maximum contribution towards their country's national well being. In view of what has been said about the benefits which can accrue from the use of appropriate technology, it is important that they play a major role in ensuring that the information reaches the people who are most likely to benefit.

Within Government Forest Departments it will be necessary to ensure that there is a harvesting development team, whose task might initially be to collect and disseminate information on appropriate forest harvesting technology, and later on, to identify technologies which need further development, or gaps in the existing technology field, and formulate R and D projects to produce the required solutions.

To assist these harvesting development teams in their work it may be valuable to seek finance for a regional newsheet on appropriate technology, which would help in the task of increasing awareness of existing technology, and provide a vehicle for progress reports from future work in this field.

資料Ⅲ　林道設計規準（仕様書）

第１条　林道の調査測量設計作業は本仕様により実施するものとし，本仕様に定めのない事項については発注者とそのつど協議し，その指示に従って作業を行うものとする。

第２条　調査のための土地の立入りは事前に当該土地所有者の承認を得るものとする。

第３条　伐開は必要最小限にとどめる。

第４条　調査設計上の必要により調査した事項は総て野帖に記録し保存するものとする。

第５条　林道の構造は次の構造基準による。

No.	項目	1級（幹線林道）	2級（事業林道）	3級（作業道）
1	車線	2級線（当面は1車線）	1車線	1車線
2	設計速度	20Km／h	10Km／h	―
3	幅員 有効幅員 路肩	（7.0m）4.6m （5.5m）3.6m （075×2）0.5×2	4.6m 3.6m 0.5×2	4.0m 3.0m 0.5×2
4	待避所有効幅員 同上有効長 同上全長 同上設置区間	6.0m 20.0m 40.0m 200m以内	6.0m 20.0m 40.0m 300m以内	
5	最小半径	30.0m	15.0m	
6	最急勾配 同上やむをえない所	7% 10%	9% 14%	12% 14%
7	視距	40m	20m	20m
8	路面舗装 敷厚	砂利 10～25cm平均20cm	砂利 5～20cm平均10cm	―
9	切取法面	8分～1.2割 草木の種子吹付 編柵工	1.0割 草木の種子吹付	1.0割 草木の種子吹付
10	盛土方面	1.5割～2.0割 草木の種子吹付 編柵工 種子吹付	1.5割 草木の種子吹付	1.5割 草木の種子吹付

No.	項目	1級(幹線林道)	2級(事業林道)	3級(作業道)
11	橋梁 同幅員	Hービーム鋼橋 (Hービーム単純桁) 4.0 m	Hービーム鋼橋 木橋 4.0 m	ー
12	洗越	コルゲートパイプ埋設 コンクリート洗越	コルゲートパイプ埋設 コンクリート洗越	ー
13	暗渠	コンクリートパイプ使用 コルゲートパイプ	コンクリートパイプ コルゲートパイプ	 丸太水切
14	構造物	コンクリート擁壁 蛇篭古タイヤ 練石積 編柵工	蛇篭 古タイヤ 編柵工	古タイヤ 編柵工

註

(1) 1級林道は1車線の設計とするが，路線選定にあたっては，将来の拡巾を十分考慮して実施する。

(2)曲線半径は最小半径15 mとし，曲線半径25 m以下の場合は拡巾を行うものとし，車輪の円滑な走行を図るために，次の基準の拡巾量を内側に拡巾するものとする。

曲線部拡巾量

曲線半径 R	拡巾量 W・m	緩和区間長 ℓ・m	BC，ECの拡巾量 W・m
15 m以上	0.8	5.0	0.69
16 〃	0.6	5.0	0.53
18 〃	0.5	5.0	0.44
20 〃	0 4	5.0	0.36
22〜25 m	0.2	5.0	0.19

(3)勾配変移数値の代表差が5 %以上の場合は，縦断曲線を設置するものとする。

第 6 条　設計上の区分

1）規制区間……次の(1)又は(2)の区間では路線を確定，施工基面を決定の上切取，盛土量を積算する。

(1) 中心線における1ｍ以上の切取或は盛土が連続し，運搬盛土，運搬捨土，運搬流用の何れかを必要とする区間

(2) 橋梁，擁壁等主要構造物を必要とする区間

2）延長積算区間

(イ)中心線に於ける切高或は盛高が1ｍ未満の区間及び(ロ)切高或は盛高が1ｍ以上2ｍ未満程度あっても，その連続延長が100ｍ未満の区間は，切取，盛土量を積算せず，延長積算区間とする。

第 7 条　実測の方法

中心線測量，縦断測量，横断測量はその測量方法によって，「普通測量」と「簡易測量」とに分類する。

原則的には幹線林道は普通測量法により，事業林道は簡易測量法によるものとする。

中心線は第6条の基準によって規制区間，延長積算区間の何れかに分類しその区間を定める。

第 8 条　普通測量

(1) 測角…交角の観測は1分読以上のトランシットを用いる。

(2) 測距…距離の測定は鋼巻尺又は布巻尺により行う。

(3) 曲線設置…曲線部にはＢＣ杭，ＭＣ杭及びＥＣ杭を測設する。

(4) 中心杭…中心杭は30ｍを越えない範囲内で地形の変化点に測点杭を設置する。

(5) 縦断測量…縦断測量には気泡管の感度が2㎜当り40秒以内のレベルを使用し，標尺は目盛5㎜以内のものを使用する。

(6) 仮水準基標（ＴＢＭ）…路線に沿ってほぼ500ｍ毎にＴＢＭを設置するものとしその精度は往復観測差50㎜以内とする。

(7) 横断測量…規制区間の横断測量はハンドレベルとテープ又はポールで行い，距離及び高さの単位はｍ小数位1位とし勾配の単位はパーセント単位とする。

延長積算区間の横断測量は中心線より左右各々の平均横断勾配をハンドレベルによって測定する。

(8) 平面測量…平面測量は横断測量の範囲外についても10ｍ間隔の等高線で図示できる程度に地形測量又はスケッチで行う。

第 9 条　簡易測量

(1) 測角…交角の観測はコンパス又はトランシットを使用し角度は30分単位で測定する。

(2)　測距…距離の測定は，巻尺又はメートル縄を用いる。

(3)　曲線杭…規制区間に於ては，普通測量の方法で曲線杭を設置するが，延長積算区間では曲線杭を省略できる。この場合もなじみよい曲線を想定の上中心杭の距離を決定しなければならない。

(4)　中心杭…規制区間にあっては普通測量の方法によるが，延長積算区間にあたっては，１００ｍ毎に測点を設ける。

(5)　縦断測量…規制区間の縦断測量は普通測量と同じ方法により行うが，延長積算区間ではハンドレベルを使用して測定してよい。

(6)　仮水準基標…規制区間の前後に独立した１対としてＴＢＭを設け，その間の距離が５００ｍを越える時はほぼ５００ｍとなる様中間にもＴＢＭを設けなければならない。延長積算区間の縦断精度はこのＴＢＭに拘束されない。

(7)　横断測量…横断測量は普通測量の方法により行う。

(8)　平面測量…１０ｍ間隔の等高線を図示出来る程度のスケッチで行う。

第１０条　　構造物の調査

設計上必要な構造物については，次の事項を調査しておくものとする。

1　橋について

(1)　中心線と流水の角度および方向

(2)　流水量およびH•W•L，L•W•L

(3)　橋台橋脚予定位置付近の土質

(4)　流木の有無

(5)　河川の管理者

(6)　橋の形式

(7)　その他必要な事項

2　溝きょ類について

(1)　設置すべき位置，および中心線との方向角度

(2)　集水面積，流水量

(3)　地盤，土質

(4)　その他必要な事項

3　擁壁類について

(1)　設置すべき位置，延長，高さ

(2)　地盤状況と土圧の関係

(3)　流水，水深

(4)　その他必要な事項

第１１条　　工事材料の調査

工事用材料として採取するものについては，その採取位置，品質形状，量，運搬距離および運搬路の状況ならびにその所有者および採取料金等について調査しなければならない。なお，必要がある場合には，工事用材料としての品質試験を行わなければならない。

第１２条　　土取場，土捨場等

工事実行のために特に土取場，土捨場を要するときは，その位置，運搬距離，運搬路の状況，その所有者等について調査しなければならない。この場合，土捨場の土砂流出防止施設を特に必要とするときはその施設に関する十分の調査を行わなければならない。

第１３条　障害物の調査

工事の支障となる家屋，電柱，電話線その他の構造物についてはその名称，位置，数量，支障の程度，所有者等について調査しなければならない。

第１４条　設　計　図

設計図は，調査測量結果に基づき正確丁寧に作成し，誤謬，脱漏のないよう注意しなければならない。

2　設計図の作成は，第１５条から第２１条までに規定するところによらなければならない。

第１５条　図面の種類は路線平面図，縦断面図，横断面図及び土工定規図並びに構造物設計図とする。図面の大きさはＡ版とし，折りたたみ仕上りをＡ４版とし，縮尺は工事実施上支障を生じないものとする。

簡易測量による場合は，平面図を省略し5,０００分の１地形図にＩ・Ｐを図示してこれに代える。延長積算区間の縦断図並に横断図はこれを省略してよい。

第１６条　位　置　図

位置図は，事業図またはこれに準ずる５万分の１の地形図を用いて計画路線と既設路線の区別を明らかにしておかなければならない。

2　計画路線については，その起点の林道粁程，予定延長，工区界，実行年度等を記入しなければならない。

第１７条　平　面　図

平面図には，次の事項を記入しなければならない。

1　計画路線の中心線

2　Ｉ・Ｐの番号および曲線に関する諸数値

3　Ｂ・Ｍおよびその番号と高さ

4　方位

5　地形および地物

6　凡例

7　平面図の縮尺は，1,０００分の１または2,０００分の１とする。

第１８条　縦　断　面　図

縦断面図面には，次の事項を記入しなければならない。

1　測点および地盤高，施工基面高，盛高，切高，勾配

2　縦断曲線に関する諸数値

3　Ｂ・Ｍの位置およびその番号と高さ

4　橋の名称および橋長

5　各種構造物の名称，型状寸法および数量

2. 縦断面図は縮尺は，縦１００分の１，横1,０００分の１または縦２００分の１，横2,000分の１とする。

第１９条　　横　断　面　図

横断面図には，各測点ごとに次の事項を記入しなければならない。

1　中心線および地盤線

2　中心線における切盛高の数値

3　施工基面，路幅，側溝，土工の法

4　工種の区分

5　擁壁，石積等の形状

6　橋，溝きょ等の位置（測点）

7　水位および附近の地物

2. 横断面図の縮尺は，１００分の１または２００分の１とする。

第２０条　　構造物設計図

橋その他重要な構造物に対しては，その設計図を作成し，必要寸法については細部まで記入しなければならない。

2. 橋その他重要な構造物についての設計図には，次の事項を記入しなければならない。

1　設計条件

2　所要材料表および数量調書

3　中心線および測点との関連

4　施工基面との関連

5　水位に関係ある場合はＬ・Ｗ・ＬおよびＨ・Ｗ・Ｌの関係

6　各種部分の形状寸法・法勾配等

7　その他必要事項

3. 石積，擁壁，管渠等でその構造が簡単な場合は，それを定規図および縦横断面図等に明示して，設計図として扱うことができる。

第２１条　　定　　規　　図

当該計画路線について設計上次の事項について一定の定規を設けた場合は，定規図を作成しなければならない。

1　施工基面の造成幅，側溝等

2　切盛土工の法勾配

3　暗きょにおける最小覆厚および基礎構造等

4　石積工における法勾配，積石控長，裏込砂利厚等

5　コンクリート擁壁工における天端厚，法勾配等

6　篭工における法勾配，裏込砂利厚等

7　その他必要な事項

第22条　略符号

野帳，図面等に略符号を記入するときは，次の標準とする。

名称	略符号	名称	略符号	名称	略符号
中心線	∅	曲線中点	M・C	施工基面高	F・L または F・H
起点	B・P	曲線終点	E・C		
終点	E・P	破鎖	BR・C	盛高	B・H
交角点	I・P	水準基標	B・M	切高	C・H
交角	I・A	測点	S・P	盛土面積	B・A
曲線半径	R	前視	F・S	切土 〃	C・A
切線長	T・L	後視	B・S	盛土量	B・V
正割長	S・L	器機高	I・H	切土量	C・V
曲線長	C・L	移器点	T・P	縮尺	S
曲線始点	B・C	地盤高	G・H	勾配	G

第23条　数量計算

数量計算は，正確に行い，その算出根拠は明確にしておかなければならない。

2　数量計算は，算式によるか，または図上計算或いは実物測定によらなければならない。

3　面積の算出は，計算，三斜法またはプラニメーターによらなければならない。

4　数量計算は各工種区分ごとに行わなければならない。

第24条　土積計算

一般的な切取量および盛土量の計算は，両端断面積平均法によるものとし，両断面積の平均にその断面間の距離を乗じて算出しなければならない。

2　一般的な切取量および盛土量の計算には土量の膨脹，収縮による増減等は必要に応じ考慮する。

3　切取量および盛土量の計算にあっては，必要がある場合を除き，次の事項は考慮しないものとする。

(1)　不陸均し区間の土量

(2)　盛土の余盛

(3)　盛土内における内径60センチメートル以下の管渠類および1個の容積1立方メートル

未満の構造物の容積

(4) 側溝をメートル単位で算出する場合の容積

第２５条　　側 溝 の 延 長

側溝の延長は，その始点と終点との測点間距離とする。

第２６条　　石 積 の 面 積

石積の面積は，展開図によるかまたは横断図から法長を算出して計算しなければならない。

2　石積工の中に埋設する内径２０センチメートルを超える管渠等の容積または面積は，これを控除しなければならない。

第２７条　　コンクリート構造物の容積

コンクリートの容積は，構造物ごとに算出しなければならない。

2　コンクリート容積内に埋設する構造物等の容積は，これを控除しなければならない。ただし隅角の面取り，桁受の沓ボールト孔等および内径２０センチメートル以下の管渠類は，この限りでない。

第２８条　　管 渠 類 の 延 長

排水管　暗渠開　等の延長は，その設置箇所ごとの中心軸の長さとする。

第２９条　　数 量 計 算 単 位

工種別工事数量の集計単位は，次のとおりとする。

工　　種	単位	集計単位	工　　種	単位	集計単位
延　　長	m	単　位　止	盛　　土	m³	単　位　止
切　　取	m³	〃	張芝筋芝	m²	〃
伐　　開	m	〃	捨　　土	m³	〃
床　　掘	m³	〃	不陸均し	m	〃
側　　溝	m	〃	蛇　　篭	m	1　　位
伐　　根	本	〃	土 俵 造	俵	単　止　位
石　　積	m²	〃	仮締切工	m	〃
敷 砂 利	m²	〃	仮　　道	m	〃
排水管伏設	m	1位2位止，単位止	仮　　橋	m	単　位　止
モルタル	m³	1　　位	型枠損料	m²	〃
コンクリート	m³	〃	足場損料	m²	〃
鉄筋組立	t	3　位　止			

第３０条　　設 計 積 算

設計にあたっては，所要の強度と安定性を有し，経済的にしてかつ，有効な機能を発揮させるようにしなければならない。

2　工事費の積算にあたっては，適正にして現地の実情に適応したものでなければならない。

第31条　機械設計

次に掲げる場合は，土木機械による機械施工法を採用しなければならない。

(1)　工事分量が，当該機械の機械施工における経済分岐事業量を上廻るとき。

(2)　施工上の質，および功程上から，当該機械の施工を必要とするとき。

2　前項の経済分岐事業量については，通常実施される工種の場合は，各工種ごとにその標準量を算定しておき，各路線ともそれを適用することができるものとする。

第32条　構造

重要な幹線林道における構造物は，永久構造を原則とする。ただし地形および搬路等の関係上やむを得ないときはこの限りでない。

第33条　配合

コンクリートは，原則として重量配合設計する。

第34条　成果品の提出

提出する成果品は次の通りとする。

1	設計説明書			3　部
2	設計原図			
(1)	位置図	ポリエステルベース	200#	1　部
(2)	平面図	〃		〃
(3)	縦断図	〃		〃
(4)	横断面図	ロールセクション（トレシングペーパー）		〃
(5)	土工定規図	ポリエステルベース	200#	〃
(6)	構造物設計図	〃		〃
3	設計図	陽面焼　(1)～(6)		各3部
4	数量計算書			
(1)	土積計算書			1部
(2)	構造物数量材料計算書			1部
5	流量計算書（水路構造物のある場合）			1部
6	構造物応力計算書（行政機関鑑修による標準設計によらない主要構造物のある場合）			1部
7	調査野帖			
(1)	中心線野帖			1式

(2) 縦断野帖 1式

(3) 横断野帖 〃

(4) 構造物その他調査野帖 〃

8 工事費概算書 1部

積算内訳は次の区別とする。

(1) 直接工事費

イ) 土工費（擁壁等含む）

ロ) 橋梁費

ハ) 溝　費

(2) 間接工事費

イ) 仮設費

ロ) 共通費

(3) 管理費

イ) 現場管理費

ロ) 一般管理費