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CONTENTS

	PAGE
EDITORIAL	1
J. A. M. DE SILVA AN—APPRECIATION	3
CABLE CRANES AS A MEANS OF TIMBER EXTRACTION FROM THE RAIN FORESTS OF CEYLON .. *L. C. A De S. Wijesinghe*	4
AN INSECTICIDE TRIAL FOR THE CONTROL OF COCKCHAFER LARVAE (*Anomala SP.*) IN TEAK NURSERIES .. .. *S. Muttiah*	12
A PRELIMINARY REPORT ON THE PREVENTION OF SPLITTING IN POLES OF *Eucalyptus Grandis* USING GANG NAILS *A. E. K. Tisseverasinghe*	20
AN EXPERIMENT IN THE USE OF IMPROVED TECHNIQUES IN DRY ZONE LOGGING .. *L. C. A. De S. Wijesinghe*	23
NOTES ON TIMBER .. .. *R. Ponnampalam*	33
CEYLON FORESTER (NEW SERIES) AUTHOR INDEX FOR VOL. VII 1965–1966 .. *A. W. Seneviratne*	37

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" The forest is a peculiar organism of unlimited kindness and benevolence that makes no demands for its sustenance and extends generously the products of its life activity; it affords protection to all beings, offering shade even to the axeman who destroys it."—Gautama Buddha.

EDITORIAL

CHANGING OBJECTIVES OF FOREST MANAGEMENT

WE make no apologies for lifting this title direct from Jack Westoby's paper which he read at the Ninth Commonwealth Forestry Conference, recently concluded in India. There is a lot of rethinking going on regarding matters which were formerly regarded as unchangeable. For instance the concept of sustained yield as a prime management objective has been questioned in several papers presented to the Conference by King, Nautiyal and Smith and Grayson. This was formerly regarded as central to Forestry thinking and all forest management was based on this concept but present day Forest economists do not seem to treat this with the veneration it received in the past from generations of foresters.

There is no doubt that the concept of sustained yield is a valuable one. Why then is its validity being increasingly questioned ? It is said, (Nautiyal and Smith), that the concept of sustained yield is too rigid and that it takes no account of long term trends nor of cyclical fluctuations within that trend. Instead, the concept of maximising the present worth of present and future values is advocated. It has also been said, (King), that it seems anachronistic to practice sustained yield forestry in natural forests in developing countries where the forest capital produces interest (sustained yield) which may be a fraction of the interest rates paid on foreign loans, etc. The slogan should be liquidate, invest and replace.

What relevance has all this for Ceylon ? The lesson to be learnt is that our thinking should not be cramped by having to bear a load of ideas whose validity may be doubtful. Also, that all our projects will have to be justified on economic lines. It is dishonest to speak of subsidiary benefits if we are unable to prove that an investment will pay for itself. As Jack Westoby truly says " Contrary to what many outsiders believe, forestry is not, in its essence, about trees, It is about people. It is about trees only so far as they can serve the needs of people." There is therefore no virtue in maintaining or growing forests for the sake of forests.

In Ceylon circumstances have been such that nobody had a great deal of time to spend on debating various theoretical concepts—the problems facing foresters here, are of such immediacy that a series of *ad hoc* measures have been taken. This is of course not a good thing in the long run because a sound theoretical foundation is essential for good forestry practice, but in the short run it has meant that action has replaced sterile argument.

It is time now for us to take stock of the situation and approach our problems in the light of the new thinking. Whether this new thinking is on the right lines or not will be debated in the years to come but even heresies help true believers to understand their own doctrines better and even if this is all that the new thinking achieves, it is still worthwhile. Some think it distasteful to discuss the art of forestry in such jargon as linear programming, simulation, operational research, game theory and so on, but if we want to find out what the " mods " are thinking we have to learn their language.

Taungya in India

We had the opportunity of visiting some reforestation areas in Uttar Pradesh and West Bengal and were impressed with the extremely thorough manner in which the agricultural part of the *Taungya* system was being managed. Mostly the areas are stumped and the ground is tilled before every new crop is introduced. As a result the growth of the forest trees in the cropped areas is better than that in the uncropped areas. In West Bengal particularly, many experiments are being done using new techniques. Clearing is done using heavy machines which push down the trees so that stumping is also achieved. Tilling is done using farm tractors and agricultural crops are obtained from the land for many more years than in the traditional *taungya* system. Shade tolerant crops such as turmeric are grown. Pineapples are also grown without tending and the clumps produce fruits when the tree crop is thinned !

U. N. Special Fund Project

This project was to have ended last year but the mechanized logging section of it has been extended. A Cable Crane which was received last year has just been installed at Dediyagala under the guidance of Mr. Peter Bauernfried, F.A.O. Expert. We take this opportunity of welcoming him to our midst.

AN APPRECIATION

J. A. M. DE SILVA

The shocking news of the death of J. A. M. de Silva (or 'Jadi' to his many friends) on the eleventh of February 1967 was received from the Phillipines where he had been on an F. A. O. fellowship. It was indeed a tragedy that a life so full of promise should have been cruelly cut short by this stroke of fate.

Born on the ninth of September, 1932, he completed his early education at Royal College, Colombo, where he excelled in athletics and established several public schools records in the sprints. Joining the University of Ceylon, he took an Honours degree in Zoology while continuing his active participation in sports. Selected as a Junior Assistant Conservator of Forests in the Forest Department, he joined Keble College, Oxford, like his father before him and read for an Honours degree in forestry. Returning to the island, he served the department ably in varied capacities. In particular, he pioneered the road building project in the inaccessible Gilimale and Sinharajah Forest Reserves in the Wet Zone. Later he served as Divisional Forest Officer, Trincomalee, during which time he was responsible for the extensive reforestation of Teak in the Dry Zone jungles.

As a member of the logging team of the U. N. S. F. project, he proceeded on the ill fated fellowship tour of Japan and the Phillipines to study logging techniques. The experience and know-how gained in this tour would have been of immense benefit and the Department is all the poorer for his loss. He always showed a keen awareness and understanding for practical problems affecting both forestry and field officers. This was a rich attribute which he had undoubtedly inherited from his illustrious father, a former Conservator of Forests.

Besides his official life, 'Jadi' had rare personal qualities. He will be remembered and greatly missed for his ready wit and repartee which he possessed in abundance and which enlivened many a conversation or discussion. He was cultured and knowledgeable.

Our deep sympathies go out to his wife, two young children and to his parents.

S. M.

Cable Cranes as a Means of Timber Extraction from the Rain Forests of Ceylon

L. C. A. DE S. WIJESINGHE

SUMMARY

Mechanised methods should be used to supplement the present method of timber extraction by elephants if the outturn of timber from the Rain Forests of Ceylon is to be appreciably increased. As these forests are situated in mountainous terrain, cable cranes may be used in areas with a gradient of over 25 percent. The writer has pointed out that the type of crane with two cables—a carrying cable and a combined lifting and traction cable—should be used for trials in Ceylon. Selective fellings, the multi-storied nature of the stand, the composition of the forests which consist entirely of broad leaf species, and the lack of trained personnel will create problems that will have to be overcome in introducing cable crane extraction to Ceylon.

A plan for trying out extraction by cable crane in the Dediyagala Forest Reserve was drawn up by the writer and is now being put into effect.

INTRODUCTION

The total extent of forest in Ceylon is estimated to be a little over 7 million acres which is about 40 percent of the land area. About 85 percent of the forest area is situated in the region called the 'Dry Zone' where the climate is characterised by a period of drought of 3 to 4 months duration. The natural vegetation of this region is a high forest consisting of deciduous and evergreen species. One noteworthy feature of this Formation is that it has a very poor stocking of utilisable timber species.

The balance 15 percent falls into the Wet Zone where the forests are situated in the mountainous region in the South West quarter of the country. The vegetation of this area is the Tropical Rain Forest, which, in contrast to the Dry Zone forest, is fairly well stocked with good timber species.

Despite the 7 million acres of forest in Ceylon the annual output of timber (other than fuelwood) is estimated to be only about 10 million cubic feet. The low yield in the Dry Zone is the direct result of the poor quality of the forest, while in the Wet Zone it is due to the fact that many of the forests have not been opened up. Even in those forests of the Wet Zone which have been opened up, the road density is extremely low, and haulage of timber from the forest to the road by the methods now in use is slow and time consuming.

PRESENT METHODS OF TIMBER EXTRACTION IN THE RAIN FORESTS OF CEYLON

By the term 'extraction' the writer refers to the haulage of timber from the stump to a point from where it could be directly transported to the mill. This term is synonymous with "minor transportation" as used by Cermak & Lloyd (1962). What is referred to as 'transport' by the writer is the second stage of haulage, namely, the moving of logs from the collecting points in the forest to the mills. Cermak & Lloyd refer to this operation as "major transportation".

The chief method of timber extraction in Ceylon is skidding by elephants. Timber haulage is also done by bullocks with the aid of sling carts, but this is confined to a few forest areas with easy terrain in the Dry Zone.

Skidding by elephants has many advantages over mechanised methods, but there are serious limitations in regard to its use in Ceylon. The chief among these is the acute shortage of elephants for forest work. There is no easy solution to this problem as the trapping of wild elephants is now virtually prohibited because of their dwindling population, and they do not breed in captivity. Another limitation is the long skidding distances. Road networks as such are totally lacking in the Wet Zone forests, and very often an elephant has to drag timber for a distance of several miles. A third difficulty is that in very steep areas skidding by elephants is impossible, and such part of the forest remain unworked even though the forest as a whole has been opened up.

In order to increase the output of timber from the Rain Forests, therefore, it is necessary that they should be provided with good road networks, and that for extraction of timber, elephants be supplemented by mechanised means. One distinct possibility in regard to mechanised extraction is the introduction of cable cranes to areas which are too steep for skidding by elephants.

THE PLANNING OF EXTRACTION SCHEMES

Extraction schemes must be planned in relation to the proposals that have been made for opening up the forest. The forest is opened up by means of a communication network, in the planning of which, the following should be considered : the terrain, the stand, the technical and economic feasibility of using different means of communication (like roads, railways etc.) and the methods of extraction which may be used.

Once a communication network is planned a detailed extraction scheme could be prepared. The different means of extraction in common use are :

- (*a*) animals, such as elephants
- (*b*) tractors, generally equipped with winches
- (*c*) self operated winches
- (*d*) cable cranes and other forms of cable logging like high leads.
- (*e*) skidding on the ground or along chutes by gravity.

The factors which should be analysed in considering the possibility of using the different methods of extraction are: gradient, condition of the ground surface, management practices, and the yield (not the annual increment but the outturn per unit area at the time of cutting). Once these factors are evaluated, in the final analysis, it will be the cost of extraction per cubic ft. which will be the decisive factor in the selection of a mode of extraction from among those which are technically possible. The extraction plan which is prepared on the basis of the above information should indicate the methods of extraction to be used over the whole area covered by the plan, and also, wherever possible, the main extraction routes.

THE CABLE CRANE

Cable cranes are distinguished from cableways in that they can be used for skidding out logs right from the stump site. A cable crane is therefore essentially a means of extraction. A cableway, on the other hand, is a means of transport. It cannot be used for hauling logs from the stump site as the logs have to be manually suspended on to the transport cable at special loading stations. Cable cranes are generally not constructed for distances of more than 1 mile,* while cableways, which are a substitute for roads, may be several miles long.

A cable crane consists of an overhead cable (carrying cable or main cable) suspended between two points, a carriage for picking up logs and transporting them along the main cable, and a single or double drum winch with the necessary cables. The winch is generally situated at the mountain station, and it provides the power necessary for carrying out the extraction operations. During haulage along the main cable the logs may be suspended clear of the ground and over the crowns of the trees, which is the general case with long range cable cranes, or, as is common with short range cable cranes, they may be partially suspended and skidded with one end resting on the ground.

Cable cranes work best in terrain with a general gradient of more than 25 per cent. Cable cranes which work on level ground are also available, but they can be used for short range haulage only. The other terrain factors which influence the operation are obstacles on the ground and microtopography.

A cable crane is set up along a line, and the area of extraction is a strip of forest a few hundred feet wide. The extraction takes place in two main stages. Firstly, the logs are skidded laterally from the stump site to a point directly below the main cable. In the second stage, the logs are lifted up to the carriage and transported along the main cable to the unloading station (collecting depot).

* Cable cranes may be classified on the basis of length into short range (up to 300 yards), medium range (300 to 700 yards) and long range (over 700 yards).

TYPES OF CABLE CRANES

The main types of cable cranes observed by the writer in Western Europe fall into one of the following 2 categories :

(1) Two-cable type with a single drum winch ; and

(2) Three-cable type with a double drum winch.

The two-cable type (Fig. 1.)

The two cables are the main cable and traction cable. The winch draws the traction cable and so moves the carriage along the main cable. Besides moving the carriage, the traction cable also skids the logs from the stump to a point below the main cable and then lifts them up to the carriage. During this operation, and also when the logs are released at the collecting depot, the carriage is held stationary by means of stopping devices on the main cable. One of the stops is at the collecting depot while the other could be moved along the main cable to the different points from where the timber is to be collected. The stop is held stationary at the required point by means of a wire rope which is fastened to some object (e.g. base of a tree) on the ground.

If the logs have to be picked up from the forest and hauled to a collecting depot downhill the operation takes place in the following stages :—the upper stop is moved along the main cable and fastened at the point below which the logs are situated. The carriage is then hauled up along the main cable, and as it strikes the stop the two get automatically linked. When the traction cable is now released the choker hook at its end descends to the ground. The hook is drawn out and the logs attached to it. When the traction cable is now pulled by winch the logs are at first skidded to a point below the main cable, and then hoisted up to the carriage. The hook then gets clamped on to the carriage and simultaneously the carriage is automatically released from the stop. When the traction cable is now released the carriage runs down towards the unloading station. The movement of the carriage is controlled by the brakes on the winch drum. At the collecting depot, when the carriage makes contact with the stop, the hook gets released from the carriage and the load can then be lowered.

Cranes of the 2-cable type are manufactured by the firms Nessler and Hinteregger of Austria, Wyssen of Switzerland and Huber of Bavaria, Germany.

The firms of Wyssen and Bachmann of Switzerland also produce carriages with automatic brakes (Fig. 1). By means of the brakes the carriage could be clamped on to the carrying cable at any point without the aid of special stops. The brakes of the Wyssen crane are worked by a time device-the carriage getting clamped on to the carrying cable some seconds after the carriage has halted. The brakes on the Bachmann carriage come into operation when the carriage is halted and then moved a short distance in the reverse direction. Janeschitz of Klagenfurt, Austria, has developed a new automatic carriage the brakes of which are controlled by radio signals.

The Three-cable type

There are really 2 basic 3-cable types, both worked by double drum winches. In one type the movement of the carriage and lifting of the logs are done by the traction cable as in the 2-cable type. The second drum is used to operate a haul-back line. This kind of crane is used in flat country where it is not possible to make use of gravity for moving the carriage in either direction.

In the other 3-cable type (fig. 2) there are separate traction and lifting cables operated by the two drums of the winch. The end of traction cable is fastened on to the carriage. The lifting cable passes through the carriage, then through a pulley block and back through the carriage, after which it passes down to the lower terminal where it is fastened. On braking the traction cable drum and releasing the lifting cable, the pulley block descends. The logs are then fastened on to a choker hook on the pulley block; and the load is lifted by operating the lifting cable drum. Once the pulley block reaches the carriage the drum is braked. The carriage is moved by means of the traction cable, and during this movement the lifting cable runs through the carriage and pulley block without appreciably altering the position of the load in relation to the carriage.

One advantage of the 3-cable type described in the previous paragraph is that the carriage is extremely simple in construction and presents no problems in repairs and maintenance. Also, it could be stopped at any point on the carrying cable for picking up logs without the encumbrance of having special stopping devices or automatic brakes. A disadvantage is that the separate lifting and traction cables might get entangled with each other and with the crowns of trees, and for this reason the use of this type on long range cable crane lines is not recommended.

CABLE CRANES FOR TRIAL IN CEYLON

The 2-cable type of crane is recommended for use in Ceylon for extraction over distances of more than 300 yards. The models with stops for halting the carriage should be preferred to ones with automatic brakes because of their lower cost and relatively simple construction. For short range haulage the 3-cable type with separate traction and lifting cables may also be tried out.

Whatever the type of crane, working with it in the Rain Forests of Ceylon which are composed entirely of broadleaf species requires much greater skill than in those temperate forests where conifers predominate. In the Tropical Rain Forests installation and operation are hampered by the dense understories and the heavy crowns, and unlike in a coniferous forest, suitable trees which could be used as natural supports for the cable are not freely available. Also, when selective fellings are carried out as is done in Ceylon, extraction with cable crane is much more difficult and much less economical than when the forests are clearfelled. These factors stress the need for proper training of personnel in all aspects of cable crane work and an evaluation of the economies of cable crane extraction before wide spread use of this method of extraction is attempted.

CABLE CRANES—ECONOMIC CONSIDERATIONS

An unique feature of cable cranes as compared with other means of extraction is that the cable crane has to be set up afresh each time an extraction operation is to commence. The main jobs connected with the setting up of the crane are surveying the trace, opening the line, taking up the winch to the mountain station, construction and erection of supports and fixing of the carrying cable. Once extraction is completed in the strip of forest covered by the crane, the cables and supports have to be dismantled and the equipment moved to a new line.

The expenditure for installing and dismantling have therefore to be added to the operational costs of the machine for calculating the cost of extraction per cubic ft. It follows that, within limits, the greater the output per installation the more economical will be the operation. Two factors which affect the output per installation are the yield per acre and the width of the strip of forest covered by the crane at a setting. As for the output per acre, it is obvious that the higher the yield the more economical will be the operation. The second factor, the width of the strip of forest, will depend on how easy or how difficult is the lateral skidding operation. In extraction with cable cranes, the skidding of the logs from the stump to a point below the main cable (i.e. lateral skidding) is the most time consuming operation. As pointed out by Wettstein (1961), the factor :—total distance skidded time taken, is not constant but decreases with increase in skidding distance. Therefore, for any set of conditions there will be a certain lateral skidding distance beyond which it would be more economical to shift the cable crane to an adjacent line than to increase the skidding distance further.

In Swiss forests lateral skidding distances vary from 100 to 200 ft. In Ceylon, working conditions will be more difficult and it will be advisable not to plan for lateral skidding distances of over 150 ft. on either side of the main cable.

PLAN FOR TRIALS WITH A CABLE CRANE IN CEYLON

A preliminary plan for using a cable crane for the extraction of timber from the Rain Forests of Ceylon was prepared by the writer. The area selected was the Dediyagala Forest Reserve, which has an area of about 15 sq. miles.

The Logging operation, of which extraction by cable crane forms a part, was planned in the following stages :—

1. Demarcation of the productive areas.
2. Planning a transport network.
3. Classification into gradient classes.
4. Deciding on the method of extraction to be used.

Demarcation of productive areas, and also the further classification of the forest into yield classes, had been done some years back (1961) by the Hunting Survey Corporation of Canada with the assistance of the Forest Department, Ceylon. The yield class map prepared in 1961 is still valid as little or no operations have been carried out in this forest since the time of the inventory.

Planning of a transport network is the next stage. The four means of transport that can be considered for this forest are:

(*a*) Transport by water.

(*b*) Special Railways.

(*c*) Cableways.

(*d*) Roads.

Transport by water is possible only to a very limited extent by way of the Hulandawa Oya. In any case, the proportionate distance of transport by water is negligible if the full distance from the forest to the industrial centres is considered, and for this reason, transport by water need not be given serious attention in the overall planning. Likewise, forest railways and cableways can be ruled out, as once the timber is out of the forest, it will in any case be transported through the existing network of public roads, and it is much more economical to load the timber into road transport vehicles once and for all in the forest rather than to transport the logs by railway or cable way in the forest and re-load them into lorries for transport to the mills. Also, roads have much greater public utility value than either forest railways or cableways.

A base road starting from the south-east corner of the Reserve, and linking up with the main Akuressa-Deniyaya was traced. Five miles of this road has been constructed at the time of writing.

Classification into gradient class was carried out only in a restricted area. Two classes: Over 25 percent and under 25 percent were selected as indicating the areas suitable for extraction by cable crane and by tractor respectively. The gradients were calculated from the map—with ground checks—by measuring the slope at right angles to the contours. The areas with a gradient of less than 25 percent can also be worked by means other than tractors, such as elephants and winches, but our attention in this article will be directed to the steeper areas where, at present, extraction by cable crane is the only technically possible method.

Figure 3 shows a small section of the forest with the two gradient classes indicated. Having demarcated the area into gradient classes, the next stage is to mark the proposed cable crane lines in areas with gradients of over 25 percent. However, since this will have little practical value until the trials have indicated the optimum spacing between the lines, only two lines have been marked and traced on the ground. These are indicated in the sketch.

It will be noted that the area selected for these trials has a gradient of only just over 25 percent. Normally, steeper terrain is better suited to cable crane extraction as a certain allowance has to be made for the sag of the cable, and with gradients of 25 to 30 percent there is a possibility of a negative gradient on the lower part of the cable, and this will result in the carriage not moving down to the valley station. However, as this is the first installation of its kind in Ceylon excessively steep gradients were avoided so that the shifting of the winch to the upper station would not be difficult, and calculations were made to ensure that the gradient was sufficiently steep to permit the carriage to move freely to the lower station.

When at a later stage a full scheme of cable crane lines is drawn up the following points will have to be borne in mind :—

1. The most economical spacing between the lines.
2. The lines should generally be at right angles to the contours.
3. It is advantageous to have two or more lines starting from a common mountain station, or conversely, two or more lines starting from separate mountain stations and converging towards a common valley station.
4. The unloading station should be spacious enough to accommodate the logs.
5. Suitable anchors for the main cable should be available at the mountain and valley stations.

For more details on the installation of cable cranes the reader is referred to the work of Pestal (1961) on cable cranes and cableways.

At the time of writing, a Nessler 2-cable type of crane obtained under the United Nations Special Fund/Ceylon Pre-investment Survey Project has just been installed on line 1. An F.A.O. Expert, Mr. Bauernfried, who has long experience in cable crane work carried out the installation and is now training Ceylonese personnel in the operation of this crane.

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An Insecticide Trial for the Control of Cockchafer Larvae (Anomala sp.) in Teak Nurseries

By S. MUTTIAH

INTRODUCTION

COCKCHAFER larvae attack in Teak nurseries, especially on the heavier soils, is a common observation. The intensity of attack has been found to vary not only with the kind of soil but also with the particular time of the year and age of the plants—the younger seedlings being susceptible to heavier attack. This poses a real problem in nursery management especially if severity of attack claims as much as 20 per cent. of the total plant stock. In fact, this situation had arisen at the old Kumbalpola nursery in the N.W.D. in 1962. Similar attack but on a smaller scale was also noticed in the other four nurseries in the division. If this attack was not checked it would have upset the nursery programme which had to be geared to meet an increased reforestation target. Undue plant mortality again meant a financial loss since it cost nearly 07 cents to produce a stump. This value is based on the average cost of production in three of the N. W. D. nurseries during the years 1963 and 1964 given below: (The nurseries include the two Kumbalpola nurseries and the Henegederalande nursery).

	Total cost in rupees (to nearest thousand)*	*Total No. of stumps produced (to nearest thousand)*	*Cost/stump (to nearest cent)*
1963	38,000	422,000	·09
1964	40,000	950,000	·04

(The increased stump production in 1964 was to a certain degree due to an increased acreage at the new Kumbalpola nursery but it was primarily the result of a better germination per cent).

Thus a 10 per cent drop in stump production in a division which produces a million plants a year can result in a loss of Rs. 7,000 annually. This is a tidy sum in comparison with the money allocation for nursery management.

Experience has shown that there are two main problems in Teak nurseries affecting early growth, provided there is satisfactory germination of seeds. These are: (1) cockchafer damage, and (2) weed competition and suppression, particularly by grasses. Attempts had been made in the past to control cockchafer larvae by manual picking as well as by the use of insecticides such as D. D. T., gammexane and aldrex—2 but these were trial and error methods without a firm basis, and, in any case, these did not control the population effectively. Weed control was effected by manual weeding which was quite tedious. Accordingly two sets of trials to attempt chemical control were laid out at the old Kumbalpola nursery during the sowing period in 1962 and where both factors were well represented. This paper deals only with the trial regarding cockchafer larvae, identified as those of a scarab beetle of the genus *Anomala*.

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*Includes cost of depreciation at 10 per cent. for sprinkler irrigation set up at the new Kumbalpola nursery.

NATURE AND SCOPE OF DAMAGE

Studies on the damage caused by this insect to tea in Ceylon has shown that the life cycle lasts for one year irrespective of any differences in climate. This is quite unlike in temperate regions where the larval stage of related species is relatively long varying from one to three years. Adult emergence of *Anomala* is said to take place from March-May and young grubs appear around June and develop until the end of the year. They pupate during the months of January and February. The larvae have powerful mandibles which work like a pair of shears. The young larval forms are noticeable in the teak nurseries usually around June-July when they are ½-1″ long. They feed voraciously on the tender roots of young plants until they are nearly double their size by August-September. Plants right from the time of emergence up to about 10″ high are damaged by their eating habits. Both taproots and lateral roots are devoured and the characteristic shearing off of the taproot can be seen in photograph I. The taproot is normally incised just below the collar region. The freedom from attack of plants more than 10″ high may be due to suberisation of the roots.

The first external symptom of attack is manifested in the curling of the terminal leaves downwards, soon to be followed by the lower pairs of leaves. Within two to three days, the entire shoot withers and presents a crumpled appearance as seen in photograph 2-4. On gently pulling such plants, the top portions come off easily leaving behind the lower portions of the taproots below the ground. Some of the taproots are not cut right through and these plants can be stumped to be grown again. Wholly cut plants do not revive. The larvae can be easily traced if the soil is dug around freshly cut plants. Handpicking at this stage will prevent the larvae from causing further damage but the difficulty is to trace all of them since they lie buried at various depths ranging from a few inches in the Teak beds to about two feet in the adjoining turf between the beds. The larvae feed not only on the tender and succulent Teak roots but more so on the roots of grasses. This is a good reason for keeping out the growth of grasses so as to starve the worms of their permanent source of food.

It has been observed that the plants are attacked in patches. The attack is more severe by night. It may happen that a few beds in a series are heavily attacked while an adjoining lot of beds may be relatively free of attack. This conforms to the generally ‘patchy’ distribution observed with garden chafer beetles (1). It is therefore imperative that affected beds should be more heavily treated with insecticide than those further away.

It has also been noted that chafer attack is more pronounced on clayey and clay loan soils, e.g., Kumbalpola old nursery, while it is least on sandy and sand loam soils found in the rest of the nurseries in the North-Western

Division. A similar observation has been made by Burke (2) who studied populations of pasture scarab in certain areas of Australia where rainfall is not plentiful. On the other hand, Milne (1) observed that the garden chafer—*Phyllopertha horticola* flourished best on light soils but under higher rainfall conditions. This suggests that the density of population is not directly depend on the type of soil but on its moisture status. Milne has demonstrated experimentally that population density of the larvae decreases when wetness increases and that this may be due to a direct effect of moisture. Other authors attribute the low survival under wet conditions to lack of available oxygen or to an 'osmotic effect'. Milne concludes that apart from proper food, survival of the larvae depends on the soil containing neither too much nor too little water for too long. It is most probably on account of this reason that the larvae which are present under normal moist, irrigated conditions in the nursery make their exit with the onset of the monsoonal rains. This phenomenon can be usefully employed by sowing Teak seeds during the latter part of the monsoonal period, perferably during November and December depending on the rate of uprooting plants and availability of nursery space for raising future stock. In practice, sowings go on until the following March or even April so that exposure to larval attack cannot be discounted altogether.

METHOD

The following insecticides were used in this trial at the dosage stated against them :

Name of Insecticide	*Dosage (for all five beds)*
Sevin (S)	5 ozs./$2\frac{1}{2}$ gallons water
Gammexane (G)	5 ozs./$2\frac{1}{2}$ gallons water
Endrex (E)	1 fl. oz/30 gallons water
Aldrex —2 (A)	1 fl. oz/30 gallons water

Sevin — a wettable powder containing 85 per cent. sevin.

Gammexane — a wettable powder.

Endrex 20 — an emulsifiable concentrate containing 20 per cent. endrin.

Aldrex 2 — an emulsifiable concentrate containing 24.6 per cent. aldrin.

Details.—A certain lot of Teak seeds was intimately mized and after the usual pretreatment was sown on 18.6.62 in test beds, 9 ft. × 4 ft., at the rate of 5 lbs. per bed. With the treatment-free control beds, the statistical lay out was a 5 × 5 latin square. The beds were separated from each other by cut drains 18 in. deep to prevent contamination by insecticides from neighbouring beds. Since moisture has an important bearing on population density and distribution of the larvae, care was taken to see that all the beds were watered alike. The dosages of the different insecticides were based on the general recommendation for agricultural crops. The chemicals were sprayed on the soil on 11.7.62

after the seeds had sprouted. The attacked plants were removed and counted at regular intervals. Observations were continued until October '62 by which time the incidence of attack was hardly visible in any bed.

RESULTS AND DISCUSSION

The counts of the plants attacked by sub plots and dates are given in the table of results. The degree of attack at intervals by treatment plots is also expressed in the table as mean percentages. The statistical calculation of the variance is shown in the appendix.

It would be observed from the results that from the time of insecticide application the mean percentages except with Sevin had increased reaching a peak around the early part of August and then declined. With Sevin there has been a decline from the very beginning. Unlike with others, the values obtained with Sevin were consistently low indicating a marked controlling influence. This was confirmed by the statistical analysis. The analysis of variance showed that the effect of Sevin was significantly more than all others. Though no significant differences were obtained between the other treatments in this experiment, it may be necessary to test them further in a more comprehensive lay out.

The beneficial effect of Sevin has since been established on a management scale. Photograph 6 depicts the old Kumbalpola nursery well stocked after timely treatment with Sevin and stands in marked contrast to the situation in the same nursery the previous year as shown in photograph 5. In nurseries prone to this damage, it is advisable to apply Sevin immediately after plant emergence or at least with the beginning of first attack. Badly affected beds may have to be treated more heavily by application of a double dose. It has been found that treatment of beds with this insecticide in a particular year does not preclude attack the following year thus necessitating application annually.

ECONOMICS OF SEVIN APPLICATION

Notwithstanding the distinct advantages of using Sevin the biggest setback is its cost. It is priced at Rs. 7 to 8 per lb. which is ten times that of a cheaper chemical like gammexane. Hence would it not be more economic to use twice, thrice or even four times the quantity of gammexane as Sevin to achieve the same or better results ?

This aspect is important and worth further investigation.

On the results obtained so far, control with Sevin seems assured. Compared to the total cost of production of stumps, the cost incurred on Sevin is small. At the old Kumbalpola nursery which had an annual production of 140,000 stumps, the loss due to chafer damage was about Rs. 2,000, whereas the amount spent on Sevin was only Rs. 525. The saving would of course be accentuated as the nursery stock and potential chafer attack assume larger proportions.

SUMMARY

Cockchafer larvae cause considerable plant and financial losses in Teak nurseries especially on heavier soils under moist conditions. The attack is restricted to young plants till they reach a certain height. An insecticide trial was initiated with four chemicals, viz., Sevin, Gammexane, Endrex and Aldrex 2 in a 5 $\times$ 5 latin square arrangement. The values of mean percentages of plants attacked and, more conclusively, the statistical analysis point to the significant and superior results obtained with Sevin as against all others. More investigation is required to determine significance, if any, between the other treatments. Manual picking and destruction of the grubs can be usefully combined with Sevin control in the event of an attack. Timely application is necessary. The main setback with Sevin is its high cost. Further experimentation is required to determine the relative merits of these insecticides in achieving greater economic control.

ACKNOWLEDGMENT

Thanks are due to Dr. D. Calnaido, entomologist of the Tea Research Institute, Kandy, for identification of the insect species ; to Mr. J. Navaretnam, Statistician of the Department of Agriculture for the analysis and finally to Mr. S. Cumarasingham, Forester (Silviculture), for collecting the field data.

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TABLE OF RESULTS

Treatment Beds	20.7.62 No. of Plants	20.7.62 No. of Plants attacked	10.8.62 No. of Plants	10.8.62 No. of Plants attacked	24.8.62 No. of Plants	24.8.62 No. of Plants attacked	7.9.62 No. of Plants	7.9.62 No. of Plants attacked	21.9.62 No. of Plants	21.9.62 No. of Plants attacked	6.10.62 No. of Plants	6.10.62 No. of Plants attacked	Total No. of Plants	Total No. of Plants attacked
Sevin I	365	—	416	—	416	—	413	3	410	—	411	—	416	3
Sevin II	245	9	268	2	240	2	275	—	278	—	279	—	279	13
Sevin III	343	2	293	2	408	—	395	—	390	—	392	—	408	4
Sevin IV	286	2	334	—	332	—	334	—	270	—	270	—	334	2
Sevin V	232	6	245	5	191	—	335	—	320	—	331	—	335	11
Total	1471	19	1556	9	1587	2	1752	3		nil	nil		1772	33
Mean per cent		1.3		0.6		0.1		0.2						1.8
Endrex I	306	10	346	22	295	—	289	1	248	—	247	—	346	33
Endrex II	319	3	272	5	244	6	210	5	325	1	328	—	328	20
Endrex III	167	14	107	40	117	2	103	7	147	—	197	—	197	63
Endrex IV	276	4	210	16	240	—	220	2	230	—	240	—	276	22
Endrex V	284	8	301	7	222	—	362	2	370	—	379	—	379	17
Total	1352	39	1236	89	1018	8	1184	17	1320	1		nil	1526	155
Mean per cent		2.9		7.2		0.8		1.4		0.8				10.2
Gammxane I	272	6	220	33	202	3	201	—	223	1	225	—	272	43
Gammexane II	277	9	164	73	177	4	205	—	125	—	128	—	277	86
Gammexane III	236	5	163	32	212	2	182	—	186	—	185	—	236	39
Gammexane IV	261	15	210	18	180	5	158	6	159	—	160	—	261	44
Gammexane V	347	12	240	13	210	2	203	—	219	—	221	—	347	27
Total	1393	47	997	169	981	16	949	6	912	1	nil	nil	1393	239
Mean per cent		3.4		16.6		1.6		0.6		0.01				17.2
Aldrex I	169	5	145	31	280	2	161	—	144	—	151	—	169	38
Aldrex II	165	4	140	41	120	4	137	6	133	—	130	1	165	56
Aldrex III	206	10	152	20	154	—	158	6	160	—	162	—	206	36
Aldrex IV	274	3	236	28	272	1	310	—	310	—	315	1	315	33
Aldrex V	336	7	353	8	385	22	305	1	310	—	327	—	385	38
Total	1150	29	1026	128	1211	29	1071	13	1057	nil	1085	2	1240	201
Mean per cent		2.5		12.5		2.4		1.2				0.2		16.2
Control I	135	—	74	21	31	—	32	—	37	2	37	—	135	23
Control II	143	14	86	23	81	1	93	3	97	1	98	—	143	42
Control III	333	2	296	16	286	—	250	—	251	—	450	—	450	18
Control IV	238	10	246	18	207	7	253	1	261	3	460	—	460	39
Control V	212	2	201	18	205	15	190	—	190	—	196	—	212	35
Total	1061	28	903	96	810	23	818	4	836	6		nil	1400	157
Mean per cent		2.6		10.6		2.8		0.5		0.7				11.2

APPENDIX

Working Sheet Showing Details of Statistical Analysis

Treatment	*per cent*	*Conversion*
S1	0·721	4·88
S2	4·659	12·45
S3	0·980	5·68
S4	0·599	5·73
S5	3·284	10·45
E1	0·954	5·60
E2	6·098	14·30
E3	31·980	34·43
E4	7·971	16·39
E5	4·485	12·20
G1	15·809	23·43
G2	31·047	33·86
G3	16·525	23·99
G4	16·858	24·24
G5	7·781	16·20
A1	22·485	28·31
A2	33·939	26·63
A3	17·476	24·71
A4	10·476	18·89
A5	9·870	18·31
C1	17·037	24·38
C2	29·371	32·81
C3	4·000	11·54
C4	8·478	16·93
C5	16·509	23·98

	Col. 1					*Total*
Row 1	10·45	16·20	12·20	18·31	23·98	81·14
R 2	24·24	16·39	18·89	16·93	5·73	82·18
R 3	34·43	24·71	11·54	5·68	23·99	100·35
R 4	35·63	32·81	12·45	33·86	14·30	129·05
R 5	24·38	4·88	23·43	5·60	28·31	86·60
	129·13	94·99	78·51	80·38	96·31	
Mean						
7·84	4·88	12·45	5·68	5·73	10·45	39·19 S
16·58	5·60	14·30	34·43	16·39	12·20	82·92 E
24·34	23·43	33·86	23·99	24·24	16·20	121·72 G
25·17	28·31	35·63	24·71	18·89	18·31	125·85 A
21·93	24·38	32·81	11·54	16·93	23·98	109·64 C
Total	86·60	129·05	100·35	82·18	81·14	479·32

$$CF = \frac{229{\cdot}747{\cdot}6624}{25} = 9189{\cdot}91$$

Total = 11,352·33 — CF = 2162·42

$$B/Col. = \frac{47598{\cdot}0376}{5} = CF = 329{\cdot}70$$

$$B/Treat. = \frac{51{\cdot}086{\cdot}4930}{5} = CF = 1{,}026{\cdot}39$$

B/Row = 47,560·8370 — CF = 322·26

Analysis of variance—

Source	*D. F.*	*S. O. S.*	*M. S.*	*F.*
B/Col.	4	329·70	82·43	
B/Rows	4	322·26	80·57	
B/Treat.	4	1027·39	256·85	6·38
Err.	12	483·07	40·26	
Total	24	2162·42		

L. S. D. for Treat. means = 2·179 40·74 × 2/5
= 8·74

A	G	C	E	S
25·17	24·34	21·92	16·58	7·84

A preliminary report on the prevention of splitting in Poles of *Eucalyptus grandis* using gang nails

By A. E. K. TISSEVERASINGHE

SUMMARY

AN experiment was tried using clamps before felling and gang-nails after felling to prevent the end-splitting of poles of *Eucalyptus grandis*. The indications are that gang-nailed poles can be dried to acceptable levels of moisture content without excessive degrade while poles without gang-nails cannot be so dried. Clamps before felling do not appear to be necessary.

INTRODUCTION

Until a year or two ago the only species used for transmission and telegraph poles was Hora (*Dipterocarpus zeylanicus* Thw.). Its strength, straightness, low degree of taper and amenability to pressure impregnation make it a very desirable species for this purpose. It has been increasingly felt however, that it was not good management practice to remove the best trees at a pole stage leaving only second rate trees to grow to maturity. Hora in pole sizes also became increasingly difficult to locate. A search therefore had to be made for other species. Others have been tried with varying degrees of success but no other species proved to have the same desirable characteristics of Hora except *Eucalyptus grandis* which might be considered even more suitable than Hora from the point of view of straightness and low degree of taper.

This species however has a serious drawback which makes it impossible to be used as a pole, i.e., trees split very severely. Splitting starts soon after felling and continues during the seasoning period. At the end of the seasoning period the splitting is sometimes so severe that only firewood can be recovered. Earlier attempts to control splitting by using S-hooks ended in failure. This problem exists in other parts of the world as well but yet no acceptable solution has been found. A full account of the different methods which have been used and their drawbacks is given by Barnacle and Christiensen (1968).

It was observed that splitting starts at the pith and spreads radially outwards. Once the split reaches the outside, it spreads rapidly in a longitudinal direction. It was thought that if the initial splitting could be prevented, perhaps by clamping and holding the central part of the log together with gang nails then no splits would develop in the pole. In this paper the results of this experiment are described.

MATERIALS AND METHODS

Clamps were made by rivetting spring steel bands on to angle-irons. The angle-irons were drilled and bolts and nuts were provided so that the spring steel bands could be tightened round the trees. Photograph 1 shows the clamp in position.

Gang nails were supplied free for experimental purposes through the kind courtesy of Mr. John Stokes of Automated Building Components Pty., Melbourne, Australia. Besides various sizes suitable for building timber trusses, 3 each of 5 in. × 5 in. and 4 in. × 4 in. gang nails were supplied. These were used for the experiment.

A plantation of *Eucalyptus grandis* was located in Diyatalawa. This plantation although only 11 years old contained poles of sufficient girth to supply 32 ft. poles according to the specifications of the Department of Government Electrical Undertakings.

The selected poles were first de-barked in a strip round the tree at the point where the clamp was to be placed. The clamp was then placed in position and the nuts tightened on both sides (see photograph 1). The tree was then felled just below the clamp using a chain saw. As soon as the tree was felled the trunk was again cross cut with the chain saw so as to obtain a flat surface. A 5 in. × 5 in. gang-nail was then hammered in (see photograph 2). The clamp was then removed. The top end was similarly treated, i.e., it was de-barked in a strip, the clamp was tightened, the tree was cross cut using a chain saw, a 4 in. × 4 in. gang nail was driven in and the clamp removed. 3 poles were felled in this manner and three more were felled without clamps or gang nails as controls.

The trees were de-barked at site and transported by train to the Research Laboratory in Colombo. The trees were felled on 23rd October, 1967. They arrived in Colombo on 25th November, i.e., almost exactly one month after felling. On arrival the moisture contents were checked and the average moisture contents (as measured by a Delmhorst Moisture Meter) were 40 per cent at 1/4 in. depth. 50 per cent at 3/4 in. depth and 65 per cent (maximum on the scale) at 1 in. depth.

They were stacked on bearers under cover and moisture content determinations were done at regular intervals.

RESULTS

Photograph 3 shows the butt ends of the three gang-nailed poles soon after arrival at the Laboratory, i.e., one month after felling. There were no splits on Poles 1 and 3. Pole No. 2 shows lens-shaped splits radiating outwards from the edges of the gang-nails. Photograph 4 shows 2 of the control poles being unloaded from the lorry on arrival at the Laboratory. The Pole on the left-hand side was already fairly severely split and the other pole was showing signs of splitting.

The poles dried slowly, moisture contents at 1 in. depth were more than 65 per cent right up to the beginning of January, 1968. By the middle of February, 1968, the poles had dried to a reasonable extent. Average values of moisture content at the mid point of the poles determined on 24th February, were as follows :

at 1/4 in. depth 22 per cent

at 1/2 in. depth 26 per cent

at 1 in. depth 33 per cent.

By the time the poles reached this moisture content the splitting had become quite severe in the control poles. Photograph 5 shows the top ends of the 3 controls on 21st February, 1968. All had split beyond acceptable limits. Photograph 6 shows 2 gang-nailed poles and it is evident that the splitting has been kept under control. One of the gang-nailed poles (pole on the right in photograph 7) showed quite a lot of splitting but this was confined to the region between the edges of the gang-nail and the outside. This particular pole had fairly severe barrel checking also—it appeared to have been one which had been subjected to severe growth stresses.

DISCUSSION

Although the number of poles on which gang nails had been tried out was small the indications are that splitting can be controlled and that the poles can be seasoned to acceptable levels of moisture content without excessive degrade.

As far as the controls are concerned none of them would be acceptable for treatment. Their top ends (see photograph 5) correspond to ratings varying from 3-7 of the numerical rating for end degrade as given in the Draft Australian Standard Specification for Wood Poles, whereas it should not exceed 2 if it is to be acceptable. The gang-nailed poles are difficult to rate because the rating appears to depend on the progression of splitting from the centre outwards. The gang-nailed poles of course, are not split in the centre, and hence different numerical ratings will have to be given to such poles. However, from general appearance it is probably true to say that 2 of the three gang-nailed poles would be acceptable while the third one (pole on the right hand side of photograph 7) would be rejected both due to end splits and excessive barrel checking. Thus this experiment is worth continuing.

When the felling of the poles was done, it was found that splitting started at the pith within about 15 minutes after felling. It would seem that strapping of the tree before felling is not necessary provided gang-nails are driven in without any delay. Trials will be continued along these lines. It would also appear that circular gang nails of approximately the same diameter as the poles would give much better results. Whether the manufacture of circular gang-nails of this size is technically possible is not known.

ACKNOWLEDGMENTS

The writer is indebted to Mr. John Stokes of Automated Building Components Pty., Melbourne, Australia for sending free of charge the gang-nails used for this experiment.

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An Experiment in the Use of Improved Techniques in Dry Zone Logging

By L. C. A. DE S. WIJESINGHE

SUMMARY

The main obstacle to modernising logging operations in the natural forests of the Dry Zone of Ceylon is the inherently poor quality of the forest. Because of the very low yield no attempt has been made to open up the forests by permanent roads, and all transport within the forest is through temporary tracks which can only be used during half the year, in the dry season.

Methods now practised by logging contractors are felling and other cutting operations with hand saws and axes, skidding of logs mostly by elephants and by bullocks with the aid of sling carts, and transport in 3-5 ton general purpose lorries.

Modern equipment consisting mainly of chain saws, timber skidding tractors, semi-trailers, and a lorry specially designed for timber transport were used in a logging operation aimed at removing from the forest an estimated 50,000 Hoppus ft. of timber, most of which had already been converted into logs. Seven 5-ton lorries also assisted in the transport, but most of them were in use for only a short period. The distance of transport along forest tracks varied from 20 to 35 miles.

The operation lasted 4 months. The first four weeks were spent in reconditioning the forest tracks which had been opened in earlier logging seasons. 45,643 H. ft. of timber were extracted at a cost of Rs. 86,219.17. At standard Forest Department rates the amount payable to a contractor had he carried out the same job would have been Rs. 106,327.88.

Climate and its Influence on Logging

As logging is done at present in the Dry Zone of Ceylon, the sequence of operations is to a great extent influenced by the climate, or more specifically, by the rainfall. The Dry Zone is so called purely because of the prolonged period of drought which occurs annually from June to September. When one considers the annual rainfall of this region, however, one is surprised that an area with an annual rainfall of 50 to 75 inches is termed Dry. Most of the rainfall in this region occurs in 4 months of the year, from October to January.

In the forests of the Dry Zone, roads are entirely absent. Logs have therefore to be transported through forest tracks up to the main public roads. Transport distances along forest tracks may vary from a few miles to 40 miles or more. These tracks can only be used in dry weather, so that transport cannot commence before April or so, and the operation has to cease with the onset of the rains in October. In practice the early part of the dry weather period is spent in repairing the tracks, culverts and bridges, so that actual transport is generally confined to 4 or 5 months in the year.

Some logging contractors do not suspend operations entirely during the wet season. During this time they carry out felling and cross-cutting wherever possible.

Yield from the Dry Zone Forest

The only comprehensive inventory of the forests of the Dry Zone is that carried out by the Hunting Survey Corporation, Ltd., of Toronto, Canada, in co-operation with the Forest Department, Ceylon, and published in 1961. According to this inventory the natural forests of the Dry Zone* have been classified into medium yield, low yield and unproductive.

The distribution of the Dry Zone forest area by yield classes, and the average volume per acre in each class is given below.

TABLE I

Area and Volume Figures for the 3 Yield Classes in the Dry Zone

	Medium Yield	*Low Yield*	*Unproductive*
Area (in 1,000 acres)	376	3,130	2,691
Volume per acre (cubic feet)	1,097	701	309

An examination of the volumes of the different species in the inventory referred to above shows that the major part of the standing volume is of inferior species which are not extracted at present. *Drypetes sepiaria* (Wira), the most abundant species which at present finds no use at all, accounts for 25 per cent. of the volume. Of the first 20 species (listed according to availability) only 7 are of high quality**, and the volume of these in all yield classes is 26 per cent. of the total volume. The other species, which are considered to be of inferior quality, are, for the most part, not extracted at present because the cost of logging is generally higher than the sale price of the material.

The trees for felling are selected on the basis of a minimum girth limit. All utilisable trees with a girth (at breast height) of 4 ft. and over are marked for felling. The nearest approximation to this girth limit found in the inventory mentioned above is a diameter at breast height of 16 inches. The volumes by yield classes of trees of 16 inches in d.b.h. and over of the 7 high quality species are given below.

TABLE II

Volume per acre of trees 16″ + in Diameter of the 7 high Quality species which are among the 20 most abundant Species of the Dry Zone

	Volume/acre
Medium Yield	180·3 cub. ft.
Low Yield	106·4 cub. ft.
Unproductive	39·7 cub. ft.

* Dry Zone plantations consisting mostly of Teak are at present about 50,000 acres in extent. This forms only a minute fraction of the dry zone forest estate, and, furthermore, most of the plantations are less than a decade old. These plantations may therefore be disregarded in a consideration of logging operations in the Dry Zone.

** These are species classified as Special Class, Class I and Class II in the timber classification scheme of the Forest Department.

These figures indicate the extremely poor quality of the Dry Zone forest. The picture is even more dismal if we disregard the Medium Yield class which accounts for only a small fraction of the Dry Zone forest area. The felling cycle has not been definitely fixed, but it may extend to 20 years or more.

Problems in Dry Zone Logging

The basic problem has already been mentioned in the previous section, i.e., the very low productivity. Because of this, no investments have been made in the opening up of permanent forest roads. In the absence of permanent roads the transport of timber is carried out through a net-work of temporary forest tracks. These tracks are made by cutting the trees as near ground level as possible and pushing aside the felled material.

As a result of the intense rainfall in the period October to January, the Dry Zone abounds in streams and rivers most of which dry up at the peak of the drought. When road construction starts in April or so the streams have to be crossed by temporary culverts and bridges. These structures generally do not last for more than one logging season since most of them get washed away during the monsoon rains. In addition to the replacement of bridges and culverts at the beginning of a logging season, the tracks have also to be repaired since they get severely eroded during the rains. This cycle of operations will go on year after year until the area served by the tracks has been completely exploited. No further operations will take place in the same area for the duration of the felling cycle.

The Logging Operation

The logging operation described here was carried out in a section of the Kumbukkan Oya (river) basin.

It will be useful as a prelude to the description of the operations at Kumbukkan Oya to give a brief account of the logging operations as they are generally carried out in the Dry Zone by contractors employed by the Forest Department.

All felling is done by hand saws and axes. Admittedly, hand saws and axes of good design and properly maintained are efficient, but it cannot be said that either description applies to the tools and maintenance techniques employed by the fellers.

The extraction of timber is mostly by elephants and by bullocks with the aid of sling carts. The distance of extraction may vary from a few hundred yards to about half a mile. Long skidding distances so common in the Wet Zone are avoided in the Dry Zone because of the easy terrain which makes it possible to construct forest tracks for vehicular traffic without any great difficulty.

Transport of timber both along forest tracks and along public roads is done in 3 to 5 ton general purpose lorries. These vehicles are generally quite unsuitable for log transport. They are not equipped with cranes or winches and the logs have to be loaded manually or by elephants. The body of the lorry consists of a plain wooden platform onto which the logs are secured by means of coir ropes. In some cases the lorries are provided with reinforced wooden or steel sides. The normal capacity of such lorries is 100 to 180 H. ft.*

Commencement of Work—Opening up of the Forest by Temporary Forest Tracks

In August 1966 the logging team of the United Nations Special Fund Ceylon Pre-Investment Survey Project was called upon to transport out of the forest an estimated 50,000 H. ft. of timber lying in an area about 20 sq. miles in extent, 20 miles to the south of the Moneragala-Siyambalanduwa road, and north of the Kumbukkan Oya. The trees had been for the most part felled, lopped, converted into logs and skidded to different points, so that there were a large number of scattered log dumps in the forest. The area was served by forest tracks which, after improvement, could be used by vehicular traffic.

Before the logging team commenced haulage, it was necessary to open about 3 miles of new forest track in order to make an exit at Moneragala. The existing forest tracks led to Siyambalanduwa through a much longer route.

In starting transport operations in August one can scarcely hope to achieve much as the rains set in by late September or early October. As it turned out, all that was done during the short period available was the opening up of the 3 miles of forest track and the transport of about 2,000 H. ft. of timber to Moneragala. The team had to make a hurried exit in October to avoid being marooned in the forest.

Operations recommenced in April 1967, and, as the U.N.S.F. personnel were busy with other matters in the closing stages of the Pre-Investment Survey Project, the writer was placed in charge of the operation, and he was assisted by Mr. C. Siriwardene, Forest Officer, and Mr. S. Sangadasa, Forest Guard.

The first task was the reopening and repairing of the forest track. Fallen trees had rendered the track impassable, and these had to be cut up and pushed aside. Damage to the road due to erosion had to be repaired. Two temporary bridges (see Fig. I) had to be redecked and all the culverts had to be re-made.

The culverts were constructed by laying two logs on the streambed with a space between them for the flow of water, and placing round poles as bearers. Over the bearers branch wood and twigs were placed and a layer of earth piled on. As no crawler tractor was available, one of the timber skidding tractors (Timberjack) which was equipped with a dozer blade assisted, to a limited extent, in earth moving.

Many dry streambeds were encountered. Because of the steep dip to the streambed the level of the bed had to be raised and this was done by depositing logs, arranging the logs in a continuous layer and piling sand and earth on top (Fig. 2). The banks were then cut so as to reduce the gradient further to manageable proportions.

A great deal of difficulty was encountered from stumps. These had been cut flush to the ground in the previous year but the rains had washed away some of the top soil, and the stumps which were protruding

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* The unit in the Hoppus ft. which is equal to 1.27 cub. ft.

from the ground were a potential danger to the tyres of the vehicles. They were cut back wherever possible and then burnt by piling debris on top and setting fire to the piled material.

Twenty miles of track was re-opened by mid-June, and this gave access to the first group of log dumps. Transport to Moneragala commenced at this stage. The distance to Moneragala was 22 miles—20 miles of forest track and 2 miles of minor road. While road maintenance work was going on in the period May-June one group of loggers proceeded to the log dumps, as soon as they were able to do so, and started skidding logs by tractor from scattered log dumps to a central wayside depot so as to facilitate loading into transport vehicles.

EQUIPMENT USED

The following UNSF/Ceylon Project equipment was available for use :—

(i) Chain Saws of different makes.

(ii) 2 Frame steered timber skidding tractors—"Timberjack 205" (Canadian) and "Valmet Terrain Tractor" (Finnish).

(iii) 1 "Massey Ferguson 35" agriculture tractor with Joutsa (Finnish) double drum winch attached to the power takeoff.

(iv) 1 "Steyr Puch" Timber Lorry (Austrian).

(v) 2 Semitrailers; "Rosson" (Swedish) and "Rysky" (Finnish), both fitted with tandem wheels. The Rysky wheels were provided with "flotation" tyres.

(vi) Miscellaneous small equipment such as Cant Hooks, axes, etc.

In the course of the logging operation the following additional vehicles were brought in at different times :—

2 Heavy Massey Ferguson agriculture tractors (Models "65" and "165"), one equipped with a caliper grab for skidding timber.

7 Five-ton lorries.

Cutting and Haulage

No new fellings were done since the operation was confined to the removal of the felled material. Although the major part of the timber had already been converted into logs there was a fair number of trees which had only been felled and left at stump site. Some of these trees, though severed at the base, were leaning on other standing trees. The leaning trees had to be hauled down by tractor. Branch cutting and cross-cutting were done with chain saws.

The timber consisted mainly of Halmilla (*Berrya cordifolia*), and the logs of this species were mostly of small to medium dimensions. There was a small proportion of Ranai (*Alseodaphne semecarpifolia*), the logs of which were quite large, some of them $2\frac{1}{2}$ ft. or more in diameter. It was estimated that the logs were from $\frac{3}{4}$ to $2\frac{1}{2}$ tons in weight.

Of the chain saws that were used, the Stihl Lightning gave the best performance for felling and cross cutting. With a rated Horse Power of 8.5 (S.A.E.), a weight of 26.5 lbs. and an overall good design and sturdy construction, this machine was excellent for use on the hardwoods of the Dry Zone.

The timber lying at stump site was extracted by means of the two frame steered tractors. These machines were also used to skid logs from scattered log dumps to the central wayside depots. In the latter operation the Massey Ferguson 65 equipped with a caliper grab (Fig. 3) was also used with success.

The Timberjack 205 performed very efficiently and proved to be a very versatile machine, thereby confirming the impressions gained throughout its two years operation in Ceylon. The Valmet (Fig. 4) was beset with breakdowns, but otherwise its performance was good. These two tractors were also used to haul the semitrailers loaded with timber to Moneragala.

Logs were loaded into the transport vehicles at the central wayside depots and at convenient points along the main forest track. The Steyr timber lorry, as expected, proved to be superior to any of the other transport vehicles. This lorry is equipped with a semitrailer which could be mounted on the body of the lorry during empty running. The two cross baulks on which the logs rest are fixed each to a turnable, one on the body of the lorry and the other on the semitrailer. The side supports consist of collapsible stanchions. The logs were loaded by means of a "Glogger" double drum winch mounted behind the driving cab (Figs. 5 and 6). Loading of this vehicle took an unduly long time. This was mainly due to the unevenness of the logs most of which were bent, as this made it difficult to stack them firmly on the lorry. On one occasion the whole loading operation took four hours.

Many useful lessons were learnt during the loading operation and these will help to cut down loading time in future work. However, it appears to the writer that side loading by means of a double drum winch will, at any rate, be a slow operation particularly when small dimensional logs are to be transported, and that one should give serious thought to the possibility of using a special loading crane.

The Steyr semitrailer model is suitable for hauling logs up to 40 ft. in length. However, logs of this length were not encountered, and, in any case, it would not have been possible to transport such long logs through the rough forest tracks. The axle of the semi-trailer had therefore to be pushed forward and the vehicle was used at about ¾ capacity. Even with this reduced load a severe strain was imposed on the vehicle because of the sharp dips and the rough nature of the forest track, and this resulted in the bending of the trailer draw bar. There is no doubt that inexpert handling of the vehicle was also a contributory factor in causing this damage.

This model of lorry is primarily intended for hauling large loads on good roads. In Ceylon, however, a fair proportion of the transport is through narrow forest tracks, and, in the writer's opinion, a lorry with chassis and loading platform forming a single unit is preferable to the semitrailer model.

It may be noted that the double turntable arrangement also caused a great deal of difficulty in handling the Steyr in the forest.

Unfortunately, in the closing stages of the operation this lorry met with an accident when returning empty to the logging camp, and this has put the vehicle out of commission for some months.

The Rysky semitrailer coupled to the Timberjack (Fig. 8) hauled moderately large loads with ease. The logs were loaded by means of a "Joutsa" crane fitted on the semitrailer and powered by the Timberjack winch (Fig. 7). This crane could cope with small to medium sized logs only, the heavier logs being left to the Steyr lorry.

The Rosson trailer which was much lighter than the Rysky was drawn either by the Valmet or by the Massey Ferguson 165. This trailer, and also the 5-ton lorries, were loaded either by hand (Fig. 9) or by means of a Joutsa double drum winch powered by the Massey Ferguson 35 (Figs. 10 and 11). Hand loading required 8 to 10 men, and only small logs were handled.

The table below gives the quantities transported by the different vehicles.

TABLE III

Quantities transported by the different Vehicles

Vehicle	*No. of trips to Moneragala*	*Volume in H. ft.*	*Average haul per trip in H. ft.*
Steyr	43	13,212·1	307
Timberjack with Rysky semitrailer	22	6,134·8	279
Ferguson 165 with Rosson semitrailer	35	4,127·3	118
Valmet with Rosson semitrailer	7	1,265·9	181
Seven 5-ton lorries	193	20,902·6	108

The disparity in performance between the Steyr and the 5-ton lorries is not as great as it appears from the figures. With the smaller vehicles the average haulage distance was more than with the Steyr. This came about when in the latter stages of the operation forest tracks had to be opened further afield, and as time was running out, these tracks were made just wide enough to take the smaller vehicles. The weighted average haulage distance was about 3 miles more with the 5-ton lorries than with the Steyr. Nevertheless, the overall performance of the Steyr was still far superior to that of the others.

The operation had to be terminated by the end of September when heavy monsoonal showers washed away some of the culverts and rendered some parts of the forest tracks dangerous for vehicular traffic. At this stage the track to Moneragala was about 35 miles, and it was deemed expedient to call off the operation rather than attempt to carry on longer under adverse conditions. The total quantity of timber removed to Moneragala during the period June to September was 45,643 H. ft.

Costing

The costs are given below. In calculating the depreciation of the machines a life of 5 years was assumed for the lorries and tractors, and 8 years for the jeeps. No interest was added as the period of use was small.

		Rs. c.
I.	Salaries of saw operators, chokermen and other daily-paid workers employed in the logging team	6,917 50
	Salaries and subsistence allowances of staff	8,944 33
	Salaries, subsistence and overtime allowances of drivers and cleaners of the permanent staff of the Forest Department employed in the transport operation	15,977 53
	Incentive bonuses to logging team	9,770 00
	Total	41,609 36
II.	Depreciation of Vehicles (for the appropriate period of use)—	
	2 Jeeps	940 00
	Steyr	2,769 00
	7 five-ton lorries	3,385 00
	Timberjack	5,250 00
	Valmet	3,750 00
	2 Massey Ferguson tractors (165 and 65)	1,477 00
	1 Massey Ferguson tractor (135)	1,050 00
	Other equipment (estimate)	1,000 00
	Total	19,621 00
III.	Running costs of vehicles including minor repairs	16,910 51
IV.	Major repairs to Steyr damaged during the operation (estimate)	5,000 00
V.	Consumable stores (camp equipment, medical supplies, etc.)	1,078 30
VI.	Fraction of cost of opening forest track in 1966 (estimate)	2,000 00

Total expenditure = Rs. 86,219·17
Quantity extracted = Rs. 45,643 H. ft.
Cost per H. ft. = Rs. 1·89.

It is difficult to compare this figure with the standard rates normally paid to contractors, as the major part of the initial logging operations had already been completed when the logging team took over the work. This included the opening up of most of the forest tracks, felling, and a major part of the conversion into logs and skidding.

The standard rates normally paid to contractors are as follows:

Felling and extraction over the 1st mile 90 cents per H. ft.

Transport on forest tracks 10 cents per mile per H. ft.

Transport on minor roads 3 cents per mile per H. ft.

These rates cover also the cost of opening up the forest tracks.

At an estimated weighted average distance of 23 miles on forest track and 2 miles on minor road, the standard rate payable to a contractor would be Rs. 3.26 per H. ft. or Rs. 148,796.18 for the full quantity of timber brought out of the forest. From this, the value of the initial operations carried out prior to the commencement of work by the departmental logging team has to be deducted if the value of the work performed by the team is to be estimated at standard rates. This is done as follows :

	Rs.	c.
Felling, lopping, cross-cutting and skidding :		
41,130 H. ft. (figure obtained from despatch register) at 90 cts. per H. ft ..	37,017	0
Felling :		
4,513 H. ft. at 10 cts. (estimated cost of felling) per H. ft.	451	30
Part of cost of opening up forest tracks (estimate)	5,000	0
Total ..	42,468	0

The difference between the two figures (Rs. 148,796.18 and Rs. 42,468.30) would then represent the value of the work performed by the departmental logging team at standard rates. This amounts to Rs. 106,327.88. The actual expenditure incurred was Rs. 86,449.17.

Some Reflections

We have no reason to be complacent about a job well done merely because the cost is less than the rate that would have been paid to a contractor. There were many shortcomings in the operation, but this is inevitable in the early stages of the introduction of mechanized logging techniques. Despite the shortcomings many lessons were learnt and these will make for better performance in the future.

One thing about which there is reason to be satisfied is that the members of the logging team, both labourers and officers, worked tirelessly and with a degree of dedication rarely seen in other Government enterprises. The workers were 'daily paid', but a system of bonuses was evolved whereby both officers and labourers were paid additional remuneration on the basis of the output and in relation to each man's contribution to the operation.

This job also brought out most forcibly the fact that in an enterprise of this nature increased production can only be achieved by relating payments to production. A fixed monthly salary gives no incentive for increased production but, on the contrary, encourages laziness. The lorry drivers who were not members of the logging team were paid in this way and there was a noticeable lack of enthusiasm on their part.

Payments to forest labourers should either be on a piece rate basis or, alternatively, a relatively low monthly or daily wage should be fixed and, in addition, extra bonuses should be given on the basis of production.

Another useful organizational hint is that jobs should not be rigidly defined. A lorry driver should assist in other operations too, such as loading and unloading, particularly when these operations are mechanized, and in the event of a breakdown they should assist in minor repairs. As it now stands, the lorry driver's job is only to drive the vehicle, and during loading his only contribution to the work is to stand by and watch the operation.

On the technical side, there is room for improvement in nearly all the operations. To start with, in the opening up of forest tracks explosives could quite easily be used for removing the stumps, and this would give much quicker access to the forest than the present method of felling the trees and cutting back the stumps.

3—CP 2926 (3/68)

In the operation and maintenance of chain saws the general standard of the workers is poor, and only two workers can be said to have reached even a moderate degree of competence. More intensive training is therefore called for.

Skidding was relatively well carried out. One worker in particular had acquired a high degree of skill in operating the frame-steered timber skidding tractors both for dragging timber from the stump and also for hauling the semitrailers.

Loading of logs into vehicles was far too slow an operation. Much difficulty was experienced due to the unevenness of the logs. This is a common feature in Halmilla, but the difficulties could have been minimised if debranching and cross-cutting had been more thoughtfully carried out. Branch stumps and bends on the logs cause wastage of time at all stages of the logging operation and they should be eliminated as far as possible at the time of felling.

Loading of the Rysky semitrailer was done by a crane, and this operation was much faster than rolling up the logs by winch. This suggests that, instead of each lorry being provided with its own loading device, a special loading crane with a lift capacity of 3 tons might be the best means of carrying out all loading operations.

The performance of the Steyr timber lorry indicates that high powered, double axle drive, timber trucks capable of taking payloads of 8 to 10 tons are far superior to the small lorries now used for timber transport everywhere in the Island. Initial investments on such vehicles are high but there is no doubt that with such vehicles the cost of transport per cub. ft. could be reduced. One obvious saving in using a high capacity truck is that the man power cost component of tranport will drop appreciably.

Finally, one may pose the question as to how far improved logging techniques can be generally applied to logging in the Dry Zone.

Improved logging methods include the mechanization of cutting, skidding and loading, the use of better techniques for opening up forest tracks, and the use of modern timber trucks for transport. If the Dry Zone forests had been high yielding there is no doubt that the introduction of modern techniques and machines would substantially increase output and keep costs down. But yields being very low, mechanization should be introduced with caution. The logging operation described in the foregoing pages cannot give a final answer to the question since much of the initial operations had been completed when the logging team commenced work. However, the success of this operation indicates that mechanization could be introduced to some selected forest areas. Such operations should be planned well in advance of the commencement of logging, and special attention paid to the organizational and technical suggestions made in this paper.

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Notes on Timbers

by

R. PONNAMPALAM

Botanical Name.—*Eucalyptus microcorys,* F. Muell.

Trade Name.—Tallow-wood.

Family.—Myrtaceae.

The Tree.—Native of Australia (N. S. W. and Queensland) attaining a height of 150 ft. Very tolerant of shade in the early stages and coppices well but the seedlings are frost tender. Flowers freely. Bark reddish in colour, fibrous but not the typical 'stringybark', furrowed and persistent throughout. Juvenile leaves opposite for 4 to 5 pairs, elliptical to broadly lanceolate, pale green sessile or on short petioles. Adult leaf alternate 8 to 10 × 2 to 3.5 cms., lanceolate or broadly lanceolate, paler on under surface, thin petiolate. Venation moderately conspicuous. Inflorescence axillary or terminal, 4 to 8 flowered umbel on a flattened 13 to 20 m.m. long pendunclе. Buds 6 to 7 × 4 to 5 m.m. pedicellate. Flowers in July to November (3). Fruit a capsule. Girth increment studies on *Eucalyptus microcorys* have been made by Perera (4).

Distribution.—Exotic successfully introduced since 1888 into Hill Country at 5,000-6,000 ft. elevation (1). Used for afforestation of grass-lands in the Hill country. Plantations are found in Haputale, Conical Hill, Pattipola, Diyatalawa, Kotmale and adjacent areas. *Eucalyptus microcorys* has also been successfully introduced in the Cameroons, Congo Republic, Hawaian Islands, Kenya, New Zealand and Rhodesia (3).

General Description.—Some of the planks sawn in the Forest Department Research Laboratory were knotty, and, in some, included bark was also noticed. The knots may be due to the neglect of pruning in the early stages. Sapwood is 1 to 1½ inches wide in logs 4.5 ft. girth.

The wood is greyish white with a yellowish tinge or straw coloured, darkening with age. Growth rings are indistinct, the texture is fairly coarse and the interlocked grain gives a faint but pleasing figure. In some planks of the species, yellowish streaks were noticed at the separation of the heartwood and sapwood. Brown patches as well as small patches of soft tissue were seen in few planks. Waxes are found in the wood which is noted for the greasy feel. The silica content of the ash of the wood varies from 8.96 to 57.84 per cent. Gum veins are occasionally found. Tannin in bark is 5 to 7 per cent. and in wood it is 5 to 8 per cent (3).

Anatomical Structure.—Pores are medium sized, elliptical in shape and arranged in radial multiples of 2 to 6. They also occur in clusters and singles. Parenchyma vasicentric. Rays fine and fairly distinct.

Mechanical Properties.—Bending strength, stiffness, toughness and hardness are of a high order. Its resistance to splitting is relatively poor. Average density 76 lb. cu. ft. green and 62 lb. cu. ft. air dry (12 per cent.

moisture content). A summary of the results of the strength tests carried out on test pieces in the Research Laboratory is as follows :—

Strength Property	*Moisture Content per cent.*	*Specific Gravity (at test)*	*Specific Gravity (Oven dry)*	
Static Bending	14·45	0·91	0·80	*Equivalent Fibre Stress* 16,124·5 lb./in²
Cleavage on Radial Plane	13·74	0·946	0·764	*Cleavage stress per inch width* 198·4 lb.
Cleavage on Tangential Plane	14·33	0·874	0·765	*Cleavage Stress per inch width* 320·0 lb
Radial Shear Parallel to Grain	13·10	0·866	0·765	*Shear Stress* 2,098·8 lb./in²
Tangential Shear Paralle to Grain	12·85	0·959	0·857	*Shear Stress* 2,668·2 lb/in²
Compression Parallel to Grain	12·85	0·959	0·857	*Max. Crush Stress* 8,951 lb./in²

Air Seasoning Features.—In the log form, after felling, the species has a tendency to develop surface cracks and end splits. However, this tendency is much less than in *Eucalyptus grandis.* Seasoning is not difficult although back sawn material has a tendency to develop fine surface checks and, as soon as the logs are sawn, some planks develop deep cracks. However, most of these cracks close before drying is complete.

Air seasoning of 1/2 in. and 5/8 in. planks using 1 in. stickers was done at the Research Laboratory. The maximum moisture content of green *Eucalyptus microcorys* recorded is 96.7 per cent. During air seasoning, defects such as bowing and cupping have been noticed in some planks, cupping being more common. Some of the knots in the sawn timber loosen during air seasoning. The fibres get raised and the surface becomes uneven.

Shrinkage measurements were taken every month on 1 inch planks in an air seasoning stack. The summary of measurements shows that average radial shrinkage is 2.19 per cent. and tangential shrinkage 3.04 per cent. These shrinkages correspond to a drop in everage moisture content from 83.5 per cent. to 18.7 per cent.

Durability and Treatment.—Very durable. The sapwood is susceptible to attack by Powder Post Beetles. The results of the laboratory tests (2) (Using Kolle flasks) for natural durability compared with Teak (*Tectona-grandis*) and jak (*Artocarpus heterophyllus*) are as follows :—

Fungus : Lentinus giganteus *Species*	*Percentage loss in weight after 4 months*	
	Means of Observations	*Confidence limits for means for 99% confidence*
(1) *Eucalyptus microcorys*	7·29	4·20 – 10·28
(2) Teak (*Tectona grandis*)	0·99	0·78 – 1·20
(3) Jak (*Artocarpus hetero-phyllus*)	14·68	6·50 – 22·86

It is resistant to preservative treatment. Even with incision it is difficult to get the penetration of preservatives.

Wood Working Qualifites.—It works fairly easily, turns well, dresses to a smooth greasy surface and polishes easily. Gluing is somewhat difficut, but it bends reasonably well down to a radius of 15 cms. Nails can be driven into the timber fairly easily without causing cracks.

Uses.—The timber has a wide range of uses—posts, poles, sleepers and heavy construction as well as all phases of housing construction. Suitable for tool handles. It is regarded as one of the best timbers for dance floors. Chairs, benches, racks and shelves made out of this timber have been found to be very good in service except that it is a little heavy. Used as building and constructional timber in Up-Country. Railway sleepers cut from this timber are supplied to the Railway Department.

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CEYLON FORESTER (NEW SERIES)

AUTHOR INDEX FOR VOL. VII

(1965–1966)

Prepared by :—A. W. SENEVIRATNE

Author		Title	Vol.	No.	Page
F					
Fernando, S. N. U.	..	Fertilization of Teak Nurseries ..	VII ..	3 & 4 ..	103
Fernando, S. N. U.	..	Insects Commonly found in the Teak Nurseries of Ceylon.	VII ..	1 & 2 ..	54
Fernando, S. N. U.	..	Teak in Ceylon Nurseries ..	VII ..	1 & 2 ..	57
M					
Muttiah, S.	..	A Comparison of Three Repeated Inventories of Sundapola Mixed Selection Working Circle and Future Management	VII ..	1 & 2 ..	3
Muttiah, S.	..	Report on a Seminar on Forest Seed and Tree Improvement	VII ..	3 & 4 ..	70
S					
Sridas, S.	..	On Forest Inventories ..	VII ..	3 & 4 ..	86
V					
Vivekanandan, K.	..	An Experiment to Determine the Capacity of Nine Wood-Rotting Fungi, including Polystictus sanguineus and Lentinus giganteus, to cause Decay of Grevillea robusta Wood	VII ..	1 & 2 ..	36
Vivekanandan, K.	..	A Report on the Seminar and Study Tour on the Protection against Forest Diseases and Insects held in the U. S. S. R.	VII ..	1 & 2 ..	39
Vivekanandan, K.	..	Determination of Basic Densities of some Ceylon Timbers	VII ..	3 & 4 ..	107
W					
Wijesinghe, L. C. A. de S..	.	The Planning of Transportation Networks and Extraction Schemes in The Forest	VII ..	3 & 4 ..	96
ව					
වර්ණකුල සී. ඒ. ඇල්	..	හංසිල තේක්ක සහ එහි පැවැත්ම ..	VII ..	1 & 2 ..	60

CEYLON FORESTER (NEW SERIES)

SUBJECT INDEX FOR VOLUME VII

(1965–1966)

Prepared by :—A. W. SENEVIRATNE

	Vol.	*No.*	*Page*
A			
A Comparison of Three Repeated Inventories of Sundapola Mixed Selection Working Circle and Forest Management	VII	1 & 2	3
A Report of the Seminar and Study Tour on the Protection Against Forest Diseases and Insects held in the U. S. S. R.	VII	1 & 2	39
An Experiment to Determine the Capacity of Nine Wood Rotting Fungi including Polystictus sanguineus and Lentinus giganteus, to Cause of Grevillea robusta Wood	VII	1 & 2	36
D			
Determination of Basic Densities of some Ceylon Timbers	VII	3 & 4	107
E			
Editorial	VII	1 & 2	1
Editorial	VII	3 & 4	67
F			
Fertilization of Teak Nurseries	VII	3 & 4	103
I			
Insects Commonly Found in the Teak Nurseries of Ceylon	VII	1 & 2	54
O			
On Forest Inventories	VII	3 & 4	86
P			
Proceedings of a Seminar on the Utilization of Forest Produce	VII	3 & 4	109
R			
Report on a Seminar on Forest Seed and Tree Improvement	VII	3 & 4	70
T			
Teak in Ceylon Nurseries	VII	1 & 2	57
The Planning of Transportation Networks and Extraction Schemes in The Forester	VII	3 & 4	96
සි			
සිංහල තේක්ක සහ එහි පැවැත්ම	VII	1 & 2	60

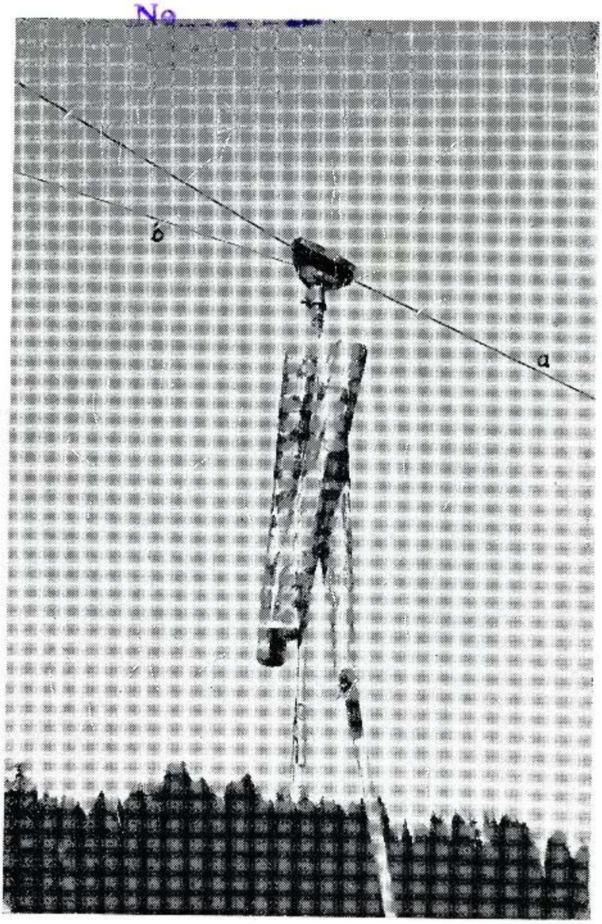


Fig. 1. Two-cable type of crane with Bachmann automatic carriage hauling logs in Switzerland. *a* : Main cable. *b* : Traction *cum* lifting cable.

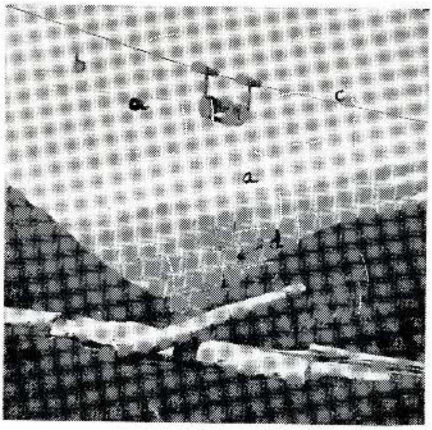


Fig. 2. Three-cable type of crane with separate lifting, (*a*) traction. (*b*) cables. (*c*) main cable. (*d*) Pulley block. The log is being released at the collecting depot in the valley station. The carriage is one manufactured by Guido Meyer of Bellinzona, Switzerland, and the logging operation is in the same district.

4—CP 2926 (3/68)

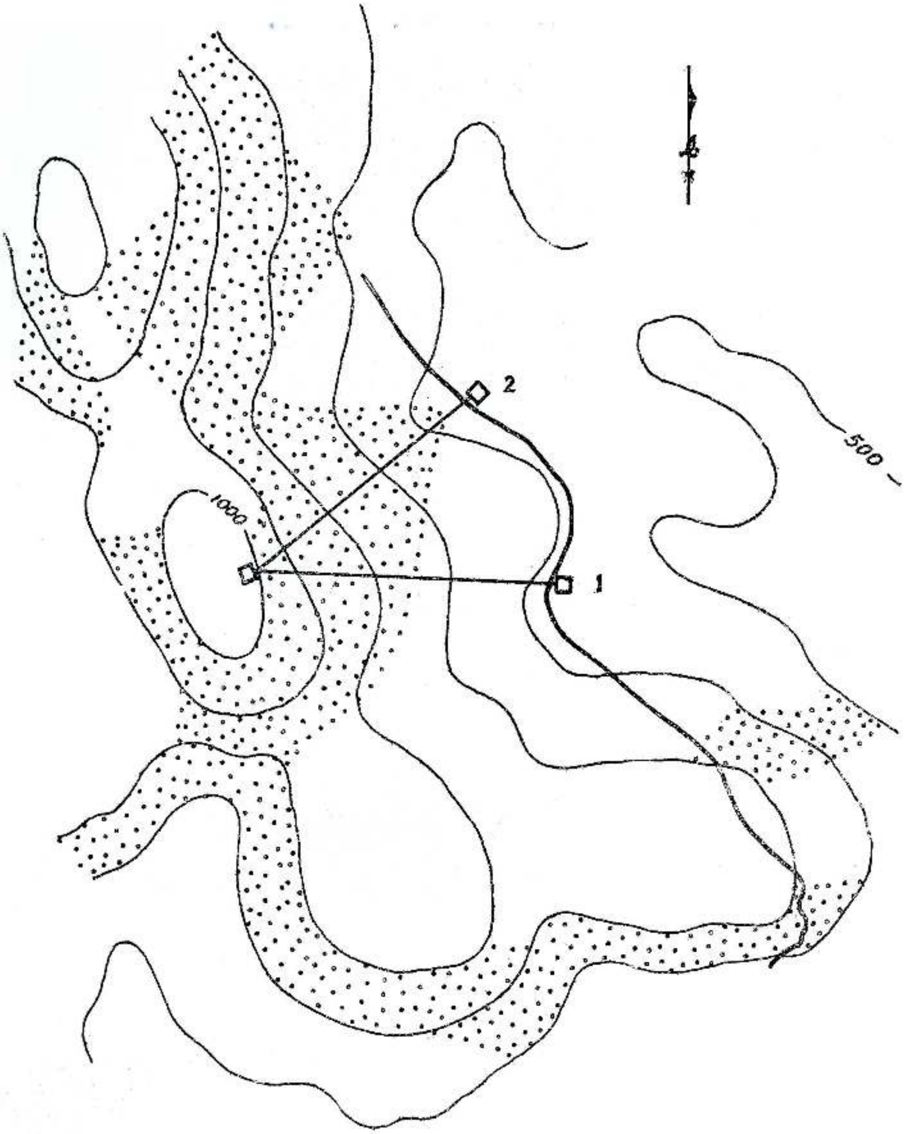
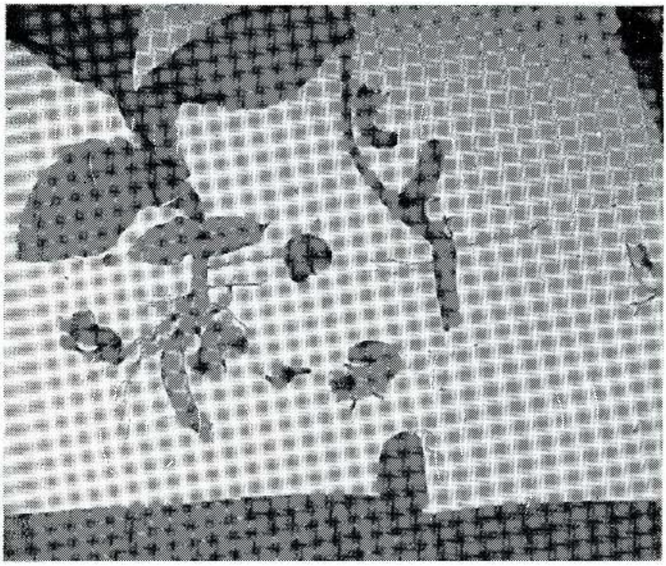


FIG. 3

SCALE 1: 12,672 (AN ENLARGEMENT OF MAP ON THE SCALE OF 1: 63,360)

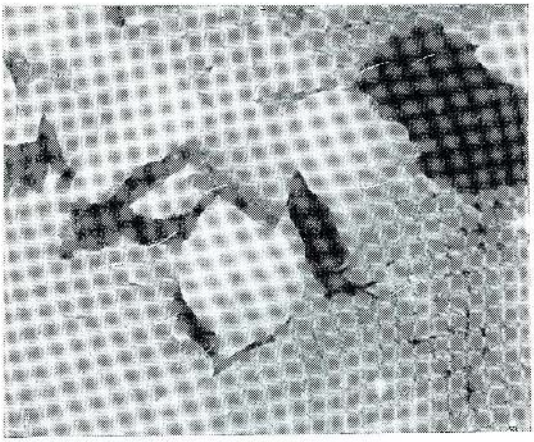
PART OF DEDIYAGALA FOREST RESERVE

PART OF FOREST ROAD
CABLE CRANE LINES FOR PRELIMINARY TRIALS
CONTOURS (100 FT. INTERVAL)
AREAS WITH GRADIENT OVER 25 PERCENT.

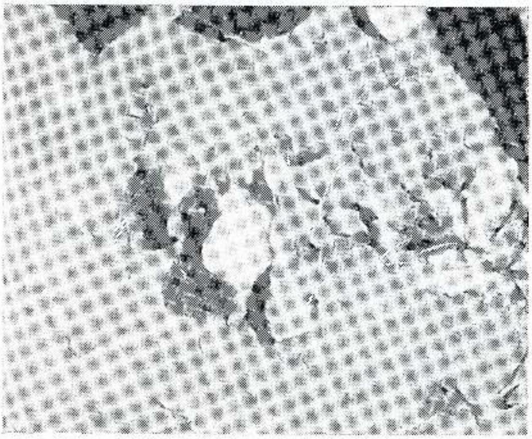


Photograph 1—showing adult cockchafer larvae and damaged Teak seedlings with incised taproots.

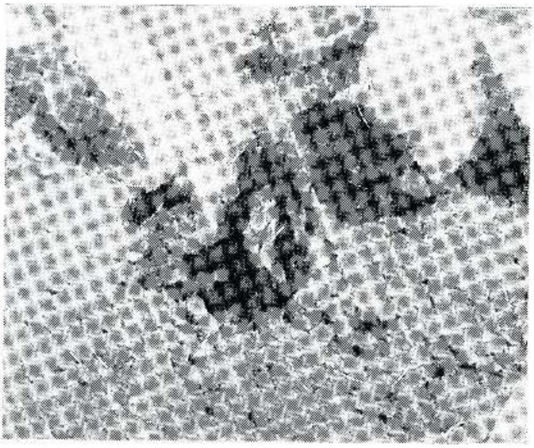
Young seedlings showing different stages of attack by cockchafer larvae.



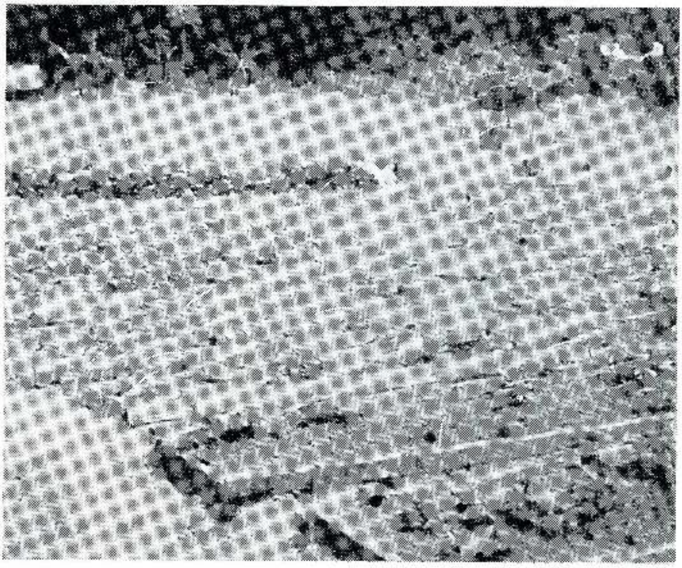
Photograph 2—initial stage showing curling of the terminal leaves downwards.



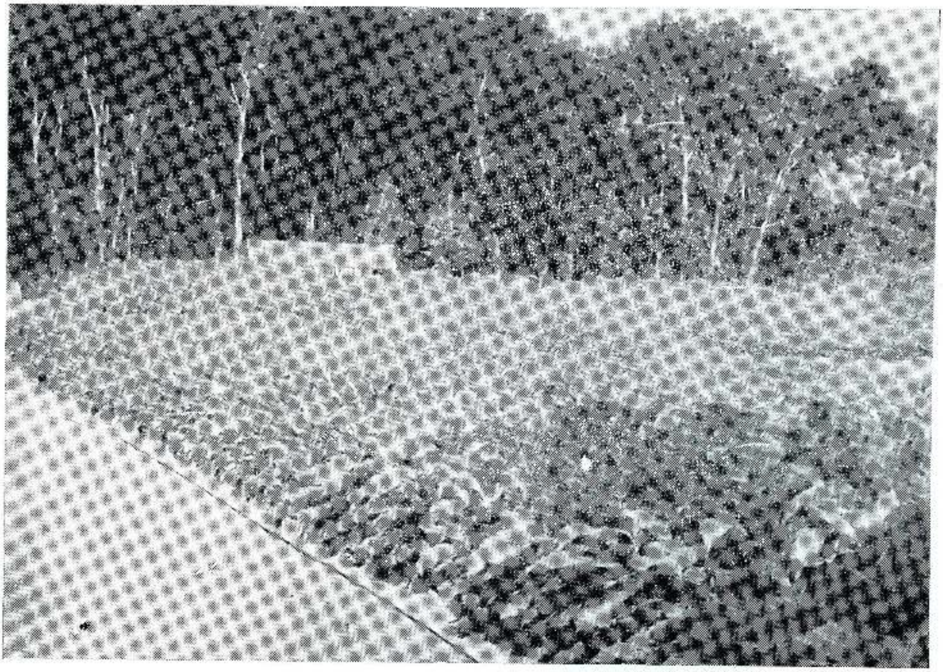
Photograph 3—later stage.



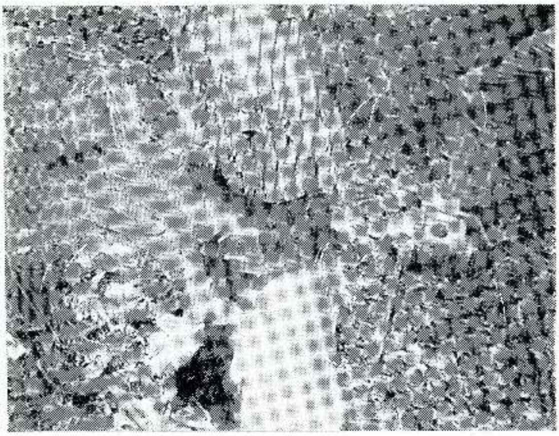
Photograph 4—late stage. Note withered and crumpled appearance of the plant.



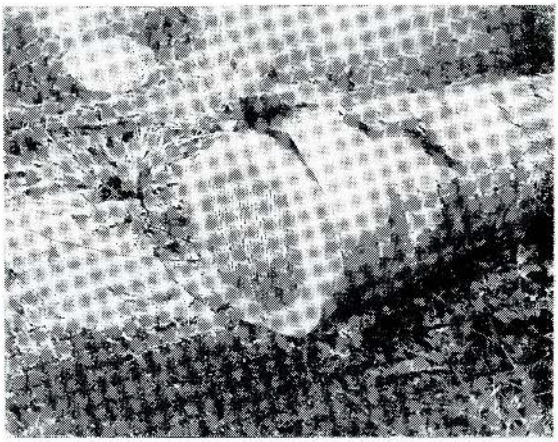
Photograph 5—The old Kumbalpola Teak nursery showing beds attacked by cockchafer larvae in the foreground—note 'patchy' nature of attack. Older plants in the background are practically devoid of attack (1962).



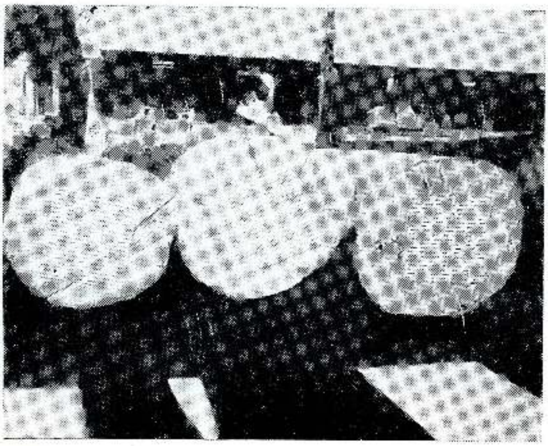
Photograph 6—the same nursery in 1963 with well stocked beds after timely application of sevin.



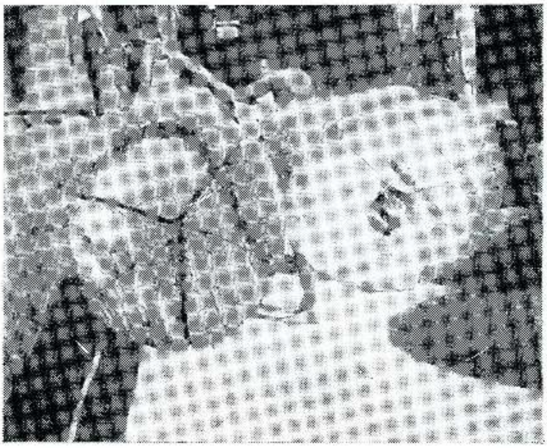
1. Clamp in position.



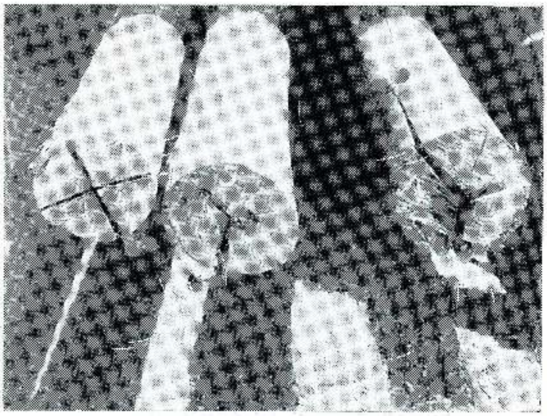
2. Gang-nail in position.



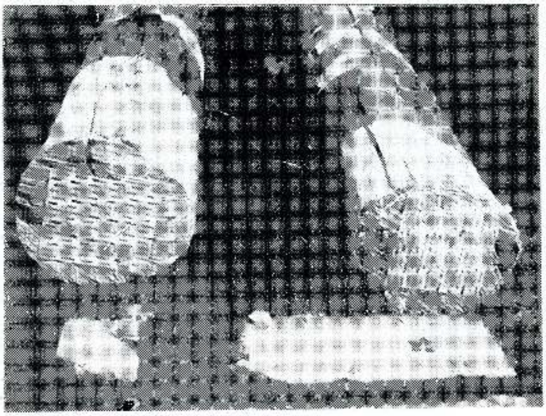
3. Butt ends of gang-nailed Poles, one month after felling.



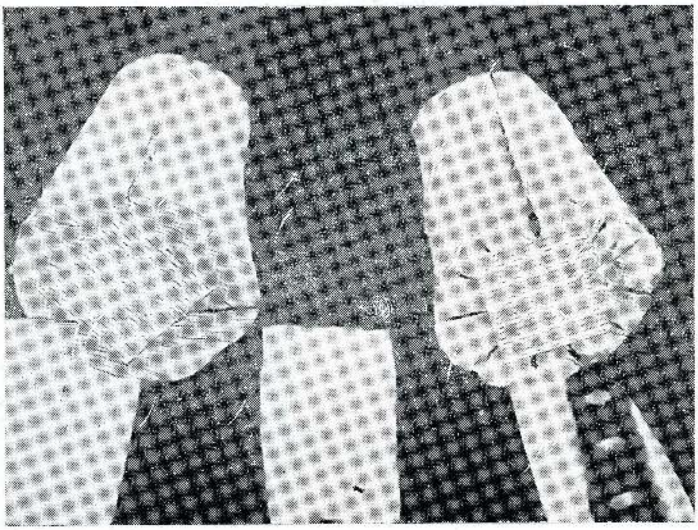
4. Poles without gang-nails, one month after felling.



5. Top ends of controls, 4 months after felling.



6. Top ends of gang-nailed poles,
4 months after felling.



7. Butt ends of gang-nailed poles, 4 months after felling.

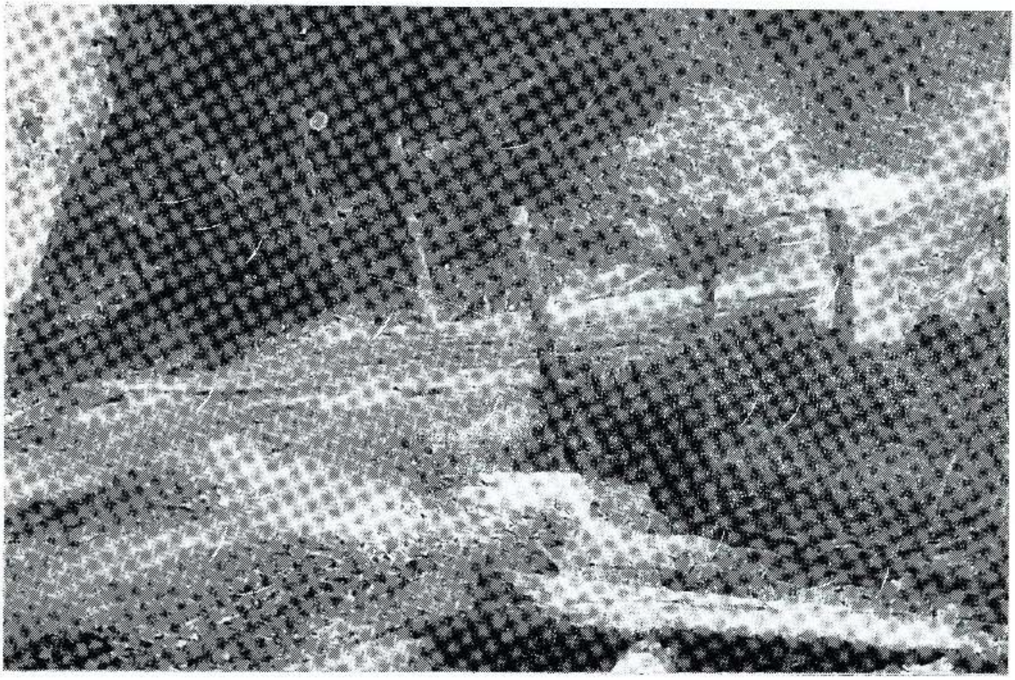


Fig. 1. Temporary bridge made out of round timber.

Fig. 2. The forest track crossing a dry stream bed. Track consists of a layer of logs with sand piled on.

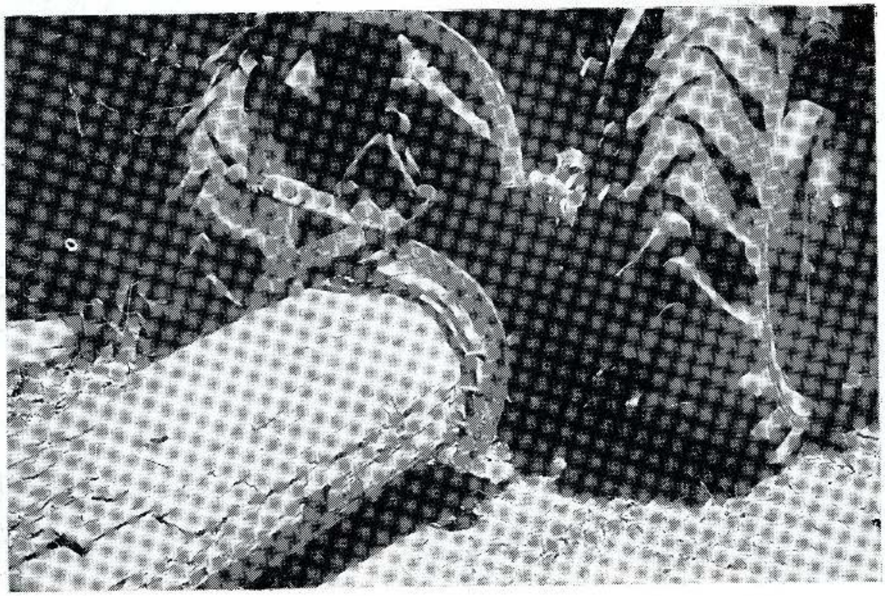


Fig. 3. Caliper grab on Ferguson 65 skidding a log.

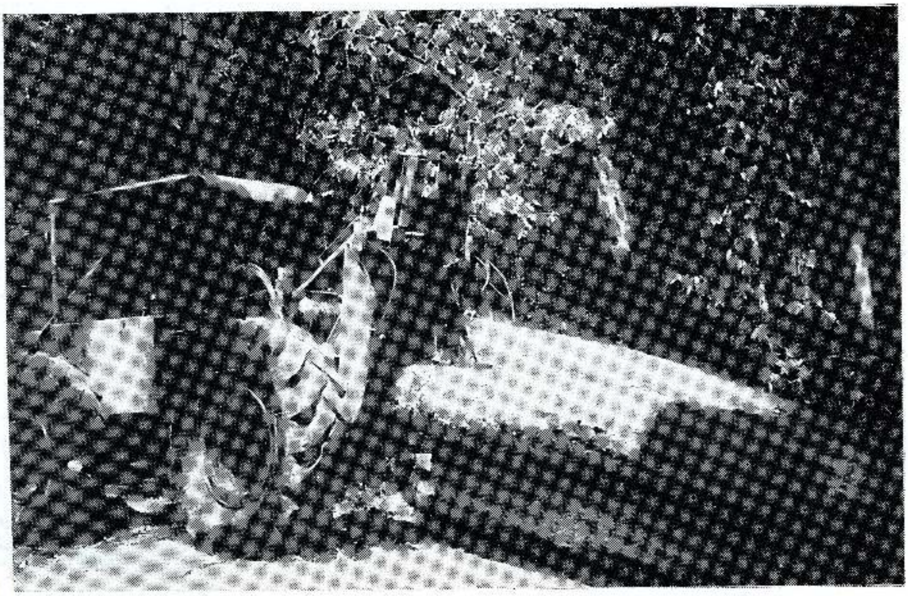


Fig. 4. Valmet Terrain tractor skidding logs.

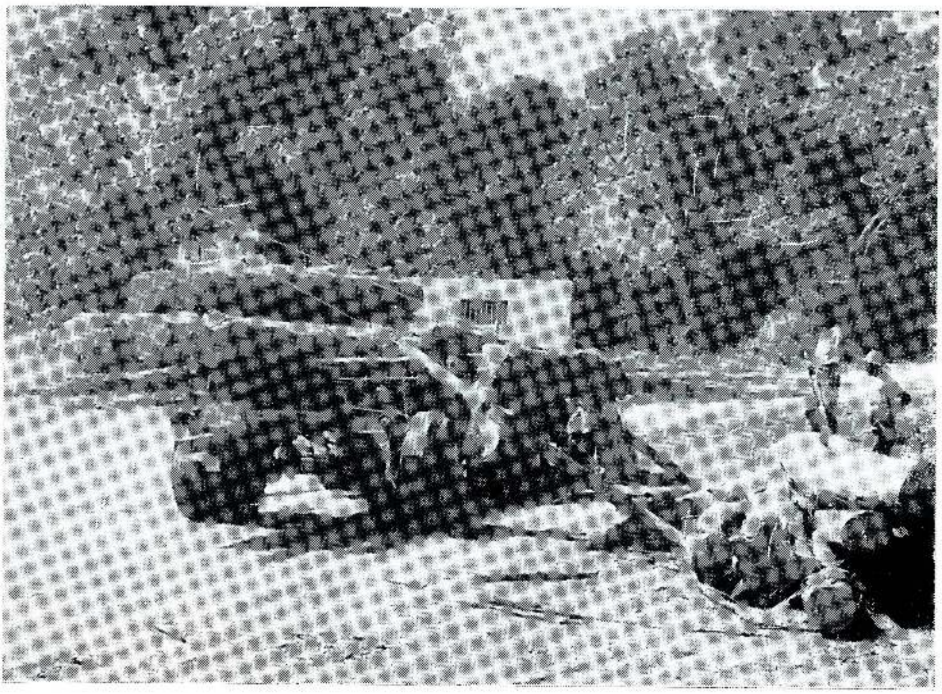


Fig. 5. Steyr lorry being loaded by winch.

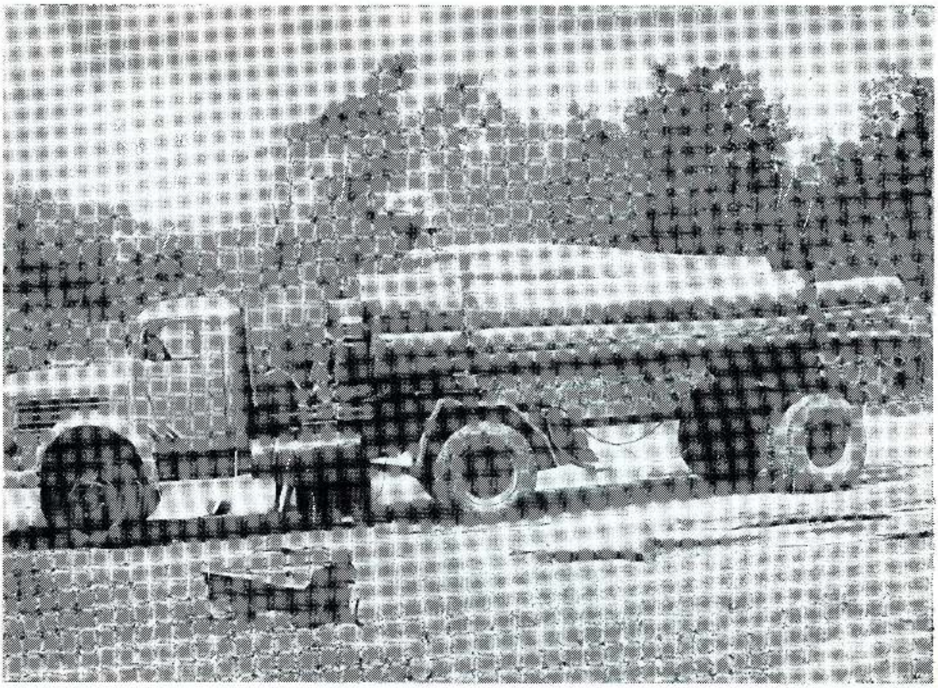


Fig. 6. Steyr lorry with a load of timber.

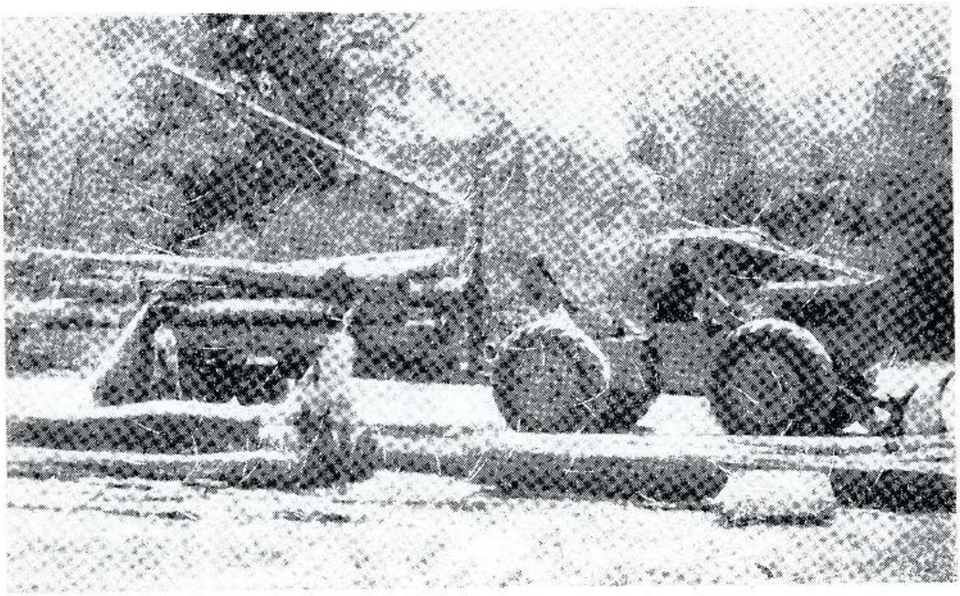


Fig. 7. Timber Jack with Rysky semitrailer being loaded by crane (Model " Joutsa ").

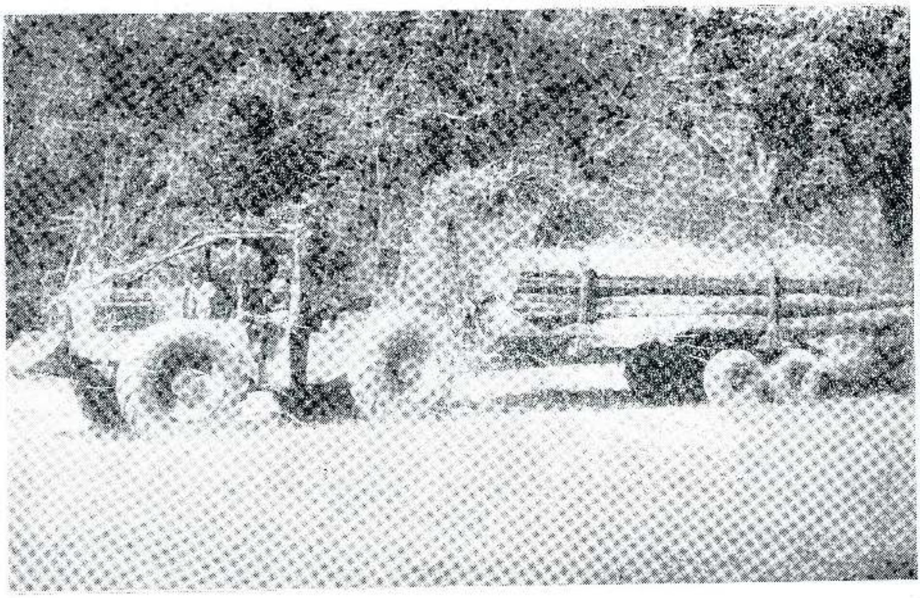


Fig. 8. Rhysky semitrailer with a load of timber drawn by the Timber Jack.

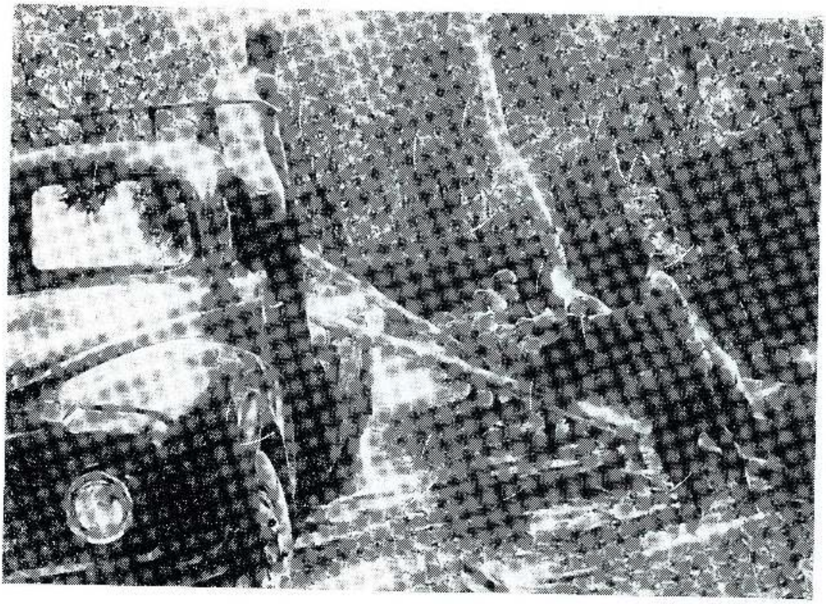


Fig. 9. Loading by hand.

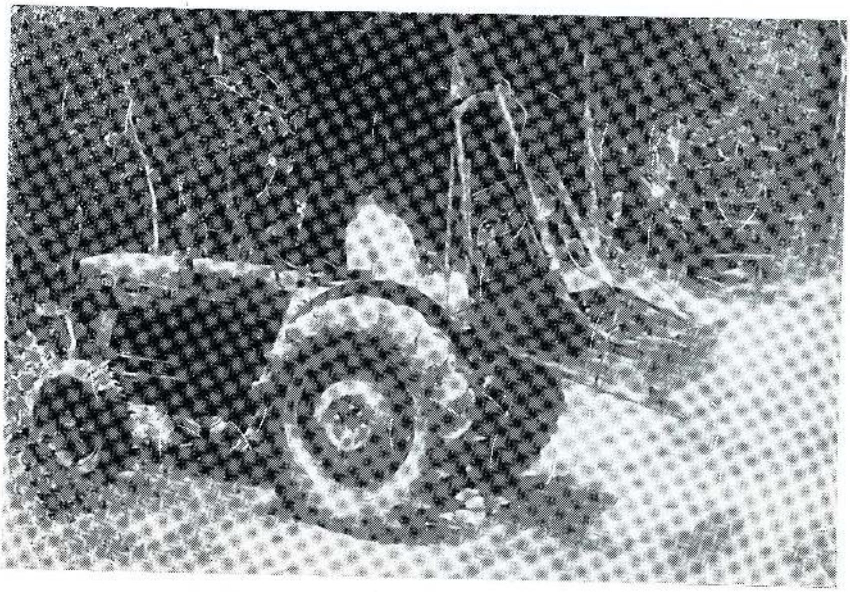


Fig. 10. "Joutsa" double drum winch fitted on to Massey Ferguson 35.

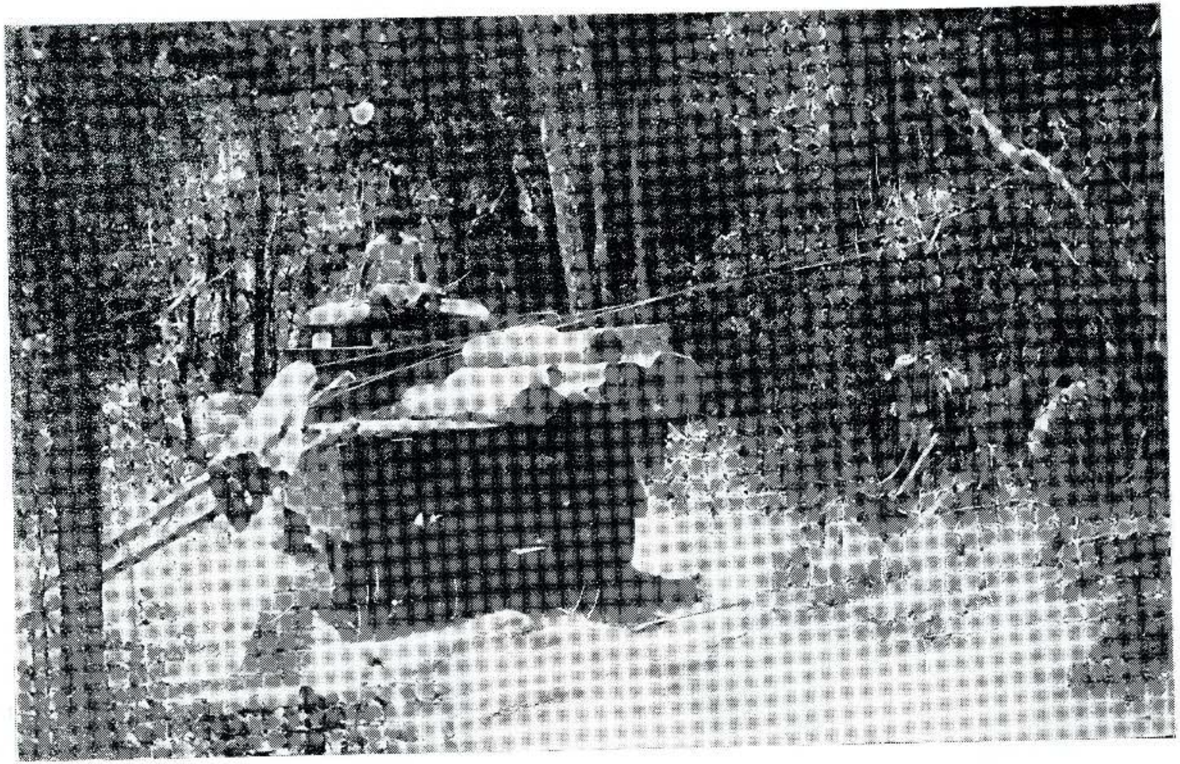


Fig. 11. Loading by "Joutsa" double drum winch (winch not visible in picture.)