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Technologies for basic needs: the case of Philippine forestry[1]

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The creation of productive rural jobs has been emphasised as a key condition for the successful over-all development of the Philippines during the years ahead.[2] When considering employment possibilities in rural areas, planners almost invariably concentrate their attention on agriculture and neglect forestry, a sector which in the Philippines figures prominently in the national economy[3] and could absorb much more labour if appropriate technologies were developed and applied.

Technologies appropriate for Philippine forestry would ideally improve working conditions, enhance the safety of work, protect the environment and generate a large volume of employment.[4] Considerations of quality of work are of particular concern to forestry workers, since theirs is one of the most strenuous and hazardous of all occupations. Compared with other sectors, forestry has always suffered high accident frequency, severity and fatality rates in a wide range of countries.[5]

The background

This article reviews the technological options available for various forestry operations in the Philippines. It discusses those that come closest to the ideal characteristics of providing more employment, improving working conditions, enhancing safety and protecting the environment. Rarely does a single technology meet all these criteria simultaneously. For this reason the emphasis is on compromise and balance, as exemplified by " intermediate " technologies.

In 1976-77 the ILO collaborated with the Government of Finland and the Philippine Bureau of Forest Development to research and develop some of these intermediate alternatives for Philippine forestry. The present article briefly summarises the project's findings with the aim of showing (1) that the scope for technological choice in forestry is relatively broad and that viable

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intermediate methods do exist, and (2) that intermediate methods are often the least-cost alternatives, especially when the definition of " cost " includes ergonomic and environmental considerations as well as the more usual economic ones.

The project staff carried out work studies of alternative methods for selected operations at six different locations throughout the Philippines. These locations represented a broad spectrum of site conditions and geographic characteristics. Each work study required the computation of production rates and the derivation of operating costs. Analysis of variance was applied to test differences in production rates for their statistical significance. Hourly equipment and labour costs were derived for each technological alternative as the sum of several items, e.g. machine or tool depreciation, interest, fuel, oil and lubricants, repair and maintenance, and wages and social benefits.[6]

The approach was the same for each operation investigated. First, the techniques currently in use were identified; they ranged from primitive hand tools at one extreme to sophisticated equipment at the other. Next, intermediate alternatives were introduced and tested. Often these involved no more than the reorganisation and improvement of existing labour-intensive methods by the use of better hand tools, new aids and more efficient working techniques. The unit costs of the various alternatives were then compared, as well as their acceptability to workers and employers. An attempt was also made to promote indigenous manufacture of some of the appropriate tools in rural workshops.

Results of the studies

Felling and cross-cutting

The logging sequence begins with the stump-site operations. The tree is felled, the usable bole is debranched and cross-cut into appropriate log lengths. The choice of technology for these operations is very sensitive to the diameter of the trees and the diameter and weight of the logs.

Three alternative methods of felling and cross-cutting trees of large diameter were examined. The first involved use of the large, heavy-weight power chain saw of 9-13 horsepower, equipped with a long guide bar. This is the predominant method in the Philippines for large-diameter timber. It has replaced manual felling with the two-man cross-cut saw, which was the traditional method until the 1960s.

The project introduced a smaller and lighter power chain saw of 3-5 horsepower as the third and intermediate alternative. The small chain saw cut somewhat slower than the large chain saw, but three times faster than the two-man cross-cut saw. Hence labour productivity and labour usage were balanced between the two extremes.

The lowest cost of $19 per 100 cubic metres (all costs are shown in United States dollars) was achieved by the intermediate method, the small chain saw,

compared with $23 to $26 for the large chain saw, and $22 for the manual cross-cut saw.

Apart from direct monetary savings, the small chain saw has advantages in terms of health, safety and the environment. Manual sawing in tropical climates places great physical strain on the workers, especially if their diet is not completely adequate. The large chain saw is no better, since it is heavy and entails a high risk of accidents and hearing loss. In contrast, the small chain saw is equipped with anti-noise and anti-vibration devices; it is light and well balanced.

With respect to impact on the forest environment, reliance on manual cross-cut saws can lead to the exclusion of the very large trees. The workers tend to cut only the medium-diameter trees, and this adversely affects the future age and size structure of the timber stands.

Broader acceptance of small chain saws depends on at least two factors. If they are to be used on a wider scale for large-diameter timber, there will have to be much greater diffusion of the technique of cutting " around " rather than " through " the tree. With this technique the undercut is made as usual. The centre cut is then made with the help of the roller-nose bar. Leaving hinges at the side of the undercut, the final step is to walk around the tree to complete the felling cut.

Secondly, the large chain saw cannot be completely dispensed with since there are some trees too big to be handled using the small chain saw with its short guide bar. But the small chain saw could be used in combination with the large one, either simultaneously with different teams of workers, or sequentially with the same team using first the small and then the large chain saw. The small chain saw could be used for the majority of the trees, and the large saw only to cut the few giants.

Thinning

Thinning is the selection and removal of the smaller, poorer and badly leaning trees to improve the growth and quality of the rest. The diameter of the trees removed is small, and the small power chain saw was studied as the most equipment-intensive alternative. While the small power chain saw had been the intermediate method in large-diameter timber as discussed previously, the bow saw became the intermediate method in thinning. The third and most primitive alternative was thinning with the use of axe and bolo, a machete or jungle knife commonly fashioned from discarded leaf springs, old saw blades or other pieces of hard steel that happen to be available.

The bow saw was truly intermediate when compared with the small chain saw and either the axe or bolo as regards working speed. To thin 100 stems, the chain saw required about 4 man-hours and the axe about 17. The bow saw came squarely between them at about 9 man-hours per 100 stems.

Unit costs were $35 per thousand stems thinned by small chain saw as against $34 per thousand stems thinned by bow saw. Although the total unit costs of the two techniques are roughly the same, most of the costs of using

the chain saw are machine costs. In contrast, most of the costs of using the bow saw consist of wages for labour.

The substitution of the bow saw for the chain saw eliminates the risk of injuries from noise and vibration. Its replacement of the bolo or axe leads to a marked reduction in the level of wood waste, the bow saw's cutting waste being only 9 per cent of that of the bolo and 15 per cent of that of the axe.

Short-distance log transport

To transport logs from stump to road, 70 per cent of the timber companies in the Philippines use highly capital-intensive cable systems, which are usually necessary because of steep slopes and large log size. But ground skidding is practised wherever favourable terrain and smaller logs permit.

The project studied the transport of small logs by crawler tractors and four-wheel skidders as the most capital-intensive alternatives, and by manual carrying as the most labour-intensive. Intermediate alternatives were the farm tractor and the water buffalo.

Manual carrying generated twice the labour input of skidding by water buffalo, but load size averaged only 0.08 cubic metres compared with 0.17 cubic metres by water buffalo and 0.25 cubic metres by farm tractor. The farm tractor was equipped with a winch, which increased its productivity by 200 per cent for a cost increase of only 9 per cent.

The most economical alternative for round trips of under 440 metres was the water buffalo, and beyond that distance the four-wheel skidder.

Subject to certain constraints of load size, terrain and distance, the water buffalo and farm tractor offer highly practical means of ground skidding. Furthermore, both water buffaloes and farm tractors can be used to skid logs during the agricultural off-seasons.

Taking into account the difference in travel speed and load size, an integrated approach would favour some combination of manual carrying, water buffaloes and farm tractors equipped with winches to transport the logs the short distance from stump to main trail. From there four-wheel skidders would transport the bunched logs the longer distance to the roadside. Given a minimum scale of operation and suitable terrain, this kind of integrated system could create considerable employment in harvesting the country's industrial plantations and tree farms.

From an ecological perspective, log extraction by means of water buffaloes and light tractors causes far less damage to the remaining trees than does extraction by means of heavy tractors or cable systems. From an occupational safety point of view, manual carrying of heavy and slippery logs entails obvious hazards, and it may be socially advisable to sacrifice a certain margin of labour intensity to have this work done more safely by water buffaloes and farm tractors.

Debarking

Three alternative methods of removing bark from pulpwood were compared. The capital-intensive method was mechanical debarking. The most

labour-intensive method was the use of the bolo. The project introduced a properly designed debarking spud (a long-handled tool with a small spade-like head) as the improved manual alternative.

Use of the debarking spud in place of the bolo increased labour productivity by between 33 and 129 per cent depending on timber species and bark characteristics. Yet the debarking spud absorbed considerably more labour than the mechanical debarker.

Ergonomic considerations played an important role in the difference between methods. When using bolos, the workers were constantly stooping; in contrast, the debarking spud allowed them to maintain a semi-upright stance. Use of the spud also reduced the risk that the workers would lacerate themselves, as frequently occurred with the bolo. Moreover, when used to debark pine, the spud helped to reduce bodily contact with the resinous wood.

Log loading

A number of different log loading techniques are in use in the Philippines. The alternatives range from strictly manual techniques to ones requiring only a single piece of equipment and a single operator. As in so many other logging operations, log size plays the key role in determining the technical and economic viability of the alternatives. Labour-intensive log loading is more feasible for small logs than for large ones.

Labour-intensive pulpwood loading was improved by introducing hand tools such as tongs, stacking claws, pulpwood picks and lifting hooks. This trebled productivity. Nevertheless, manual loading with the assistance of hand tools required approximately ten times more labour than was needed with a rubber-tyred mechanical loader.

Manual loading was found to be cost competitive. It cost $107 to load 100 cubic metres of pulpwood with the mechanical loader but only $89 using manual methods. What is noteworthy is that labour accounted for about 10 per cent of the loading costs using the mechanical method compared with nearly 60 per cent with manual loading.

Introduction of the tools in place of bare hands and sheer muscle reduced both the strain of the work and the risk of injury in lifting, pivoting and dragging heavy and slippery logs.

Underbrush clearing

Many forestry operations, both small- and large-scale, call for the removal of underbrush, vines and herbaceous vegetation, e.g. in order to make clearings prior to reforestation, to tend and weed the growing plantations and to carry out liberation cutting.

Technologies for controlled removal of vegetation by mechanical severance (i.e. excluding fire and chemicals) range from crawler tractors equipped with bulldozer blades on the one hand, to very labour-intensive clearing with bolos on the other. Technologies between these two extremes and applied in

combination with them make use of chain saws, motorised clearing saws, hand saws and axes.

The project compared the brush hook with the motorised clearing saw as an equipment-intensive alternative, and with the bolo as a more primitive hand-tool alternative. Use of the brush hook generated 70 per cent more employment than the motorised clearing saw, while its productivity was more than double that of the bolo. The brush hook was therefore the intermediate or improved labour-using method which helped to strike the important balance between labour absorption and labour productivity. Cost per hectare was $23 when using the brush hook, $48 when using the bolo, and $51 when using the motorised clearing saw.

Introduction of the brush hook also contributed to reducing the strain on the worker. It is heavier and stronger than the bolo and is used with two hands rather than one. Swinging from an overhead position, a worker using a brush hook can completely sever a sapling of 7 to 8 centimeters in diameter with a single blow, whereas use of the bolo requires many more strokes from a stooped working position.

Tree planting

The Philippines has vast employment opportunities in tree planting and auxiliary reforestation activities. To date mechanised planting methods have had little success. Tractor-drawn planting machines can operate only on relatively level ground where there are not too many impediments. Mechanised planting is therefore confined to isolated level sites within larger tracts of generally steep wastelands. This puts the burden of the reforestation effort on manpower.

The project introduced an oval-bladed planting hoe as an improved hand tool to be compared with other less satisfactory planting tools already in use. The oval-bladed hoe increased productivity by from 22 to 35 per cent above that of the existing hand tools, but required seven times the labour input of a tractor-drawn mechanical planter; it should also increase seedling survival since it does not leave an air pocket under the seedling or compact the soil on all sides of the planting hole. In addition, its cutting edge facilitates clearing dense grass that might otherwise choke the seedling in early growth.

Pruning

The object of pruning industrial tree plantations is to minimise the number and size of knots in the lower boles of timber grown for veneer and sawlog purposes. Sometimes it is done to remove persistent lower branches that hinder access and movement in closely spaced stands. In regions subject to forest fires it can be helpful in eliminating lower limbs and foliage that might transmit ground fires upwards to the crowns. Pruning may also satisfy purely aesthetic aims, by improving the appearance of stands exposed to public view.

In the Philippines pruning is not yet widely practised. One large timber concessionaire has initiated pruning in its industrial plantations. The dissemina-

tion of suitable tools and working techniques should help to establish the feasibility of the practice and contribute to a modest increase in employment.

The project compared pruning with the bolo, the present practice, with use of a pruning saw. Productivity and costs were virtually the same with the two methods. But the pruning saw is ergonomically superior.

The worker using a bolo has to climb the trees to reach some of the branches to be pruned. In the trees he is often bothered by bees and ants and risks falling. A worker with a long-handled pruning saw, on the other hand, can reach the upper branches without climbing. Besides, use of the bolo is more tiring: the pruner has to climb up and down the ladder and the tree, reach out and lop off branches with his arms fully extended, and carry a heavy ladder from tree to tree. In contrast, the cutting action of the pruning saw is smooth and rhythmic. The pruner rocks his body at the waist, bending slightly at the knees. The work is done by the thighs, and there is minimal strain on the hands and arms, which are used to direct the saw, not to exert the cutting force.

Local manufacture of forestry tools

The practicability of the " improved " labour-intensive technologies in the forestry sector hinges on the availability of the appropriate tools and equipment. An effort was therefore made to promote their manufacture in local rural workshops. The results are briefly described below.

Most of the deficiencies of forestry hand tools made in small-scale rural workshops have more to do with lack of suitable materials and facilities than with any want of skill or craftsmanship.

With existing Philippine technology, the forestry and logging tools and accessories produced most satisfactorily are items such as felling aids, felling wedges, wooden bow-saw frames, and tongs, hooks and picks for manual log handling and loading. Items produced less satisfactorily are planting tubes, planting hoes, brush hooks and debarking spuds. Finally, items out of the technological reach of the rural workshops include saw blades and skidding grapples.

The metal used to make planting hoes, brush hooks and debarking spuds is not uniform from one piece to another. Discarded leaf springs from motor vehicles are the principal raw material and these originate from different and unknown sources. In general, the silicon content of most spring steels is too high to make a blade that can be kept sharp with a file and that will not crack or split under hard use. Although perfectly adequate for traditional bolos and knives, spring steel is not as satisfactory in fulfilling the more rigorous demands of planting hoes, brush hooks and debarking spuds, all of which are subjected to greater strain.

Without proper analysis of the metal or any quality control other than subjective trial and error, existing methods of open-flame heat treatment at the rural workshops make some of the pieces too brittle and leave other pieces

too soft. Sometimes a single piece may be both too brittle and too soft in different places. The rural workshops do not possess—nor, as small-scale producers, could they afford—the facilities and equipment ideally suited for final heat treatment of the metal at very high, controlled temperatures (e.g. in an electric furnace).

Therefore remedial action will have to be taken in two areas: (i) uniform batches of steel having known composition and specifications suitable for the intended purpose will have to be purchased; and (ii) final heat treatment in an electric furnace or similar facility will have to be carried out on a co-operative basis or by subcontracting. The latter can easily be organised; at present several rural workshops with no welding equipment often have recourse to a single welding shop; similarly, heat treatment facilities in one shop could serve a cluster of other workshops.

Conclusion: the prospects for intermediate technologies

This brief article has shown that intermediate or improved labour-intensive technologies for Philippine forestry do exist. Their use leads to increased productivity when compared with more primitive techniques, but decreased labour displacement when compared with more capital-intensive ones. In addition to generating productive employment, these intermediate technologies offer in varying degrees the advantages of improved working conditions, less risk of injury and greater protection of the environment.

The intermediate technologies are often the least-cost alternatives at prevailing market prices. This is very important if they are to receive serious consideration and acceptance by employers and other decision-makers in the forestry sector.

It is also important to recognise the implications for factor shares. The intermediate technologies direct a large share of factor payments to labour in the form of wages. The equipment-intensive technologies direct a large share of factor payments to capital in the form of machine costs.

It is foreseen that the old-growth forests in the Philippines will be logged over in the next 30-35 years, if not earlier. Efforts will therefore increasingly be committed to reforestation and silviculture. The scope for the new technologies becomes broader in such man-made forests, both for the expansion of the plantations and for the harvesting of small-size timber. Timber stand improvement, if carried out on a massive scale with the new technologies, could generate millions of man-hours for liberation cutting, clearing, girdling, thinning and other cultural improvements; indeed, some of these activities already constitute a major pillar of the Philippine Government's forest rehabilitation efforts. The prospects for the spread of intermediate technologies are therefore bright.

Notes

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[2] ILO: *Sharing in development : a programme of employment, equity and growth for the Philippines* (Geneva, 1974), p. 55.

[3] Exports of forest-based products account for about a quarter of the nation's foreign exchange earnings. Forests cover nearly 60 per cent of the land area of the Philippines.

[4] ILO: *Meeting basic needs : strategies for eradicating mass poverty and unemployment*, Conclusions of the World Employment Conference (Geneva, 1977), p. 36. See also Hans Singer: *Technologies for basic needs* (Geneva, ILO, 1977).

[5] Idem: *Conditions of work and life in the timber industry*, Report II, Second Tripartite Technical Meeting for the Timber Industry, Geneva, 1973, pp. 87 ff.

[6] Details of the methodology are available in ILO: *Appropriate technology in Philippine forestry*, Report of the Joint Philippine Bureau of Forest Development/ILO/Government of Finland Project (Geneva, 1977; mimeographed).