PAMPHLET No. 5
BULLETIN No. 58

The Foresters' Manual

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PART IV

AFFORESTATION WITH PINES
(South-West)

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CONTENTS

This Pamphlet Covers:—

Issued 1952

INTRODUCTION

The attention of officers receiving this pamphlet is drawn to the introduction in Pamphlet No. 1 which is applicable to the Manual as a whole.

It is to be noted that each section as issued will override the instructions contained in circulars on subjects covered by the section and such circulars will automatically be cancelled.

Pamphlets Nos. 1 to 4 issued in 1950 covered Part 1—General District Work (South-West).

This Pamphlet No. 5 covers Part 4—Afforestation with Pines (South-West).

T. N. STOATE,
Conservator of Forests.

1952.

PART IV—AFFORESTATION

PUBLICATIONS

470. Since the writing of the first edition of the Foresters' Manual considerable knowledge has been built up on the problems of afforestation with exotic conifers. Officers dealing with plantations should be familiar with the "Nutrition of the Pine" Bulletin No. 30 Forestry and Timber Bureau 1950. Other publications of interest to students of pine establishments are as follows:—

Publications.

"Plant Nutrients and Pine Growth," by S. L. Kessell and T. N. Stoate. Australian Forestry Journal, Vol. 1, No. 1.

"A Field Trial for Gnangara Plantation," by T. N. Stoate. Australian Forestry Journal, Vol. 1, No. 1.

"Pine Nutrition," by S. L. Kessell and T. N. Stoate. Australian Forestry Journal, Vol. III, No. 1.

"The Effect of Superphosphate on Pinus pinaster," by D. H. Perry. Australian Forestry Journal, Vol. IV, No. 1.

"Pinus pinaster in Western Australia," by D. H. Perry. Australian Forestry Journal, Vol. V, No. 2.

"Pine Establishment," by T. N. Stoate. Australian Forestry Journal, Vol. IX, No. 2.

"Deficiency Diseases in the Pine," by T. N. Stoate and D. H. Perry, A.N.Z.A.S. (1946 Meeting).

"Nutrition Studies in W.A. Pine Plantations," by T. N. Stoate, A.N.Z.A.S. (1947 Meeting).

"Pine Establishment," by T. N. Stoate. Forest Dept. Bulletin 53.

"Pine Establishment," Forests Dept. Bulletin 53A.

State Plantations.

471. Although only approximately 18,000 acres of pine have been established over the past 30 years, the plantations concerned have covered a wide range of the soils and climates of the South-West from Pemberton to Gnangara; and have resulted in the development of techniques in soil survey, selection of species, establishment and nutrition, and in pruning, thinning and marketing problems.

The pine working plan.

472. A Pine Working Plan (1950) envisages a target of at least 200,000 acres of pine plantation for the State and an annual programme of 2,000 and perhaps up to 5,000 acres. The object of this plan is to provide softwood for the expected increased population of the future or for use both as timber and as long fibred pulp, of which a percentage is needed in many classes of paper as a mixture with the short fibred pulp of eucalypts.

The need for softwood.

The increased use of plantation grown softwood is also necessary as population increases to provide for an anticipated deficiency of supply from our hardwood forests; moreover the export trade in these high priced hardwoods cannot continue indefinitely unless a percentage of softwood is used locally.

SURVEY AND SUBDIVISION

Soil survey and layout.

473. All plantation proposals are the subject of careful soil survey before a Working Plan proposal is adopted. Following this work the preliminary subdivision of pine plantation areas is carried out by means of prismatic compass and 5-chain band. The general layout or scheme of subdivision will be influenced by the topography of the area. Firebreaks should be suitable for ploughing and grades satisfactory for future lines of transport.

General scheme of layout.

474. The plan following paragraph 479 represents a diagrammatic scheme of subdivision, but modifications will always be necessary in practice. The major internal firebreaks should run more or less at right angles to the direction of the dangerous winds. For example, if easterly or westerly winds are the most dangerous, the 2-chain internal firebreaks should run mainly north and south.

Designs to be approved by Head Office.

475. If the general outline of subdivision has not been decided during the soil survey, the officer responsible for subdivision work on any plantation shall first make a preliminary reconnaissance and submit a proposed design to Head Office. No plans may be prepared by the Drafting Office or detailed layout marked on the ground until this design is approved.

Plans to be five years in advance.

The preparation of plans and preliminary subdivision work should be maintained at least five years in advance of clearing on each plantation. In special cases where large areas are being cleared, the Conservator may approve of the final pegging and survey of compartments being delayed until after the burn in order to economise in survey costs.

Pegging compartments.

476. At the north-west corner of each compartment a peg is erected, and on this peg the number of the compartment is cut. The standard size for corner pegs is 4in. square in section and 3ft. long (2ft. in the ground and 1ft. above ground). Trenches are cut on either side of each corner showing the direction of the compartment boundaries. In figure at paragraph 479 these "direction" trenches would be at right angles to one another. The standards set out hereunder are to be accepted as a general guide in the design of breaks in and around pine plantations. At the same time, full consideration needs to be given to local conditions, and no rules should be considered to be hard and fast.

External firebreaks.

477. For external firebreaks the aim will be a width of three to four chains and the full width will be sufficiently cleared of logs, stumps and debris to permit thorough ploughing and/or cultivating over its full width. Special circumstances such as in suburban plantations may require an approval for a variation in width. Experience has shown that the greatest risk of fire comes from outside the plantation. Careful consideration should, therefore, be given to the reservation of sufficient country beyond the external breaks to allow of adequate controlled burning. In many cases where areas of undeveloped private property adjoin the boundaries, it is possible by arrangement with the owners, to plough firelines and carry out controlled burning over a sufficient width to protect the plantation. Where standing trees occur on any part of this strip, it should never be less than 10 chains in width. On the other hand, where a plantation adjoins pasture without standing trees, the external burning may be dispensed with particularly if the pasture is well grazed. No standing eucalypts should be permitted for a minimum distance of five chains beyond the external firebreak, and every endeavour must be made to obtain the co-operation of owners in the felling and disposal of such trees. No paperbarks should be allowed within 20 chains of a plantation.

Internal firebreaks.

478. In laying out a firebreak system for a plantation the natural features largely influence the design and it is rarely possible to adhere to the perfect arrangement. The following is the ideal that should be aimed at:—

(a) To surround the whole plantation with a four-chain wide firebreak.
(b) Every 600 to 1,000 acres with a three-chain wide firebreak.
(c) Every 300 to 500 acres with a two-chain wide firebreak.
(d) Every 100 acres with a one-chain wide firebreak.
(e) Every compartment with a half chain wide firebreak.

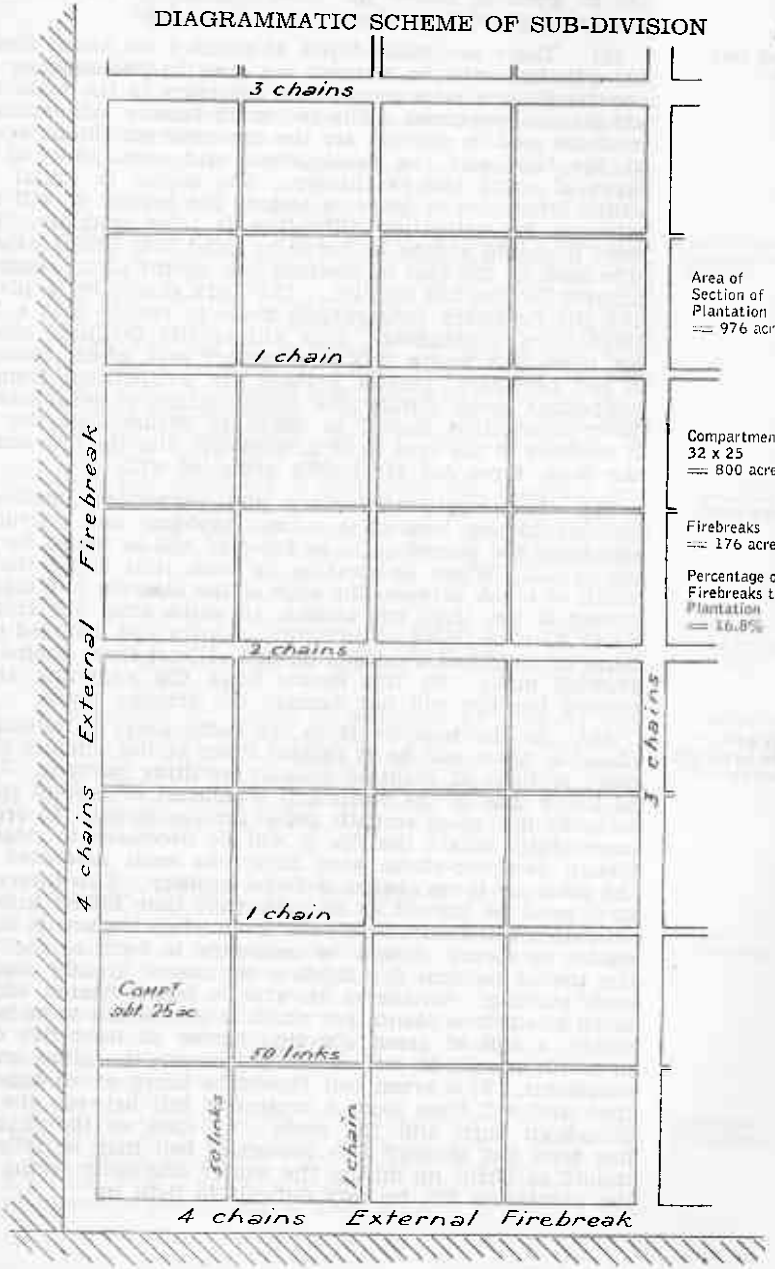
(f) All firebreaks will be sufficiently cleared of all stumps and logs to permit of ploughing and/or cultivating over their full width.

(g) Ideally each section of 100 acres will be divided by secondary breaks of 33ft. in width into about three compartments of approximately 33 acres. Twenty-five acres shall be regarded as the minimum area of any compartment and 40 acres as the maximum.

Layout for level country.

479. The resultant layout of a plantation on reasonably level sandplain country where there is no necessity to run breaks along contours, should be more or less on the lines shown in the diagram hereunder:—

DIAGRAMMATIC SCHEME OF SUB-DIVISION



CLEARING FOR PLANTING

Clearing scheme to be followed.

480. It is usually necessary in order to provide for a good burn to protect compartments from a surface fire for a minimum period of three years before clearing takes place. For this purpose firelines from 6ft. to 10ft. wide are cleared and ploughed around small areas of up to 100 acres, but where operations are on a large scale and the planting rate is in excess of 500 acres a year it is advisable to clear at least a one-chain break around the area to be held. The country outside this break should be kept in a burnt condition whilst the area is being held. These advanced breaks should, as far as possible, follow the lines pegged out for permanent breaks which will be cleared at a later date.

Design work for a good burn.

481. There are many types of country on which clearing for planting will be carried out and in consequence only general guiding principles having reference to the main types are set out hereunder. The two main factors influencing the methods used in clearing are the economic conditions existing at the time and the development and availability of new types of plant and machinery. The saving in initial costs which introduces or leaves a serious fire hazard or will make later on for extraction difficulties is false economy. However, it should always be borne in mind that initial expenditure such as the cost of clearing will mount up at compound interest for the full rotation. The work should be so planned and the necessary preparations made to ensure that a fierce clean burn is obtained. This will greatly facilitate clearing for ploughing where this is necessary and where ploughing is not necessary, greatly reduces the competition from the indigenous scrub during the initial stages of establishment. Every precaution should be taken to ensure that the burn is confined to the area to be cleared and that the provisions of the Bush Fires Act are rigidly complied with.

Clearing is a local problem.

482. The most satisfactory and economical method of clearing in any locality is a local problem, and instructions regarding the procedure to be followed will be issued for each plantation. When, in clearing an area, it is found that the width of break between the edge of the clearing and standing timber is less than two chains, an extra strip one chain in width must be felled on adjoining country and included in the burn, or bulldozed windrows pushed at least three chains from growing pines. By this means when the adjoining area is cleared the fire will not damage the growing pines.

Firebreaks and green belts to be left when clearing.

483. As the practice is to fell some years in advance of planting, there will be at certain times of the summer two or more sections of planting country awaiting burning. It will be found that in the burning it is difficult to prevent the fire escaping into more recently felled compartments. In order to successfully isolate the fire it will be necessary to clear and plough two one-chain wide firebreaks each separated from the other by three chains of felled country. This intervening strip must be burned at an opportune time taking into consideration the hazard involved. Even when burning is done in winter or spring, it may be necessary to burn at night, but the use of modern fire fighting equipment greatly simplifies such burning. Whenever an area is being cleared adjacent to an established plantation which is old enough to be inflammable, a belt of green standing timber at least five chains in width should be left standing between the pines and the chopdown. This green belt should be burnt at an opportune time and will then form a protective belt between the main chopdown burn and the pines. As soon as the main fire has been put through this protective belt may be felled. It should be burnt up during the winter and early spring when the plantation will be very difficult to light up.

484. The following example of a clearing programme may be useful as a guide to the sequence of operations:— Examples of clearing scheme or plan.

(a) An area of 2,000 acres is to be planted in 1959.

1955: Blackboys, Banksias, Sheoaks, small Eucalypts to be felled or bulldozed as a first operation. When this is completed, the remaining large Eucalypts are felled.

1956: The felled area is allowed to dry out.

1957: After the closing of the Prohibited Burning Period in late March or early April, the final burn should be put through. The major portion of the debris has thus been drying out through two summers.

1957-1958: Except during the Prohibited Burning Period the picking up and final clearing is carried out, and the area made ready for ploughing.

1958: Ploughing can commence as soon as sufficient land has been prepared for the purpose, probably January, 1958.

(b) During this period the final pegging out of compartments is carried out on the ploughed ground. The work of subdivision is thus greatly simplified and the pegs are not ploughed out. During this period also the officer in charge should consider extraction routes and peg these roughly. If this is not done high costs have to be faced, particularly in hilly country 15 to 20 years later, to form extraction roads through compartments. These routes are also valuable during the early years of the plantation for inspection work and fire control. Importance of pegging extraction routes.

(c) **1959:** The ploughing is completed, the planting rows marked out where this is standard practice, and possibly some of the fertiliser applied where this is necessary. During June and July, the area is planted and the balance of any fertiliser required, applied. Ploughing programme.

Thus approximately 4½ years are taken up in the process of conversion from indigenous scrub forest to the established plantation. Four and a half years before planting.

485. It is possible, of course to lengthen the interval during which the clearing is carried out, which is an advantage in some types of country particularly Blackbutt and Jarrah areas where the logs are difficult to dispose of. In pure Bankia country or where there are only a few big trees (Eucalypts) the period can be shortened by a year. Clearing period may be extended on Blackbutt country.

CULTIVATION OF PLANTING AREA

486. On most types of country available to the Department for planting the ground cover consists of a dense growth of woody shrubs which have ramifying and persistent root systems. Experience has shown that the destruction of this indigenous scrub is beneficial to the pines on almost all soil types although not always for the same reasons. It has been found possible to establish pines in the Ludlow district without ploughing. Initial cultivation.

487. North of Ludlow, where the summers are hotter and drier, ploughing must be a very thorough one, a depth of 9in. to 10in. being aimed at. The ploughs engaged on this work are subject to great strain and wear and require constant attention to keep them in good order. Importance of deep ploughing.

PLANTING OPERATIONS

Planting season is limited.

488. **Planting Season.**

(1) South of an East-West line through Bunbury: 1st June to 31st July.

(2) North of an East-West line through Bunbury: 15th June to 31st July.

Officers-in-charge will so organise the work as to complete the planting within the above periods. A great deal of research over a long period of years has resulted in the decision to adhere to these dates and they must be strictly observed. Time of planting experiments are carried out every year at several centres and as time goes on other districts will be tested. However, until we have sufficient evidence to support a departure from the above dates, they must not be departed from without Head Office approval.

Layout of planting area.

489. **Layout of the Planting Site.**—Planting lines will be set out at right angles to some selected baseline, which will normally correspond with one of the boundaries of a compartment. In the exceptional cases where a boundary will not serve, a special baseline must be run, as far as possible, through the centre of the area and should follow the longest axis. Such lines must, of course, be established before the planting gang moves on to the job.

Alignment.

490. Except where subsequent ploughing between the rows is required, straightness of planting lines is not the aim, but some sort of alignment is necessary to ensure that no large "blanks" are left unplanted.

Echelon method of planting.

491. Alignment will be secured by the use of echelon formation:—

With a planting gang of four men working in echelon formation, the relative position of the plants when No. 1 has put in his fifth tree would be as shown in the diagram. The inner flank man (No. 1) will be guided by the last row of pines, and the position for a tree is obtained by estimating the particular spacing distance at right angle from the line of plants or holes on the inner flank and also from the plant or hole just completed.

Importance of echelon method.

492. Unless formation is maintained more or less in echelon, the spacing and consequently the alignment will soon become too irregular. The inner flank man (No. 1) is largely responsible and should, therefore, be the most reliable man in the gang.

Persevere with echelon method.

493. At the beginning of the planting season the use of echelon formation may not secure satisfactory alignment, but this is due to inexperience on the part of the men. With a little further training, satisfactory results can be obtained under the method and overseers must be made to persevere with it.

Training of planters.

494. For the early training of a gang pegs may be erected along the baseline at intervals equal to the spacing distance multiplied by 25. Thus with 6ft. x 6ft. spacing, it would be 150ft. between pegs. From these "interval" pegs, sighting sticks would be set at right angles to the baseline. There would thus be a set of sighting sticks along each twenty-fifth planting line which will provide for correction of the alignment.

Sight sticks not to be used.

495. In most districts some men are employed years after year on planting and consequently the training of men is not difficult after the first season. There is a reluctance on the part of some officers to depart from the procedure of erecting sight sticks for each planting row in an endeavour to secure straight lines. Also echelon formation has been relinquished because the gang has not been adequately trained at the commencement of the season, subsequent supervision has not been exercised to prevent the breaking of the formation through either carelessness or a natural desire on the part of the men to work together, and through continued employment as diggers of men who are incapable of holding their positions.

Spacing of plants.

496. **Spacing.**—This is the distance between trees and between lines of trees.

For *Pinus radiata* spacing will be:—8ft. x 8ft. where no subsequent ploughing is required. To provide for ploughing between the rows, 9ft. x 6ft. if the stumps are small, to 10ft. x 5ft. and 11ft. x 4½ft. if the stumps are large, as in the Karri Belt. South Australian practice involves a reduction to 7ft. x 7ft. and even 6ft. x 6ft. on the higher soil qualities, but in Western Australia any such departure will be a matter for special direction by Head Office.

For *Pinus pinaster*, spacing will be 6ft. x 6ft., unless otherwise directed by Head Office.

Number of plants per acre.

497. The number of plants required per acre for the different spacings are:—

6ft. x 6ft.	=	1,210
8ft. x 4½ft.	=	1,210
7ft. x 7ft.	=	890
8ft. x 6ft.	=	910
11ft. x 4½ft.	=	880
8ft. x 8ft.	=	680
9ft. x 6ft.	=	807

After very little practice no measuring stick of any description will be required, as the position for digging a hole or setting a plant can then be estimated with the requisite degree of accuracy. For the purpose of check measurement it is convenient to mark on the spade or matlock a length equal to the difference between a spacing distance and the length of the spade .

Extraction routes to be left.

498. Where the topography and clearing methods allow provision should be made to miss one row in every two chains of width across a compartment. The main object of this is to give access to fire fighting vehicles prior to the time the plantation receives its first thinning. They may also be used later as log extraction routes (see also reference to this matter under paragraph 484—Example of a Clearing Programme). These access tracks are usually located by the overseer-in-charge of the planting operations, his main consideration being to avoid as many stumps as possible.

PLANTING

Keep the gang together.

499. It is important that the gang must work as a compact group and not allowed to break up irregularly into individuals or pairs. The overseer will estimate the number of plants necessary each day and only approximately that number will be lifted from the nursery or sent out to the planting site. He will spend his time organising and supervising his gang and will carry out very little actual planting himself.

Plant dumps.

500. The placing of dumps must be arranged each day by the overseer as the plants are brought on to the site, so that the planters can conveniently refill their plant carriers without unnecessary walking.

P. pinaster the main species.

501. Planting operations in Western Australia are carried on in two main types of country:—

(a) Littoral sands of the Coastal Plain.

(b) Narrow valleys and laterite covered slopes in the Darling Range and extensions.

Pinus pinaster is the main species planted, for there are only comparatively small areas with soils even rich enough for the satisfactory development of *P. radiata*.

Planting on sandy country.

(a) **Coastal Plain.**—Except on the Tuart sands at Stirling and Ludlow, where a more succulent vegetation occurs, the ground is ploughed to eliminate, or at least reduce to a minimum, the xerophytic woody scrub.

(i) On ploughed land planting is conveniently done in a furrow ploughed along the planting line, preferably at right angles to the original ploughing. This operation is known as "plough lining".

(ii) The planting method will be notch planting, the tree being inserted in a notch made by a standard planting tool driven into the ground and moved backwards and forwards slightly to form a notch about 4in. by 2in. and 12in. to 14in. deep. The seedling is inserted in this notch by the digger, who will shake it sufficiently to ensure a correct vertical disposition of the roots and the notch will be closed by a heavy stamp of the heel and the soil levelled off with the sole of the boot. One heavy stamp is all that is necessary and much light tapping and patting should be avoided.

(iii) The most satisfactory arrangement of the gang appears to be a three-man unit—one of whom is a plant carrier who hands trees to the two planters. A fair day's work planting in this manner is 3,000 trees per three-man gang. A really good gang will plant 3,600 trees per eight-hour day.

Planting on heavier soils and gravel.

(b) **Darling Range.**—Following ploughing on sandy or sandy loam surface soils containing only a slight admixture of gravel, a planting spear or inverted iron cone of about four inches basal diameter and 18 inches in length has been devised for planting in gravel or depressions which are liable to become water-logged in prolonged spells of heavy rain. This tool, which makes a small but deep hole, is used with the same organisation of personnel as for notching with the planting spear on sands. Where ploughing has not been done, a mattock or a spade may be used to open a hole on heavy or stony soils. On very heavy soils, where the breaking of a clod is involved, a small hoe may be necessary for use by the planter in filling the hole with earth, but on light soils anything which will save the fingertips, such as a woodchip, is sufficient.

Important points in planting instructions.

502. **General Planting Instructions.**

(1) Tree should not be planted against Blackboys or Zamia Palms, or too close to stumps which will coppice freely and cover the pines, but the lines should be maintained in at least one direction if possible to aid future extraction.

(2) Dry sand, or other soil, must be avoided by making another hole reasonably close to the rejected spot.

(3) The plants are set in the ground 1½in. deeper than they stood in the nursery. This means the covering of at least ½in. of the needles. This depth has been selected because it will allow a variation by careless planters of 1in. either way without serious harm.

Constant supervision is necessary to prevent planters losing their standards, resulting in settings becoming gradually shallower or deeper.

Depth must be decided from the general level of the soil. A slight heaping around the tree of loose soil which will wash down in the first heavy rains often gives a false appearance of depth.

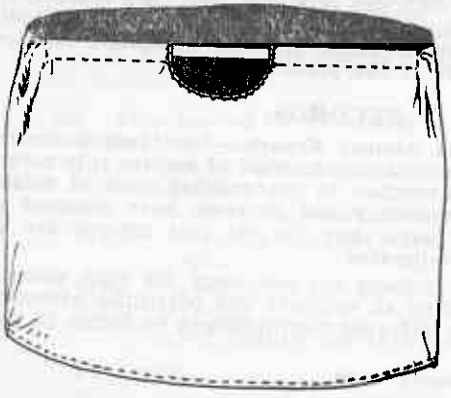
(4) The notches or holes must be deep enough to permit the roots to be disposed more or less vertically without bending.

One-year seedlings will not be root pruned subsequent to lifting. Some long side roots of two-year stock may have to be pruned back to 12in.

(5) Care must be taken to avoid undue drying of the plants, particularly in high wind or on clear sunny days. The total of the exposures to which the roots are subjected in the various operations from lifting to planting under careful supervision has been estimated to amount to two minutes. Without care, exposure may be lengthened while grading, root pruning and actual planting after removal of the trees from the carrier. **Plants must only be taken from the carrier one at a time as required for setting in the ground.**

(6) Methods of packing plants for transport are outlined in paragraph 577—Nursery Practice.

(7) The standard plant carrier is made from a wheat sack. The sack is folded back on itself to exactly half its size and the top sown to the bottom. This produces a sack half the size of a wheat sack and with a double thickness. A slot is then cut in the sack near the mouth and a short piece of stick inserted in little shorter than the width of the bag and about 1in. diameter. This is sewn around to make it a fixture. The bag is carried by placing the hand through the slot and around the stick. The following sketch gives an idea of what is required.



These carrying bags are kept wet by constantly moistening them as needed.

(8) When the plants are delivered to the planting site from the nursery they must be placed in conveniently spaced dumps to be indicated by the overseer-in-charge of the work. The pines still intact in their containers should be placed in a shallow excavation and soil heaped up around them. If the weather is at all sunny the dumps should be shaded with leafy branches. The overseer should see that the roots of the pines in these dumps are kept moist and that when the men are filling their planting bags they do not leave the remaining pines uncovered.

(9) Water must be kept near the dumps at the planting site. This is usually provided in 4-gallon containers used for fire fighting.

(10) A constant check must be made by the overseer-in-charge to see that the prescribed espacement is adhered to. Individual planters vary their standards continually. Closer spacing than that required can greatly increase the cost of planting and over-spacing may result in insufficient stocking of the area.

Machine planting.

503. **Machine Planting.**—The Department is experimenting with the use of tree planting machines. Considerable success has been met with and continuing investigation into the use of these machines is proceeding, and special instructions will be issued to officers supplied with them.

APPLICATION OF ARTIFICIAL FERTILISER AND MINOR ELEMENTS TO PLANTATIONS

Fertilisers to be used only as instructed.

504. Where it has been found essential to apply artificial fertilisers to a plantation to maintain normal growth the type, quantities and method of application will be the subject of instructions from the Conservator. Continuing research is being made into the methods of application and modification of the various implements used.

Zinc sprays

505. Zinc and Phosphate are the two main elements at present in use. Zinc is generally applied in the form of 2½% solution of Zn SO4, an ordinary Ladywood knapsack spray such as is used for fire fighting, being used to apply the solution.

Application of superphosphate.

506. Phosphate is applied in the form of superphosphate or ground phosphate rock. Small areas are generally dressed by hand and large areas with a drill. An H. V. McKay horse-drawn vineyard drill with two runs has been used extensively in the past to apply superphosphate. The two runs are modified to feed into a single outlet and the phosphate trickled along the row of trees at the prescribed rate.

RECORDS

Costing and reports.

507. **Quarterly and Annual Reports.**—Now that extensive planting is again organised at a number of centres it is necessary to pay special attention to the detailed costs of establishment. Labour conditions and all costs have changed so much since pre-war days that the old cost records are of little value now for estimates.

Separate quarterly reports are necessary for each plantation which is covered by an estimate and particular attention must be given to the following item numbers on forms 91 and 92.

Item 23(a) **Nursery work.**

Divide into—

(1) Establishment of nurseries giving area cleared, ploughed, fenced, etc.

(2) Actual cost of raising the stock and cost per 1,000 of stock raised, including cost of manures but not including cost of lifting.

Item 24(a) **Clearing land for planting.**

Keep cost of all work prior to the burning and separate this into steps such as—

(1) cost of original falling and/or bulldozing and cost per acre.

(2) Cost of any other operation prior to the burning such as sucker bashing if the land was left unburnt for some years.

Item 24(b) All operations, including the burning, up to the point where the land is ready for ploughing. Divide this into three steps if possible, such as—

(1) The actual burning.

(2) Crosscutting and heaping of logs if necessary.

(3) Final burning up of heaps and filling of holes.

Item 25(a) **Cultivation.**

Item 26(a) **Planting.**

This should include the cost of lifting and transporting all stock which should be shown as a separate subdivision of this item and including manuring at the time of planting. Species, spacing, serial numbers and areas should be shown in the report and on the plan.

Items 28(a) to (d) **Plantation Firebreaks.**

These are self explanatory but reports must give as much details as possible of the actual area covered, which should be shown on plan, for 28(a) and (b).

Other items.

These, as per form 92, are self-explanatory.

Progress plans required at Head Office.

508. **Progress Plans.**—Plantation plans at a scale of 10 chains to 1in. are kept for all plantations.

These plans must be brought up to date every quarter and are to be forwarded to Head Office immediately after the close of the June quarter in order that areas cleared may be checked for inclusion in the Conservator's Annual Report to Parliament.

The plans will be returned promptly by Head Office and after the completion of planting for the season they should again be forwarded to Head Office with the Annual Planting Report in September—See also paragraph 281. Prompt forwarding of these plans on the dates above mentioned is important in order that Head Office may have the necessary information for reports on the year's operations as a whole. Separate plans are to be kept to show the progress of pruning and thinning.

Plan legend.

509. **Plan Legend for Plantations.**

General.

24(a) Falling or bulldozing in progress—broken blue border.
Falling completed—blue border.

24(b) Burnt and cleared up ready for plough—blue pencil hatch.

25(a) Ploughed—blue wash.

26(a) Planting—show in black ink species, spacing and serial number and area planted.

Firebreaks.

28(a) Construction (in progress)—yellow line border.

28(b) Ploughed—yellow wash.

Annual Report.

510. **Annual Reports.**—An Annual Report is required for each plantation at the close of planting. Costs are normally taken up to the close of the September quarter which is the first pay day in September. This report must summarise the whole of the work for the year and endeavour to arrive at a unit cost for each stage of the operations. Where land is only partly cleared or partly established or firebreaks only partly cleared this must be made clear in the report and a unit cost per acre estimated to complete the job.

Importance of Plantation Register Book.

511. **Register.**

(i) A Compartment Register will be kept for every plantation. This will consist of two stiff covers and a number of loose leaves which may be inserted or withdrawn at will. This is a standard loose leaf register as used by the Accounts Branch and may be obtained by requisitioning to Head Office.

(ii) The officer-in-charge will be responsible for the preparation and regular entering up of this register. The information will be entered under compartment headings.

(iii) The head of the page will carry the compartment number. Under this will be a sketch (not necessarily to scale) of the compartment and on this will be shown the location of species, serial numbers of stock, location of experiments, etc.

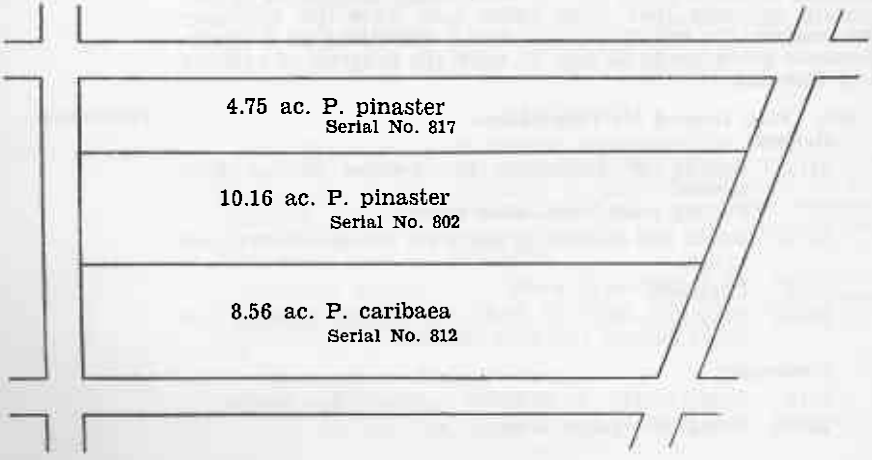
(iv) Written details of species planted, serial numbers of stock, age of planting stock, date of planting, method of soil preparation, method of planting, application of fertiliser, etc. Any information which may later be of value concerning the compartment should be entered.

(v) In later years other pages are inserted and information in connection with the number of trees to "take" after planting (usually expressed as a percentage), the serial number of stock which may be used for refilling, details of any work done on the compartment such as further application of fertiliser, pruning, thinning, etc. This register should form a complete history of all that has happened on each compartment in the plantation.

Sample page of Register.

512. Following is a suggested layout for a specimen page for the initial entries:—

COMPARTMENT 27.



SPECIES—SERIAL NOS.
P. pinaster—Serial 817
P. pinaster—Serial 802
P. caribaea—Serial 812

PLANTING STOCK.
All stock was well developed 1/0 seedings.

DATE OF PLANTING.
14th July, 1951, to 20th July, 1951.

METHOD OF PLANTING.
Planted with Lowther Tree Planter.

SOIL PREPARATION.
Ploughed once about 10in. deep with McKay Sunbow, Plough and Fordson tractor.
Furrows were later ploughed to form planting rows and the pines planted in these.

FERTILISER TREATMENT.
Superphosphate at the rate of 2oz. per tree was applied.

OTHER REMARKS.

PINE NURSERY PRACTICE

Selecting the Site.

513. The ideal site is flat or very gently sloping. Steep slopes are to be avoided if possible as they are difficult to work and easily eroded.

Nursery area required.

514. If at all practicable an area sufficiently large to allow one year's cropping of pines in three should be selected. This enables a programme of rotation of crops to be carried out which will greatly assist in the maintenance of soil fertility. Considerable experimental work in this connection is being carried out at present and results as they become available will be passed on to the Field Staff in the form of amendments and additions to this Manual.

Soils.

515. The most suitable soil is a sandy loam or sand which is easily worked. The heavier soils are generally more fertile but difficult to work. The site should be moist to within a few inches of the surface in the summer time and well drained.

Clearing nursery.

516. The nursery site will be cleared and grubbed to a depth of 12 inches. All timber to a distance of two (2) chains around the boundary of the nursery will be clear-felled. Logs felled on the actual site of the nursery can usually be rolled clear, but some heaping of logs and burning on the site may be found necessary. All small debris, including roots, etc., will be gathered into heaps and burnt. The small debris and rubbish must be disposed of in this way to prevent it being ploughed in, and so remaining an obstacle to the proper cultivation of the seed beds later.

First ploughing of nursery.

517. The area will next be thoroughly ploughed and harrowed. Harrowing is necessary in a new nursery in order to get rid of as many roots as possible. Fencing with a rabbit-proof fence where necessary will be carried out after the ploughing and harrowing is completed.

Note.—If the nursery is established on a slope, a deep trench must be dug on the top side of the nursery to carry off drainage water, and so prevent seed beds getting flooded or water-logged in winter.

First soil preparation.

518. After being harrowed the ground will be dug over with a fork in order to thoroughly loosen and break up the soil. All the smaller roots dug up in the process should be raked together and stacked in heaps for burning. Raking will be carried out in order to reduce the soil to a fine tilth.

Test of a nursery.

519. In a number of instances in recent years nursery operations have been attended with poor results. The tests of the efficiency of the operations are the type of planting stock, the number of plantable stock raised per unit of nursery bed, and the cost per 1,000 plants.

Size of plants.

520. In the case of Cluster Pine the one-year plants should be ideally 12 inches in height with a lower whorl of branches developed while with P. radiata the height should average 12-15 inches, and although no side branches are present, the plants must be sturdy and not spindly and weak.

Seed Supplies.

Seed supplies and records of seeds used.

521. Seed received at the Departmental Seed Store at Head Office is given a separate serial number for the purpose of recording origin, age of seed, etc. It is the invariable practice when despatching the seed from the Departmental Store to tie a label to the outside of the package giving all details of the seed enclosed and to place another label inside with the seed in case the outside label should be lost or destroyed.

522. It is most important that these serial numbers be:—

(a) Recorded in the Local Office files and register. This should be automatic as a letter is sent from Head Office Seed Store with every parcel of seed giving particulars of the seed.

(b) Recorded on pegs on that portion of the planted area on which stock of any one serial number has been planted.

(d) Recorded on the Progress plans, the exact measurements to a known point being given to any change in serial numbers.

Valuable records are obviously lost if these serial numbers are not carefully watched at all stages.

Germination percentage.

523. A germination test is made at Head Office and the germination percentage is recorded on each parcel for the guidance of field officers in deciding the sowing rate per foot of nursery drill. The quantities of seed used will depend in the first place on the germination percentage. See under heading "Sowing the Seed."

Time of sowing.

Time of Sowing.

524. The object of spring sowing of course, was to avoid the costly winter handweedings. It has been found in practice, however, that it is extremely difficult to maintain the original fertility level of our nurseries, and stock is inclined to decrease in size progressively each year. Where such decrease in fertility has occurred, special permission may be given to sow in the autumn about mid-May until new nurseries can be established or the fertility level raised. The aim is to produce fully developed planting stock by the following winter. More recent developments with selective weedicides show promise in reducing costs with autumn sowing.

Red lead to be used.

Red Lead.

525. Coating of the seed with red lead is a necessary precaution against birds and rodents. The seed should be mixed dry in an open tin using 1lb. of red lead per 15lb. of seed. Thorough mixing is necessary to ensure that each seed is well coated with the powder. After germination the seed coats which are pushed up above the ground will still show the red colour.

Preparation of Seed Beds.

Preparation of seed beds.

526. The width of the nursery beds will vary with the slope of the ground. Where the site is reasonably flat the beds may be from 40ft. to 60ft. wide and on steeper grades as narrow as 5ft. or 6ft. The long axis of the beds will be parallel to the contours, the object of this of course, being to reduce the eroding effect of surface water run off.

Fungus necessary for success.

527. In a new nursery it is absolutely essential that the beds be infected with the spores of mycorrhiza-forming fungi before any pine seed is sown. This is best done by collecting soil from another nursery or from under a stand of pines and broadcasting it over the surface of the nursery beds. A good heavy dusting of soil at the rate of about 5 cwt. per acre should be sufficient. The main object is to achieve an even spread over the whole area to be treated if thorough infection in the first year is desired.

Sowing a nursery.

528. Sowing is carried out with the Planet Junior Seed Sower, which is the standard machine in use by the Department.

529. Careful preparation of the soil by repeated raking and rolling is essential to ensure the good tilth which alone will allow an even depth of sowing. The depth at which the front wheel runs regulates the depth of sowing and operation at even depth can be obtained only in a well-worked soil. In very light "fluffy" soils the seed sower should be run over the ground twice, the first time without sowing seed to compact the soil in which the drill is to be opened.

Digging unnecessary.

530. Hand-digging of the beds is unnecessary, sufficient cultivation being obtainable by ploughing and harrowing.

Making a roller.

531. A suitable roller can be constructed from a well-shaped log of 4ft. in girth.

Fertilisers.

Nursery fertilisers.

532. The soils of our nurseries for the most part are podsols with leached surface horizons of a light sandy nature, and subsoils of varying retentiveness. These are extremely low in the recognised plant nutrients. The necessity for the addition of manure for the building up and maintenance of soil fertility was early shown. Unfortunately artificial fertilisers have not been helpful. Stable manure proved highly beneficial when used on the deep sands at rates varying between fifty (50) and ninety (90) tons per acre, but was not available in sufficient quantity for general application and created a serious weed problem unless very thoroughly rotted in advance. Experiments with composts of a variety of organic materials and sewerage sludge are being persevered with.

Nursery crop rotation.

533. It is now considered that the main problem in maintaining a reasonable fertility level in our nurseries hinges around the preservation of sufficient organic matter in the soil. By increasing the size of our nurseries and working them on a rotation of two or three years with nitrogenous green crops, it is hoped to achieve this. Some success has already been obtained in this connection and the problem is still being studied. As additional information is obtained on the matter, further instructions will be issued from time to time.

Setting the Planet Junior.

The Plantet Junior.

534. The gauge on the side of the tank should be set at approximately "spinach" for P. radiata and "beet" for P. pinaster. These settings are, however, approximate only and will need to be varied for any one species from year to year owing to differences in size of seed.

Sowing rate.

535. The sowing rate should be 24 viable seeds per foot of nursery line and consequently the actual number of seeds sown will depend upon the germination percentage. The sowing rate should be tested on a tent fly, board floor or other hard surface by running the drill over it and then counting the actual number of seeds dropped per foot of travel. This is done several times until the correct rate is obtained.

Trip gear.

536. The trip arrangement which permits the machine to sow at regular intervals instead of in a constant stream must not be allowed to operate. This should be prevented by lifting the throw-out provided and then jamming it with a wooden wedge. The four-spoked wheel should not be dismantled as the rotation of this wheel is the indication that the agitator in the bottom of the seed hopper is in operation.

Seed sower.

537. The seed sower should throw out of gear when the back wheel is lifted off the ground at the end of a line.

Depth of sowing

538. The small furrower should be set according to the type of soil involved. If the front wheel is sinking to a depth of nearly one inch in soft ground, the share should be raised as high as possible. On well worked and firm soil the furrower may be lowered from one to three notches. The coverers are adjustable similarly to three different heights.

Sowing the Seed.

Depth of furrow. required.

539. Seed should be sown to a depth which will allow it to be covered with a thickness of soil equal to the diameter of the seed itself. The depth of the drill should be equal to twice the diameter of the seed measured across its smallest dimension, that is a depth of $\frac{3}{8}$in. for *P. Pinaster* and $\frac{1}{4}$in. for *P. radiata*. In order to provide for unevenness in nursery soil when using the Planet Junior the depth of the drill should be increased to a maximum of $\frac{1}{2}$in. to ensure the seed remains completely covered after the first heavy rain. Too great a depth in sowing is a very common fault.

Rates of sowing.

540. The operator of the Planet Junior must be careful that he walks with his feet parallel to the seed drills so that no part of the drill is trampled upon. The walking rate should be approximately two miles per hour and an even rate must be maintained throughout.

Thinning.

541. The first drill is sown on a line but subsequent use of the line is unnecessary because of the automatic marker provided. In very wide beds an occasional resetting with a line will help in the maintenance of the straight drills which facilitate weeding.

542. Seeds of P. radiata number about 15,500 per lb. and P. pinaster 8,500 per lb.

Spacing.

543. The distance between drills should be fourteen inches (14in.) from centre to centre. The germination percentage is always given with each parcel of seed sent out from Head Office, and the number of seeds to be sown per foot of nursery line can then be calculated. The aim is to produce 18 good plants to each foot and to achieve this and allow for losses by birds and fungi, 24 viable seeds per foot of line should be sown. Thus with *Pinus pinaster* seed giving a 50% germination, 48 seeds per foot of nursery line would require to be sown.

First nursery weeding.

Weeding.

544. Two weeks after sowing, that is approximately one week before germination, annual weeds which germinate before the pine seed should be burnt off with a Hauck Kerosene Torch or Fire-gun. An obvious green cover of weeds should

not be awaited before burning off. Most of the green growth appearing shortly after sowing is from shoots of perennials. Two weeks after sowing a close examination is necessary to detect certain species of weeds developing from seed.

Torch maintenance.

545. In the maintenance of the torches, attention to washers on the pump plunger and on the filler cap is necessary. Footprints must not be used on the brass nuts and bolt heads which should be handled only with well fitting spanners. The pressure gauges do not remain accurate over a long period of years, and the maintenance of the pressure at 50-60lb. is required with some torches. Full instructions for use and maintenance of the kerosene torch are given in paragraph 560 of the Manual.

Oil weedicides.

546. While the hand torch has been used in the past, the use of special selective mineral oil weedicides gives promise of success and promises to be a much cheaper method of weeding. Instructions on the use of these weedicides will be sent out by Head Office at a future date.

Hand weeding.

547. For subsequent weeding, hand picking is necessary along the seed drills, but weeding between the rows will be done by Planet Junior fitted with special skim hoe attachments. The Planet Junior with harrow attachment will be run between the rows after every rain in summer or whenever the surface becomes caked.

Paths.

548. Paths within and immediately around a nursery must be kept clean by spading and hoeing.

Weed killers.

549. Because of the susceptibility of young pine seedlings to the toxic action of many arsenical preparations, the use of chemical weed-killers on paths has not been encouraged.

Damping-Off.

Damping off.

550. "Damping-off" is caused by fungus attack. Members of more than one genus may be responsible. *Phytophora omnivora* is one of the best known throughout the world. The presence of the disease which occurs during early germination may be indicated by a dark discoloration from dark green to black occurring on the cotyledons and stem. Should the attack be confined to the tips of the plant this may recover, but if the lower part of the stem is affected, the plant usually withers, assumes a reddish brown colour and dies without any mechanical injury being observable. Germinating plants may be attacked and die before they appear above the ground. This is known as pre-emergence damping-off and when it is known to occur the seed should be treated with one of the organic compounds of mercury, which will be supplied on requisition, by Head Office.

Attacks under damp conditions.

551. Attacks usually occur in wet weather, or on ill-drained soil. The influence of rain and shade is to favour the disease. Spread occurs through the fungus growing from plant to plant, but can be greatly accelerated by the action of man in walking about an infected nursery.

552. Seed beds on which infestation has occurred should not be used in the succeeding year if the attack has been severe. The seed beds suspected of liability to the disease should be inspected daily in early germination.

Cheshunt Mixture.

553. When any sign of "damping-off" occurs, a preparation known as Cheshunt Mixture is applied to the beds. This may be obtained at short notice by telephoning Research Branch, at Head Office. Procedure in preparing the mixture is as follows:—

(1) 8oz. of Bluestone in as finely divided a condition as possible.

(2) 44oz. of Rock Ammonia (ammonia carbonate) in a crushed condition. The rock ammonia must be fresh and should be stored in a tightly stoppered jar to prevent deterioration.

(3) The above two chemicals must be crushed separately and the powders mixed. On mixing they should be placed in an airtight glass jar and held at least 24 hours, during which some chemical action takes place. At the end of 24 hours the mixed powder can be taken out as required and, provided the glass jar is kept well stoppered, will last for a considerable time.

(4) The mixed powder is made up in solution at the rate of one ounce to two gallons of water. Hot water is preferable to increase solubility. The water should be allowed to cool and the solution applied through a watering can. Definite information about the volume necessary to the square foot is not available but it is understood that a moderately heavy watering is necessary.

(5) The watering can to be used should be coated with pitch or tar and allowed to dry, as the solution will attack the iron of the can. If it is not possible to line a watering can for the first application, care should be taken that the solution is not allowed to stand in the can for any length of time, as its chemical constitution is thereby altered. This would also render it inadvisable to dissolve the mixture in hot water in a galvanised container.

(6) The strength given should not affect the tops of the seedling pines provided it is applied in the cool of the afternoon. The whole of the nursery beds showing any sign of infection should be treated as it is a preventative and not a cure for the disease.

Cut worms.

554. **Cut Worms.**

(i) Cut worms are larvae of the cut-worm moths of which the genus Agrotis has world-wide distribution. The caterpillars in the metropolitan district are dull grey to greenish naked grubs of uniform thickness, about one inch long when fully grown and having eight pairs of legs. They are first seen when somewhat less than one-quarter of an inch in length. They feed nearly always at night, concealing themselves in the ground by day.

(ii) Water soluble D.D.T. has been found to give a very effective control over this pest. This may be obtained upon requisition to Head Office and instructions for use are usually printed on the tin.

Lifting the pines.

555. **Lifting.**

(a) **Heavy Soils.**—In lifting plants from the nursery lines, a trench is first dug along the outer row of pines and plants in this row are thrown forward into this trench by the movement of a spade inserted on the opposite side of the row. Before digging the trench the spade is inserted to its full depth vertically along the face of the row and about two inches distant from it to cut the lateral roots on that side so that the plants will not be pulled and displaced in excavating the trench. This spade which must be kept very sharp is inserted to cut the tap-roots at 9in. to 10in. below the surface. A 12in. spade inserted at the natural angle for use, that is about 22° and 4in. from the plant, will cut the vertical root system 10in. below the surface. The roots of a few trees will be cut short as they do

not all grow straight down. The plants are removed by breaking the clods of earth between the hands and separating the roots.

(b) **Light Soils.**—The operation of lifting in light sandy soils may be simplified without adversely affecting the plants in any way. Trenching is unnecessary. The spade should be inserted along the face of the row as before. A slight lift should then be made by applying light outward pressure to the spade handle. On withdrawing the spade, insert it in a similar manner on the other side, then exert sufficient pressure on the handle to raise the plants and accompanying soil to a convenient position for separating by hand.

Faults in lifting.

556. The common faults in lifting are:—

(1) Failure to keep the spades very sharp.
(2) Failure to cut the roots as directed.
(3) Failure to displace the plants sufficiently far into the trench to prevent their being under-wrenched.
(4) Undue exposure of the roots while grading and pruning.

After elimination of the rejects, the trees are covered loosely with earth until a sufficient number is accumulated for packing. The packing procedure is as follows:—

Packing Procedure.

Packing the pines for long distance transport.

557. Wheat bags are used for this purpose and are cut down one side (Fig. 1). They are then soaked in a drum of water for about 48 hours so that they become thoroughly wetted. The best method of packing pines in the bags is as follows:—

(a) **Small Plants** (i.e., with under 15in. top)—

(i) The wet bag is laid flat and a layer of packing 2in. deep, usually of rotted pine needles, grass, straw, rushes, etc., is spread evenly inside. The seedlings are laid on the packing for half the length of the bag with the ends of the roots just touching the uncut side and the tops protruding from the open side (Fig. 2). They are finally covered with a layer of packing which is placed well around the roots. The bag is then stood upright (Fig. 3a). One side of the bag is tucked firmly around the plants as shown (Fig. 3b), and the bundle is rolled tightly (Fig. 3c). A much tighter pack is obtained by kneeling on the bundle in the process.

(ii) The loose flap is then fastened around with two wire "S" hooks (Fig. 3d).

Packing for local transport.

(iii) When packing pines for transport from a local nursery to a planting site, so much care is not necessary. The bags should be thoroughly wetted, but no packing is required and after rolling, the loose flap, instead of being sewn, is adequately secured by a small wire hook.

(iv) The bundles should be watered from the top before despatch and it is advisable where large plants are concerned to secure the tops by binding with twine.

Packing large plants.

(b) **Large Plants** (i.e., with over 15in. tops).—The bag is split down one side and across the bottom as shown in Fig. 1, and then laid out flat. One corner is folded in to a depth of 21in. when using plants with 2ft. tops. The plants are then laid on the bag clear of the fold and at right angles to the diagonal formed by it so that only about one-third of their length protrudes (see Fig. 2).

558. When the required number of plants have been obtained, earth or packing is placed over the roots, the end "A" is tucked over the trees and the bundle rolled tightly towards "C" (see Fig. 3). At an appropriate point in this process, the end "B" is brought up over the roots and tucked in as shown in Fig. 4, the rolling then being completed. To secure the bundle, the flat "C" is sewn for long distance transport, or hooked for despatch to a nearby plantation. The reason for folding in the corner is that for a bundle of 9in. diameter which is about the usual size, the diagonal formed will completely encircle the bundle and produce a tight pack.

Numbers in bundles.

559. When smaller plants are used, a larger number can be packed in the same manner by increasing the size of the first fold to conform with the limits of the bag. Bundles usually contain about 500 small trees, 300 12in. to 15in. trees, or as few as 100 big two-year Pinus radiata plants.

Bundling of Large Plants

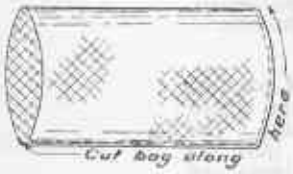
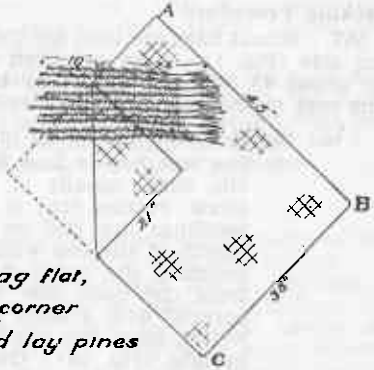
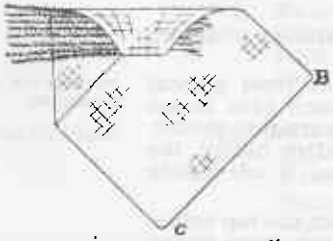


Fig. 1



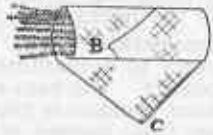
Lay bag flat, fold corner and lay pines

Fig 2



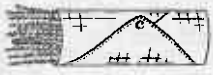
Tuck A over and roll as shown

Fig 3



Fold in end B and continue rolling

Fig 4



Sew flap C

Fig 5

BUNDLING OF SMALL PLANTS

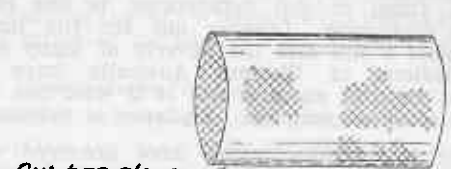


FIG 1

FIG 2

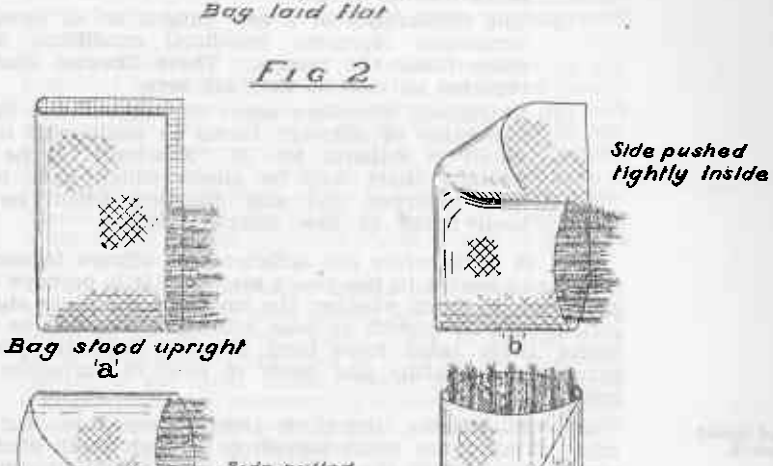


FIG 3

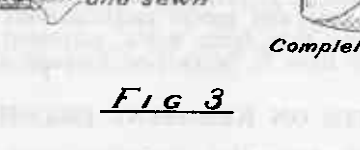


FIG 4

PLANTATION PROTECTION

Detection of forest enemies.

560. Early detection of forest enemies, be they men, animals, insects, fungi or soil deficiencies, is one of the axioms of forest protection. Leaving out for the moment the man who lights a fire and the poverty of many of our soils, the plantations of Western Australia have been relatively free of natural enemies but it is wise not to be lulled to a false sense of security. Vigilance is necessary.

Plantation losses.

561. In Western Australia, cases have occurred where rabbits and marsupials have cost large sums by their attacks. "Damping-off" has spoilt a year's planting. Lack of knowledge of soil problems has resulted in failed areas.

Insects.

562. Although it has not occurred in Western Australia, insect attack has ruined plantations in parts of the world and new insects if not discovered early could seriously damage our plantations. A plantation of a new species in itself alter the balance of nature and is therefore subject itself to an attack by a new enemy whose natural enemies are not living in the area.

Report unusual occurrences.

563. Officers in charge of plantations have, apart from man, three main factors to seek—

(a) Birds, insects, rabbits, marsupials and other animals. Should any increase in numbers or any new species be seen, the facts should be reported promptly to Head Office.

(b) The appearance of a new fungus or an insect may sometimes represent beneficial conditions and at other times the reverse. These likewise, should be reported as soon as they are seen.

(c) Nutritional disorders occur throughout the State in a number of different forms as dealt with in more detail in Bulletin No. 30, "Nutrition of the Pine." Possibly there may be others which have not yet been recorded and also disorders which have not been noted in new compartments.

564. It is therefore not sufficient for officers to count the number of deaths in the year's planting; it is perhaps equally important to study whether the leaves of the pines show any serious lack of growth or poor colour. Cases can be quoted where 100% takes have been obtained but the pines are extremely unhealthy and badly in need of corrective treatment.

Note and report poor growth.

565. All officers, therefore, should keep these factors in mind at all times when travelling through their plantations and particularly in the early years when nutritional disorders first manifest themselves. It is important of course not to overlook ordinary failures in technique and operations. Failure to note and report establishment losses in any year may prevent this from being corrected in time and the failure may have to be carried through a rotation.

NOTES ON KEROSENE PRESSURE TORCH

Description.

General Description.

566. The torch consists primarily of a metal tank with the necessary fittings to enable it to be carried on the back knapsack fashion. To this tank are fitted a pump for maintaining pressure in the tank, a pressure gauge, and a filler cap which is also designed to form a pressure release. A length of rubber hose connects the flame projector to the tank. A stop valve is fitted at the tank end of the hose, and another at the projector end. The projector is so designed that the kerosene,

before finally leaving the jet, passes through a coil of copper tubing surrounding the flame and is highly vaporised. A filter is built into the projector, and all sediment is thus prevented from reaching the jet. A conveniently placed handle is attached to the projector for carrying and directing purposes.

567. **Instructions for Use.** How to use.

(1) Turn off the two stop cocks or valves.

(2) Fill the tank from two-thirds to three-quarters full of kerosene and screw filler cap down tightly. Hand pressure is sufficient, as, if a wrench is used, the rubber washer under the cap is quickly ruined.

(3) Pump the tank up to a 40 lb. pressure.

(4) Open the valve at the tank end of the hose.

(5) Slightly open the valve on the projector and run about one-quarter of an inch of kerosene into the little tray under the burner and then turn off. Place a small piece of rag, bagging, binder twine, bark or other material in the tray to act as a wick and light. Allow to burn for four or five minutes, when the coil should be thoroughly heated, and then open the valve on the projector about one-eighth of an inch. Should kerosene run through, the coil is not yet hot enough to vaporise the kerosene. Allow the coil to heat until, when the valve is opened on the projector, the kerosene vapour spurts out in the form of a roaring blueish-white flame about 15in. long. The torch is then ready for use.

(6) It should only be necessary to open the valve on the projector very slightly to obtain the maximum intensity of flame, not more than one-eighth of an inch movement of the wheel forming the handle of the valve usually being found all that is required. To open further than this is merely to waste kerosene, and, if the torch will not burn properly unless a much wider opening is given, there is bound to be an obstruction in some part of the projector which should be cleaned out.

Two gallons of kerosene should last three hours.

(7) The pressure in the tank should not be allowed to fall below 20 lb. per square inch. This, of course, may easily be checked from time to time by the guage on the top of the tank. Some types of gauge fitted have a stop which it is necessary to release before the true pressure in the tank may be read. It is not advisable to pump over a 40 lb. pressure.

(8) When operating the projector should not be pointed into a strong wind.

(9) To shut off the flame tightly close the valve on the projector. If the torch is to be put away for a lengthy period, empty all kerosene out of the tank and thoroughly drain the hose.

Adjustment of the Projector. Adjusting projector.

568. Practically every failure of this torch to function properly can be traced to the projector.

The two most vulnerable points are the jet and the gauze strainer.

If the flame burns fitfully, either the jet is obstructed or the pressure in the tank is low. A small wire pricker is supplied for removing loose obstructions from the jet, and should always be carried when using the torch. The remedy for the latter is obvious.

When it is necessary to open the valve on the projector very considerably to obtain a good flame, and pricking the jet does not remedy the trouble, it may be taken for granted that either the gauze strainer is choked with dirt or rusty water, or a carbon deposit has formed behind the jet. The gauze is easily removed for cleaning. To remove the carbon deposit from behind the jet, this latter must be screwed out and the deposit chipped or scraped out with a piece of wire. This deposit usually adheres to the jet holder which connects the jet to the heating coil and is quite easily removed.

TENDING PLANTATIONS

General note.

569. In most centres where planting is likely to be done in future under the Pine Plantation Working Plan, our establishment methods are such that "sucker bashing" or more correctly "coppice slashing" is the main item to be considered for the first few years under the heading of "Tending".

570. In certain circumstances, however, work such as soil drainage, subsequent cultivation and "subsequent manuring" may appear necessary. In such cases the officer in charge should report to Head Office. This work will not be undertaken without the approval of the Conservator.

Diseases and lack of vigour.

571. Officers in charge of young plantations are required to make frequent inspections of the pines with a view to reporting the commencement of any signs of insect attack, disease, or lack of vigour. Soil problems such as washing down of soil, or drainage problems, should also be noted. "Thumb pruning" is not adopted as a practice in young stands but it is sound practice for all officers and overseers to thumb prune odd trees in the first few years when inspecting or travelling through young plantations on foot.

Sucker bashing to be kept up to date.

572. The destruction of indigenous scrub by slashing should not be necessary with the exception of the "bashing" of strong growing eucalypt suckers. It is important that suckers be kept down below the canopy of the pines at all stages of the plantation and officers concerned must make provision for this work where necessary on each year's estimates.

Method of sucker bashing.

573. Experience has shown that young suckers are best discouraged from vigorous shooting by being broken about one foot above the stump. The more the shoot is broken or twisted the less is the vigour of the subsequent shoot. Pulling suckers off a stump usually permits of vigorous new shoots growing from the original stump.

574. The practice to be followed in sucker bashing, therefore, is to use a slasher on small suckers and slash at about one foot above ground or stump level. Where suckers have reached a size necessitating the use of an axe they should be fallen at a point about one foot above the ground and allowed to split down below the cut in falling rather than being cut cleanly through.

Second sucker bashing.

575. On some areas a second sucker bashing is necessary at the time of pruning. This work should be done by a separate man or men while the pruning is in progress and should not be left over to be done as a later operation. Overtopping suckers from this stage onwards have a most serious effect on the form and growth rate of the pines.

Mallet plantations.

576. In mallet plantations, due to the variation which occurs in the number of stems per acre, the bashing of Wandoo suckers and other indigenous shoots cannot be set down as a routine work and must be determined for each compartment by the D.F.O. and a prescription decided upon before the work in any compartment is undertaken.

PINE PRUNING

577. Officers responsible for pruning in pine plantations must appreciate that the expenditure of money on this work is an investment which should bear interest reflected in higher future royalties for clean timber. While the low pruning of trees to 6ft. or 8ft. may be justified as a fire protection and access measure, pruning above this height must have economic justification. Pruning is an investment.

578. The work of pruning therefore requires the close supervision of the D.F.O. Supervision by D.F.O.

579. Generally speaking, the first pruning is carried out when limbs are dead or dying to about 8ft. and the trees at this stage, with our normal spacing, are between 25ft. and 35ft. high. Green pruning may in special cases be approved by the Conservator. First pruning.

580. At this stage, with a stocking of 700 or more, there are up to 20 or more per cent., depending on spacing, of trees which have become dominated or nearly suppressed, and which will not make a mill log of 4in. O.B. diameter at the small end, at the first thinning. It is therefore a partial waste of money to prune these trees. Many of them will in any case die before the first thinning and it is preferable for the overseer when working with the gang to spend his time cutting these down if they are no longer needed for canopy. Supervision by an officer at this stage is of course essential as a rule of thumb direction to cut down all trees below 3in. D.B.H. will, in places, result in small areas of stunted growth being clear felled. Removal of suppressed trees.

581. In the course of the first pruning a number of trees showing forks within 8ft. of the ground are found, but generally speaking it is uneconomical to prune off one of the forks at this stage for the simple reason that when the first thinning takes place the stand will be reduced to 400 or less per acre and the forked tree is almost certain to be one of those to be taken out. Thus, unless the forked tree is in a large opening there is no point in trimming it during the first pruning as it is not likely to become a final crop tree. Forked trees.

582. Commencing with 700 or more trees per acre it must be borne in mind that the first thinning when they have reached the height of 60 feet for *P. radiata* or 40 feet for *P. pinaster* reduces these approximately by half and the subsequent thinnings will reduce the stand to 200 or less before it is finally felled. High pruning therefore, which is an expensive operation, is warranted only on those trees which are fairly certain to remain standing for the whole of the rotation and should as a general practice be confined to not more than 100 trees per acre and also to areas of first quality growth. High pruning.

583. (i) During the first pruning it is desirable for the overseer, by means of an axe and perhaps a short ladder, to carry out a limited amount of higher pruning to give approximately 15ft. clear bole on the best trees not exceeding 50 per acre at this stage. Work of overseer.

(ii) It is found that this work, in addition to providing clear timber, enables the tree marker at a subsequent date to carry out his tree marking much more expeditiously and results in some first class peeler logs of high value being available in the future.

584. (i) With large trees awaiting first pruning, and limited funds, it is necessary for each officer concerned with the plantations to be provided with a plantation type map in order that he may confine his pruning to those areas of high quality. In many cases a photo mosaic can be supplied. Low quality areas to be left.

(ii) The pruning of areas of low quality is of very doubtful value as owing to the slow rate of growth and the comparatively small ultimate diameter of the trees, the amount of clean wood put on will be very much less for the same expenditure than that put on, on areas of good quality. In addition these low quality areas are not thinned (see chapter on thinning) and the limbs will largely die off and disappear without pruning by the time the area is to be clear felled.

Selection of trees for high pruning.

585. Similarly, when money is spent on high pruning, it is better to concentrate on those crop trees which require the least amount of work to produce an extra length of knot-free wood and to avoid pruning those trees which are found to have closely spaced whorls of heavy branches even though they may be final crop trees.

Financial returns from pruning.

586. It must be kept in mind that the high pruning of any tree which is to be taken out within 10 years of the time of pruning is unlikely to have any effect on the price obtained for the timber. The amount of clear timber put on in that 10 years is not likely to exceed an average of 2in. on the radius and a proportion of this clear timber is lost in squaring up the log. In the case of low pruning, money spent on trees which will not produce a mill log at the first thinning is mostly wasted. Money spent on low pruning of trees which do produce a mill log at first thinning is at least partly recovered at the time of that thinning by virtue of the fact that the tree must be pruned or at least part-pruned before or after felling.

Pruning of green branches.

587. Green branches are not pruned except in special cases although partly dead branches may be taken off in the case of high pruning to produce special timber. The branches of edge trees round compartments are not normally pruned, although there is no objection to this being done on southern aspects; and in later years, in the case of P. pinaster, where the lower branches die even on the edge trees, they may be removed.

Picking up of prunings not necessary.

588. In some metropolitan plantations, picking up of prunings and stacking in debris rows has been approved as a fire protection measure. The cost of this work is not considered warranted except in special cases round the edges of those plantations where there is an excessive danger from fires from outside. Within the plantation, it is found that after the first pruning there appears to be a formidable amount of debris but in two or three years the whole of this subsides leaving a comparatively clean floor apart from a few easily broken sticks. Moreover, the expenditure on picking up after the first pruning provides only a very temporary advantage as the first thinning follows a few years later and places on the ground considerably more debris than results from the first pruning. Picking up and stacking of prunings therefore should not be undertaken without Head Office approval.

Organising pruning gang.

589. It is found in practice that men work better when following the rows right through a compartment as opposed to working aimlessly in a circle or on an area. This practice, therefore, is to give each member of a gang one or two rows on which to work while the overseer carrying an axe, chops down trees too small for pruning, cuts branches too heavy for the pruners without axes, and does odd special trees as high as he can reach. This system also facilitates checking of areas completed.

If the gang is over four men, it may be found, depending on the stand, desirable to have an additional reliable man with an axe to assist the overseer's work.

Pruning tools.

590. Throughout the world considerable attention has been paid to pruning tools including the axe, saw, mallet, chisel, shears, heavy machete, bill hook and power circular saw. The

effectiveness of a tool depends upon the species being dealt with and the spacing, or size of branches, as well as the labour factor. In Western Australia we are primarily concerned with two species only, P. pinaster and P. radiata. For low pruning the Department uses the hand saw unless the men concerned are skilled axemen, when with the Regional Officer's approval, axe pruning is authorised. "Bashing" of branches with a "mallet" or "bat" is found effective with P. Canariensis and in some areas of P. pinaster and may be authorised by a Regional Officer. Shears may be used when available. Power pruning is expected to be developed in the future.

591. For high pruning, long handled saws are used. A 6ft. handle allows pruning to 13ft. giving usually 15ft. to 18ft. of clear bole. Except under Head Office instructions for special conditions, the Department does not prune higher than this. Saws for high pruning have been found more effective when made with more curve and fewer teeth per inch than the standard saws for low pruning. Requisitions should state whether saws are for high or low pruning.

Setting out and measuring work done.

592. When pruning of a compartment is to be undertaken it is the practice to prune paths in advance at approximately one chain intervals following the rows. As the pruner works he throws the branches clear of the path. The advantages of this operation are as follows:—

(a) Measuring up of areas completed, for costing and record purposes, is facilitated.

Path pruning.

(b) The paths are of value in fire control, inspection work and assessments.

(c) They are of assistance to the tree marker at a later date when marking for the first thinning.

(d) When pruning is put on a piecework basis they are essential for proper inspection of work done and fixing of coupes and prices. In a normal stand the cost of this work is not a serious addition to the overall cost.

Pruning of paths in low quality areas.

593. Officers responsible for pruning programmes will meet cases where due to irregular planting, rocky areas, dense undergrowth in poor quality stands, paths are not practicable. This, however, is the exception rather than the rule and in such cases the question of paths must be referred to the D.F.O. In any case such areas are not suitable for piecework operations due to the extreme difficulty in setting a price.

THINNING PRACTICE

Canopy and spacing.

594. As all foresters know, considerable importance is attached to the closing of canopy in our plantations of *P. radiata* and *P. pinaster*. That is to say, reaching a stage where the lower limbs die, all scrub is killed and a carpet of needles covers the forest floor. The spacings of 6ft. x 6ft. for *P. pinaster* and 8ft. x 8ft. for *P. radiata* ensures the closing of canopy at about 7 to 10 years depending on the site. It also results in the lower limbs dying at ½in. to 1in. diameter as opposed to 2in. or upwards with wider spacings, and gives sufficient trees per acre to enable the selection of good form crop trees. These spacings adopted in W.A. are based upon these reasons and other economic considerations.

Working plans.

595. Our plantations have at a number of centres reached the stage of providing a permanent output of thinnings and small sawmills are being kept in production by this output. As each plantation reaches the age when a thinning programme is desirable, the D.F.O. concerned is required to draw up working plan proposals, giving the order of thinning by compartments, with the object of determining the sustained

yield and programme for the plantation. Normally this plan should cover 10 years, inclusive of any areas of poor pine which may be listed for clear felling for conversion to other species. Practically all plantations are covered by recent air photos which are used to map the stands into quality classes. This work is done at Head Office if necessary by the use of the sterescope and multiscope and then checked in the field. In most cases the use of a mosaic eliminates the necessity for this work. The use of the photos obviates the necessity to run assessment lines at close intervals as had to be done in the past.

Assessment of quality classes.

Definition of classes.

596. Quality classes adopted for stands up to 25 years of age and plan colourings adopted are as follows:—

Quality classes P. radiata.

597. **Quality Classes and Stocking (P. radiata).**

Class.

(a) 4ft. or over per annum height growth and pines of good colour—blue on plan.

(b) 3ft. to 4ft. (or over) per annum but pines spindly lacking canopy and of poor colour—red on plan.

(c) Less than 3ft. growth per annum—green on plan.

(d) Stagnant Barren or failed patches—uncoloured on plan.

(AA) Class is used to mark special quality areas of over 5ft. per annum height growth.

Subdivision of Classes.

Stocking 1—Over 500 trees per acre.
2—400 to 500 trees per acre.
3—Under 400 trees per acre.

Quality classes P. pinaster.

598. **Quality Class and Stocking (P. pinaster).**

Class.

(a) Over 2ft. per year height growth—good colour, vigorous—coloured blue on plan.

(b) Over 2ft. per year height growth—poor colour, vigour doubtful—red on plan.

(c) 1ft. to 2ft. per year height growth—good colour, vigorous—coloured red hatched on plan. (This quality is usually confined to poor strains.)

(d) 1ft. to 2ft. per year height growth—poor colour, lack vigour—coloured green on plan.

(e) Less than 1ft. per year height and failed areas—uncoloured.

Class (AA) is used to mark special quality areas of over 3ft. height growth per year.

Subdivision of Classes.

(1) Stocking above 600 per acre.

(2) Stocking above 400-600 per acre.

(3) Stocking under 400 per acre.

(4) Stocking under 300 per acre.

F.A.Q. pine.

599. With both *P. pinaster* and *P. radiata* classes (AA) + A only are called F.A.Q. and considered as suitable for thinning. Classes B downwards have as a rule not formed complete canopy and will not be thinned without special instructions from Head Office. Class (C) in *P. pinaster* may be found to be an exception.

Calculation of yield.

600. After completion of the quality class map, the area of Fair Average Quality pine (F.A.Q.) in each compartment is estimated or taken out by planimeter. This area of known age, quality and stocking, is then recorded as to be thinned at a certain date. The guiding factor in fixing the date for

thinning is 60ft. height for co-dominants in F.A.Q. *P. radiata* and 40ft. height for co-dominants in F.A.Q. *P. pinaster*. These heights having been adopted in W.A. as representing the stage at which an economic return can be expected. Height rather than age is adopted in this State due to the wide variation in growth on different sites. If thinning is delayed beyond these heights the form of the final stand will suffer and if done prior to this stage a reduced yield of thinnings per acre is obtained. Any future change in economic conditions may effect this decision and the heights given, therefore, are simply a guide on which to base calculations. After arriving at the areas of F.A.Q. pine available for thinning and their stocking, an estimate of thinnings is made by taking one-tenth acre plots within the different classes and estimating the thinnings per acre available, using the grade of thinning approved by the Conservator and the crown diameter over bark which it is anticipated can be sold from the plantation concerned.

Thinning age or height.

Sample plots necessary.

601. The thinning "grades" (or standards) and the canopy classes adopted by the Department are those of the British Forestry Commission as follows:—

Thinning grades and Crown classifications.

THINNING GRADES DESCRIPTION

602. With the object of describing and classifying the thinnings actually required the thinning grades adopted by the Department are:—

Thinning grades.

(1) Low Thinning:

B Grade. Light thinning.

Remove classes 6, 5, 4, 3(b), 2(d) and 1(d):

This means that of the Dominants and Co-dominants, only the whips are removed.

C1 Grade. Moderately heavy thinning.

Remove classes 6, 5, 4, 2(d) and 1(d) and gradually all trees of classes 3, 2(c) and 2(b) and part of classes 2(a) and 1(c). This means the removal of some of the better form of Co-dominants, and the most defective of the Dominants.

C2 Grade. Heavy thinning.

Remove classes 6, 5, 4, 2(d) and 1(d) and gradually trees of classes 3, 2, 1(c) and 1(b) and part of class 1(a).

This means that only the good Dominants remain, except that where the removal of the Dominants would make a hole in the canopy, suitable suppressed or backward trees should be left to cover the soil.

(2) Crown Thinning:

D Grade. Light thinning in the Dominant crop.

Remove classes 6, 5, 2(d), 1(d), part of 2(a), 2(b), 2(c) and 1(b), a great part of 1(c) and also some stems of 1(a).

The suppressed and subdominant trees are untouched.

E Grade. Heavy thinning in the Dominant crop.

Remove classes 6, 5, and many stems from classes 2 and 1.

Again the suppressed and subdominant trees are untouched.

Tree classifications.

603. In the tree classification the canopy classes are:—

(1) Dominant—above the general levels of the canopy.

(2) Co-dominant—a tree which has its crown in the general canopy level and is in competition with its fellows.

(3) Sub-dominants—lower than the general canopy level, but with free space above it.

(4) Dominated—not forming part of the upper canopy. These are dominated trees of which the leading shoots are more or less free.

(5) Suppressed trees.

(6) Dead or dying;

each being further clasified "a", "b", or "c" according to good, moderate, or poor form of crown and stem.

Treemarking.

604. Treemarking of pine stands for thinning requires some technical knowledge and serious damage can be done to a stand by ill advised thinning.

Training of treemarkers.

605. In all plantations where thinning is commenced the D.F.O. will personally mark a number of plots which are to be left as a guide to the officer who is to carry on the marking. The treemarking will on no account be left to an overseer until the overseer concerned has been engaged on thinning for a period of at least six months. If the D.F.O. is of the opinion that the overseer is sufficiently trained in the work, written permission may be given by the Conservator for the treemarking to be done by him. In fully stocked stands, 500 or more per acre, unless a D Grade thinning has been done in the earlier years, the normal thinning adopted for Western Australia at 60ft. height for P. radiata and at 40ft. height for P. pinaster is a C1 Grade. It will be found that at the heights mentioned this will normally reduce the stand to between 300 and 400 per acre.

Wind bend to be considered.

606. Due to various factors, many compartments will be found to have exceeded the desirable heights (60ft. *P. radiata* and 40ft. *P. pinaster*) before thinning can be done. In such cases it must be kept in mind that spindly trees even of the upper sub-dominant level are likely to suffer from wind bend if left as crop trees and treemarking must in many cases leave a poor form bole which could have been removed had the thinning been done at the due date.

Treemarking method.

607. Treemarking in pine plantations of 500 or more trees per acre even when the trees have been pruned presents some difficulty due to the fact that the stems and tops of the trees cannot be so easily seen as those of more open stands. For this reason it is usually desirable for the officer carrying out the treemarking to have with him a man or boy who does the actual blazing of the trees while the officer indicates the trees from some distance away. In the early stages the overseer or a junior officer can with advantage be used to do the blazing as this work forms a useful training in treemarking for him. The marking of the trees is done by placing a blaze about 6in. long at breast height sufficiently deep to show the white sapwood. A paint gun may be used but is unnecessary.

Blazing of trees.

608. It is important that the blazes be all made to face the same direction—normally down hill, or on flat country in the direction of the planting rows. This enables the treemarker to see all trees he has marked from one direction and also assists the fallers later in working out falling problems to avoid "hang ups."

Felling pine trees.

609. During thinning work all trees are to be felled at ground level.

Branding trees.

610. Trees are not marked with a brand except in special circumstances where a permit holder is to do his own falling in stands of over 20 years of age.

Mark all removable trees.

611. It is important to mark all trees which may come out including classes 6, 5, 4, even if they are not of sufficient size to make a log as otherwise a further marking may be necessary if it is found that lower sizes are saleable. The marking of these also assists the treemarker and inspecting officers to visualise what his stand of crop trees will look like. In practice most of class 6 and 5 will be cut down in any case to facilitate extraction.

Extraction routes.

612. The method of extraction varies considerably throughout the State depending upon contour and presence of logs or stumps. The two extremes are (a) Flat sand plain country which has been thoroughly cleared and (b) Steep rocky areas which were poorly cleared originally and in which no extraction routes were left.

613. The treemarker in the case of (a) will normally remove a complete row of pines for a straight extraction route for motor truck pick up. In the case of (b) it is important to mark carefully all the extraction routes before doing the general marking as, unless this is done it will be found that trees it was desired to keep will have to come down later to permit extraction.

Subsequent thinnings.

614. Second and subsequent thinnings are being practiced only on a small scale at present and will be the subject of instructions from Head Office if and when required. Normally in second thinnings a percentage of "peeler" logs should be obtained.

Peeler logs.

615. Logs for peeling for the manufacture of plywood are in high demand and bring a much higher stumpage than small pine logs for sawmilling. Normally peeler logs, that is logs of 6ft. or 7ft. in length and 9in. O.B. diameter at crown, are not available at the first thinning, but in some cases where thinnings have been delayed there is a percentage of these logs.

Marking peelers.

616. Before treemarking a compartment, the officer concerned should seek direction from Head Office or from the Regional Officer regarding action to be taken with potential peeler trees. It should become normal practice to mark these trees with a paint mark to be held until they can be marketed as peelers. They should not be felled for supply to a sawmill unless an existing order for peeler logs is in hand and the two operations can then be combined.

Specification for peelers.

617. The market for pine peeler logs is developing and it is to be anticipated that all butt logs which have been pruned for some years and all logs of 9in. crown which have knots of less than 1in. diameter will become acceptable as peelers. Edge trees and open grown trees with large limbs are not likely to be acceptable.