the beginning of the Period, without checking its figure in the meanwhile. This check is what we have called the VERIFICATION OF THE ANNUAL YIELD.

The check in question consists in ascertaining, at some time during the currency of the Period, the quantity of standing material still unexploited, and then dividing that quantity by the number of years in the unexpired portion of the Poriod, exactly in the same manner as was done at its beginning. It is obviously necessary to employ the same procedure and the same tables as before, otherwise the results obtained on each separate occasion could not be compared together. Before dividing the quantity given by the valuation survey, it is necessary to deduct from it the still available portion of the Reserve Fund that may have been deduced from the annual yield in the first instance. This procedure is indispensable in the interests of the future. The whole of the unexploited stock, reserved in order to provide against extraordinary requirements, ought to continue to be available up to the very end of the Period, and this for the very same reasons which originally justified the establishment of the Reserve Fund. As regards the actual increment by which the standing stock may have increased since the beginning of the Period, it necessarily forms an integral part of the contents found by the valuation survey. But in revenge the valuation survey has nothing to do with the trees left standing after the Final Fellings; so that those trees in no way affect the calculation of the annual yield in the second instance.

If, owing to unforeseen circumstances, any considerable exploitations have had to be made in the immediately following Block, it might be expedient to effect a compensation by increasing the stock to be reserved during the rest of the Period. Under any circumstances, the Verification of the Annual Yield must alter the figure originally estimated, but it cannot modify the General Working Scheme, since the calculation of the annual yield is entirely independent of the formation of the Blocks. It is necessary to verify the annual yield of principal produce at least once during the course of each Period, so as to avoid all risk of having an accumulation of errors crowded into the last few years of the Period.

When the fellings that are regulated by area, notably so the Thinnings, have been arranged at the beginning of the Period for its whole duration, it is useful to verify also the succession of those cuttings, and to rectify it if necessary. Naturally both verifications should be made at one and the same time, at the end of the tenth, fifteenth or twentieth year, according to the forest concerned. The time for making these verifications must be prescribed by the Organisation Project.

SECTION III.

IMPROVEMENT WORKS.

The Table of Exploitations prescribes the nature of the cuttings to be made in the Working Circle concerned throughout a whole Period. But it lays down no injunctions as to the manner of making them. Now there are cases in which the success of forest operations depends on the execution of certain works of improvement. Thus it may be necessary to effect some artificial restocking or to make roads for the export of wood. If the Organisation Project did not consider such works and omitted to point out the means available for executing them successfully, it would run the risk of being an impracticable project and of defeating the object of the very operations it prescribed.

The most urgent works of improvement required by each Working Circle ought, therefore, to be a subject of special attention for the forester who has to organise it. The manner of executing these works, the appreciation of the relative urgency and timeliness of each, estimates of their cost, all these points should be discussed together in a single chapter of the Organisation Project. Thus the works that are indispensable for the carrying out of the Organisation Project form an essential part of the studies and proposals which compose it. Works that are simply useful also require to be mentioned, but more often it is best to leave to the Executive Officer the duty of proposing them when they are actually called for.

Among the works that are necessary must be included the establishment of a regular system for noting and recording facts and phenomena connected with the growth of the forest paripass with their occurrence. The Organization Project must therefore provide and prescribe the means and method of working

these observations. Whatever the form in which this record is kept, it must describe, firstly, every kind of exploitation made, together with all concomitant circumstances of an economic nature; and, secondly, the improvement works properly so called and all phenomena connected with the growth of the forest. From both these points of view, the keeping of a complete record is secured in a very simple manner by allotting to each compartment separate space in the record. What could be more simple than to assign to each compartment two opposite pages of a Begister, one to contain facts connected with the produce obtained from the compartment, the other the phenomena relating to the growth of the living stock? Each year it would be enough to enter all facts, that may have occurred, on the proper page of the Register. In a short time this Register would furnish a complete and connected history of the forest. A specimen form for the Register is given below:—

REGISTER

OF

FACTS and PHENOMENA

CONNECTED WITH

the Working and Growth

OF

the Working Circle of LE FAYS

(The following two Forms should be bound so as to face each other, as shown here; each double page will then contain a record for a single compartment extending over an entire Period.)

COMPARTMENT E4, AREA 34 A. 2 R. 20 P. EXPLOITATIONS.

YEAR	Nature of Exploitation	DEMESTY of Grop.			A	ACTUAL contents.							,	Compound Fellings an Regeneration							1	
		-	Number of trees.	ente.	-	1	Mmber.	Total, pross Receipts.		EXPLOI- TATION charges.			3		Middle			Young		REMARKS.		
		Area		Latinated orn'ente	Total.	-	Other Th			P.			p[Oak S, in girti	Oak from 3.6 % 5 fo girth.	Breech and other	3	Resch.	Other species	Beech.	Other species.	RED
																						Fracts relating to the various descriptions and chases of produce obtained, with their respective selling rake. Physicians of every kind that can have any inducance on the gr with and regrenting applies of the stock februars, drogardi, fract shindness of accura of bacchering &c. fraces demonstrations of the stock februars.

CUBICAL CONTENTS IN 1880, 246,738 C. Ft. IMPROVEMENT WORKS.

YEAR,	NATURE and Extent of the Works executed.	C	OST.		INFORMATION regarding the circumstances un- der which the Works were carried out, and the Results obtained.				
		Ra.	^-	P.	The state of the s				
ā									

SECTION. IV.

PERIODIC REVISION OF THE ORGANISATION PROJECT.

The complementary measures, the employment of which we have just enjoined, are quite sufficient to provide against all contingencies and to guarantee the success of the operations prescribed by the Special Scheme of Exploitations. But this Scheme is drawn up for the duration of one Period only, and consequently a fresh Scheme must be prepared for the next following Period also. Like the first, this latter will determine the succession of the exploitations for the whole duration of the new Period, and fix the yield of the annual fellings as well as the quota of the Reserve Fund.

The operation here sketched, which we have termed the PERIO-DIC REVISION OF THE ORGANISATION PROJECT, necessitates a new and complete study of the forest at the end of each Period. That study, while it brings out into prominence the results heretofore achieved, shows in a clear manner the modifications that it would be useful or necessary to make in the general management of the forest. Among these modifications there would be some that would in no way affect the ground-work of the Organisation Project; such would be, for instance, any proposed change in the special treatment of certain compartments. Other modifications may have for result the alteration of the boundaries of the Block; but so radical a measure should be avoided except in cases of well proved necessity. More generally it would be a change of Rotation that would seem desirable, in which case it would be enough to prolong or curtail the duration of each Period in the same proportion as the Rotation, without in any way changing the General Working Scheme.

In a well treated forest, it generally happens that a portion of the Reserve Fund is available for exploitation at the end of each Period in the Block, of which the regeneration has just been completed. The manner of turning this portion of the Reserve Fund to account is obvious enough: it must form for the next following Period a resource to fall back upon in case of emergency, and the produce furnished by it must not be considered as part of the regular yield of the forest. In the event of urgent wants arising before a new Reserve Fund can be formed, it would be perfect-

ly logical to exploit the standing one, since it represents an actual surplus. On the other hand, had such wants arisen when the forest was just organised, they could have been met only by utilising a paper surplus existing only in the estimates. Thus in the new Special Scheme of Exploitations the utilization of the available Reserve Fund ought to present no difficulty.

The exploitation of irregular produce, i. e. over and above the fixed yield, does no harm as long as it is only a fraction of the regular yield (say for instance, a fraction not exceeding 1), and as long as it consists only of trees that must soon fall, like the nurses in Regeneration Coupes that are already sufficiently sown with the new crop. The reason of this is obvious, for under such circumstances the exploitation of the stock in question cannot interfere, either immediately or at any future time, with the maintenance of a sustained yield or with the Exploitability chosen. The case would be quite different if, instead of being limited to a moderate figure, the proportion of the irregular produce exceeded all bounds, say, for instance, that it was equal to the regular yield of a well-An exploitation thus exaggerated might even stocked Block. prove fatal to the execution of an Organisation Project based on area.

BOOK IV.

ORGANISATION OF IRREGULAR HIGH FORESTS.



Under the term Irregular High Forests we include (i) all those high forests which contain crops that are of defective growth, are incomplete, or are composed of inferior species; (ii) those high forests in which an unequal gradation of age-classes would, if a regular treatment were adopted, lead to the felling of timber before it was exploitable or after full decay had set in; and (iii) also those forests in which the age-classes, instead of being differentiated into separate well-defined groups, are all intermixed so as entirely to prohibit any kind of successive order in the exploitations. Such forests are numerous, and present the most diverse forms and every degree of irregularity offering an infinitude of different types and characters.

We propose is the immediately following pages to study the organisation of forests worked by Selection and to explain how the General Working Scheme of an irregular forest of broad-leaved species should be framed. This will not only be sufficient to show how thoroughly the Area Method adapts itself to the organisation of every description of high forest, but will also prove how that Method never fails to offer the means of realising, within the measure of the possible and to any desirable extent, each and all of the principal objects of forest organisation, to wit,

- (i) The most useful production,
- (ii) A sustained yield,
- (iii) A definite order in the exploitations, and
- (iv) Continued improvement of the forest.

CHAPTER I.

THE SELECTION SYSTEM.

SECTION I.

GENERAL CONDITION OF OUR FORESTS UNDER WORKING BY SELECTION.

The Selection Method of Working is simply the exploitations of primitive humanity generalised into a system. There where wood was abundant and the forest open to all comers, each one helped himself to whatever he wanted. Broken branches, windfalls, dead standing trees, dying poles, and loppings and toppings of every kind furnished the people with firewood. Timber for building and other purposes was removed from the nearest and most accessible spot, a tree here, another there, and so on. Only what was actually wanted was taken away, the branches, toppings, and useless odds and ends, and trees that were found to be unsuitable after being felled, were, as a rule, simply left on the ground.

As long as exploitations of this nature are sufficiently restricted in quantity, exploitable trees fit to satisfy all wants can never fail, and no forest is the worse for them. Nevertheless the removal of individuals here and there from the midst of a canopied mass cannot but be very detrimental to the regular growth of trees of broad-leaved species; and hence this method of working has been, as a rule, confined to our conifer forests.

There it yields results that differ according to the prevailing species and the quantity of wood removed every year. In well-wooded regions, where for the very reason that they are well-wooded the forests are placed under favorable circumstances for growth, a forest worked merely by Selection without any fixed plan maintains

itself in fairly good condition, whatever its component species, as long as only a moderate quantity is exploited every year. Thus is explained the continuance of that method of working in most of our mountain forests, whether of pine or silver fir, which have hitherto remained inaccessible to the timber-dealer. But although the method of working has been the same everywhere in those forests, their condition is nevertheless very different according to the species composing them.

In forests of pine, where the trees require bright and abundant light, the Selection System always does more or less harm. Under its operation the leaf-canopy is very far from being uniform, is often open or breached with small gaps, and consists in places of sickly saplings and poles that can never come to anything. Hence that Method of Treatment has in nearly every case been abandoned with the development of an export trade. In forests of silver fir, on the other hand, the young plant of which species bears even heavy cover for a long time, and shoots up rapidly as soon as it is uncovered overhead, crops worked by Selection remain dense and well-stocked with trees of all ages, provided the annual exploitations are moderate. It is this peculiarity of the tree that has rendered possible the maintenance of the Selection Method in our silver fir forests on mountains of medium height, even though they may be situated in the vicinity of roads and drawn upon by the surrounding country. Nevertheless people were not long in recognising the necessity of subjecting the original Selection System to certain rules having for their principal object the limitation of the quantity exploited to a fixed figure. And so the Selection Fellings thus regularised now constitute a recognised Method of Treatment.

The Method in question consists in the removal here and there of the oldest trees, of those dying, decaying or dead, and of others still in full growth, but which are required to satisfy the wants of the proprietor. It has been applied in this manner, and often with good results, to forests of silver fir and spruce, pure or mixed with beech. The quantity to be exploited, in other words, the annual yield, was usually expressed by the number of trees to be felled. When this number included only real trees and not mere poles, the average was 04, 06 or 08 trees per acre. For instance in the forests of Levier it was fixed for certain Working Circles at 04

trees, for others at 0.6 per acre. Thus supposing a certain Working Circle measured 750 acres, the number of trees felled in it annually would have been 300 or 450 according as the number per acre was fixed at 0.4 or 0.6. Elsewhere, as in the communal forest of la Cluse the yield was fixed at about half a tree per acre. Care was taken to remove only a very few trees from any one spot, one or two only for example, so as to avoid making too large a gap any where in the leaf-canopy, since such gaps must cause considerable injury to the forest. With this method of procedure it was necessary to spread the annual operations over a large area, and indeed, as far as the pure principle went, over the whole Working Circle. Actually however the area operated upon every year was restricted in most cases to only a single canton.

When this method of treatment has been continuously applied for any length of time, trees of all ages from the seedling to the exploitable individual are found mixed up pell-mell together. A crop of this character, even though it be a complete one, cannot but consist of crowns rising one above another. Those of the large trees, standing out as they generally do singly, begin close to the ground, while those of middle-sized trees are often weak and spare, and all the younger growth is overtopped and hence, as a rule, lanky and sickly. Exceptionally, as the result of some special cause (the wind, for example, which may have blown down all the larger trees), some fine crops assume an almost regular appearance. But as reproduction is left to chance, glades and even blanks form, which, from being more or less numerous all through the forest, aggregate together at times a considerable area.

The outturn of produce of a forest worked by Selection is, acre for acre, admittedly less than that of a regular high forest. This inferiority is due principally to the languid growth of some of the trees and the sickly condition of a much larger number, and is very marked or insignificant according to the state of the forest concerned. The quality of the produce yielded is also inferior, sometimes even absolutely bad. The chief causes of this inferiority are (i) the rapid growth of the bigger trees, which in the case of conifers produces soft-grained-timber; (ii) the formation of large knots, which are serious defects when they occur in the silver and apprace firs; and (iii) the production of various kinds of unsequedness.

which induce rapid decay in the wood of the species just named. These defects, like the general unsatisfactory condition of the crops, result from the exploitations being spread over too large an area. The consequence is that the damage caused by the felling and export operations is not confined to one locality (in which case it might be easy to repair or mitigate), the commission of all kinds of offences is rendered easy, and the trees that stand out isolated above their neighbours, having their crowns exposed to the full force of the wind, are thereby broken, uprooted or shaken. Nevertheless, the worst that can be said of silver fir forests worked judiciously by Selection is that they are not regular.

The Selection System is attended also by another great danger viz., the exaggeration of the fellings, the end of which may be nothing less than the general ruin of the forest. If the quantity exploited is in excess of actual production, the forest becomes thereby rapidly poorer and poorer. As the fellings remove only the larger trees, it follows that the exploitable material on the ground goes on diminishing, until eventually there is nothing left in the forest but young saplings and poles. Then the growth becomes sparser and sparser, and the whole forest at length forms one huge glade. Should the component species be silver fir, the result is countless windfalls and the utter ruin of the forest. Herein lies the inherent and prohibitive defect of the Selection System. system is, therefore, entirely out of place in our conifer forests situated at moderate elevations, where the prevailing conditions are sufficiently favorable for regular treatment and prompt and easy regeneration. The Natural Method indeed enables us to utilize the produce of such forests in the most happy manner possible, while avoiding the defects and risks that constitute a necessary element in the Selection System.

The transformation of a selection-worked forest of silver fir into a regular high forest is effected by completing and freeing the young crops overtopped by older growth. It requires three simultaneous Regeneration Fellings, all within one and the same area and calling for great skill and care on the part of the operator. These Regeneration Fellings we will term Thansformation Curtings. The end to be secured by their means is to obtain young crops, which, if they are not at once regular, are at least capable of

becoming so in course of time. The fellings here referred to demand much skill and experience, and will be found described and treated of in any work on Sylviculture. We would advise the student to read up that part of Sylviculture once more, if he wishes to study with profit the organisation of a selection-worked forest under transformation.

While the transformation operations are going on in one portion of the Working Circle, the mature trees found over the rest of it must also be felled. Hence it is necessary to continue for a time true Selection Fellings. These must be so regulated as to avoid the risks inherent in the Selection System itself, and to minimize its shortcomings by gradually improving and increasing the growing stock. Our finest silver fir forests, those of Levier in the Jura, and of the Sault plain in the Aude, have been so worked, with moderation and judgment, for very nearly half a century in those compartments which have not yet reached their turn for transformation. These nowlcontain, splendid crops, abounding in vigorous, promising growth, and yielding every year excellent produce.

SECTION II.

MAINTENANCE OF THE SELECTION METHOD.

The Selection System, if worked with judgment, preserves a forest in a canopied state, irregular it is true, but presenting everywhere trees of large dimensions. These, thanks to their size, constitute the principal portion of the stock and the most important class of the standing timber. Thanks to them, certain forests worked by Selection present the true aspect of a regular high forest: the poles, by reason of their small diameter and their contracted crowns, do not strike the eye, while the young growth, evertopped, of no height, and incomplete as it is, makes little show. It is chiefly in spruce forests that this well-marked type is to be met with; but the Selection System admits of the maintenance of a tall canopied crop of any species whatsoever.

Moreover, under this system, reproduction is constantly going on throughout the forest. The extraction of single trees here and there from the midst of the canopied mass lets in sufficient light where they stood, and a sort of twilight under the crowns of their neighbours, conditions eminently favorable to the production of seedlings. Moreover the soil as well as the seedlings thus produced are constantly protected, another point in favour of the system. Thus it is not simply a single special Period, or a certain definite number of years that is allotted for the production of seedlings, but ages without limit; in other words every portion of a forest worked by Selection is, so to say, perpetually under regeneration.

It is now easy to understand how essentially conservative a method of treatment the Selection Method is, on the sole condition that it is worked in a spirit of moderation and that it removes none but really mature trees. The trees of such forests receive individual attention, and reproduction is assured as much as it can ever be. It is for this reason that Working by Selection has to be maintained in so many cases.

The first of these cases is that of forests conserved with a view to affording protection and shelter. Such forests are scarcely met with any where but in the wildest localities, in mountainous regions. in such places, for instance, as where landslips are threatened, avalanches are to be dreaded, the formation of mountain torrents to be prevented, and dangerous winds to be tempered or kept out altogether. Thus it is immediately above a village overhung by an abrupt slope or a canton exposed to avalanches, or it is at the point at which all the waters of a mountain-side collect to precipitate themselves into the valley below, or in a high gorge where the wind rushes violently through, that the Selection Method of working must be constantly maintained. Such localities are always well defined; they are rather single cantons than large extensive tracts. The preservation of the forest there is all the more necessary, inasmuch as it is often very difficult to restore it when once it has disappeared.

The second case in which it is expedient to continue the Selection System is that of those forests, in which reproduction is uncertain or so slow that it cannot be depended upon to recrop or regenerate any portion of such forests within a given time. The cause of this unsatisfactory condition is to be traced to the soil and to the climate. Thus in a climate where extremes of heat or cold prevail, or where shelter against the severity of dangerous winds is

wanting, it takes a very long time for seedlings to make their appearance; and when once they do germinate, the new crop grows very slowly, and takes a very long time to join their crowns and close over the ground. The time required for so desirable a consummation to take place is often quite unlimited; it left to itself the forest must of course eventually reproduce itself, but this perhaps not until after a whole century has elapsed. Such is the case towards the superior limit of arborescent vegetation, and also on elevated plateaux, on mountain ridges, although of no great height. and on the edges of a forest continually struck by the wind. Similarly, on soil that is barren either on account of its rocky nature or owing to its being scarped, it would sometimes be vain to expect a complete sowing of the ground; if the trees are removed before a young growth is ready under them to take their place, the forest is exposed to certain denudation, Instances of this are those masses of sheet-rock, which, without the cover of the forest overhead, would not, as at present, be carpeted over with their thick covering of moss; agglomerations of boulders retained in their place by the roots of the large trees growing between them; and those scarps and very steep slopes, on which any steady walking is out of the question, and from which every seed that falls must roll or slip down and be washed away by rain. All these various conditions of climate and soil are often found so combined that their joint effects cannot be attributed any more to one of them than to another. But however it be, their presence is betrayed by facts, which are a certain indication that the Selection Method is required there. In such places the leaf-canopy is seldom unbroken and continuous, and is usually breached with blanks or persistent glades; if the forest growth has been removed, the naked rock crops out, or if there is a covering of turf over it, this is wanting in places.

Lastly, and as an exceptional case, the Selection Method is the most convenient one to apply to high forests of slight extent, the proprietor of which requires every year a small quantity of large timber. Although the conditions of growth in any given high forest may be perfectly satisfactory, yet it may be of too limited an extent to contain a complete series of graduated age-classes consisting of regular crops. In such a mere grove of high forest

trees, the Selection Method is the only method of treatment which would allow a small quantity of large timber to be cat out every year. This method of exploitation is, therefore still applicable to a certain, by no means insignificant, number of small forests, and, notably so, to communal woods, which constitute a most valuable resource for the village or hamlet owning them. Such is the case when the area of the given forest is too small for the formation of Periodic Blocks of at least 38 or 50 acres each. The minimum area of a regular Working Circle must of course vary with the constituent species, according as they reproduce themselves freely or slowly, and with the situation of the forest, but above all with the close neighbourhood or contiguity or remoteness of other forests. In any case, it is scarcely possible to execute, during a whole Period of 39 or 40 years, an entire series of Regeneration Fellings over an area of only 25 acres with all the necessary order, and without the occurrence thereby of damage of all kinds amounting to devastation pure and simple.

Among the forests under the control of the State Department, the aggregate area of those which fall under one of the three cases just described is very considerable. Such are the forests in certain corners of the Vosges, also on the last series of plateaux of the Jura Range, and in the rocky mountains of Central France. The six Pyrenean departments contain together a considerable proportion of such forests. But it is chiefly in the region of the Alps that the great mass of them is situated. Of the 1,125,000 acres of communal woodlands that still exist in that region, probably onehalf can be subjected to no other treatment but the Selection Method. They are blocks or débris of forests of silver fir, of spruce, and of beech, situated at certain points in the northern portion of the region, and of larch, of Scots' pine, and of the mountain pine (Pinus montana, Mill.) in the southern portion. The same species, excepting the larch and the spruce, compose the forests of the elevated portion of the Pyrenees. In Corsica, the Austrian pine is found in addition to these other species. Thus it is is hundreds of thousands of acres that we may express the total area of our forests which must continue to remain subjected to the Selection Method; and more than this, the prevailing species in those forests are all our most valuable conifers.

The larger the area of the forest to be worked by Selection is, the more necessary becomes the judicious application of that method. But the manner of its application is different for the different species. The difference is greatest between that adapted for forests of delicate species, like the silver and spruce firs, and that suited for forests of hardy species, like the Stots' pine and the larch. In the former only a very few trees may be removed from any one point; in a silver fir forest, for instance, waly one. The young silver fir requires for its maintenance only a small quantity of light, and a full canopy is one of the first conditions necessary for the favourable growth of that tree. Where it is the dominant species, we must be careful not to remove, under the pretence of making a thinning, any over-topped poles, unless these are in a dying state; for they possess the faculty of regaining vigour and of shooting up as soon as they are uncovered, and, as a general rule, they fill up at once the place left vacant by the overtopped trees, when these have fallen, either under the axe of the woodcutter or the violence of the wind. An analogous procedure, although slightly different, must be followed in the case of the spruce, which species is slightly more hardy, has a taller habit, and forms less regular leaf-canopy than the silver fir.

For pines and the larch the treatment is quite different. Worked by the Natural Method, they require an open Regeneration Felling. When subjected to the Selection Method, the Scots' pine similarly requires the removal of several trees from the same point, so as entirely to uncover a small plot (from 8 to 14 poles, for instance), with this precaution, however, that these little gaps are made at sufficiently wide intervals. The young seedling of the Scots' pine requires plenty of light to maintain itself and develop, and the trees of these species are averse to growing up side by side unless they are all more or less of the same height. When the large trees have been felled, it is perfectly useless preserving the poles that were growing under or close against them; such poles are always more or less sickly and can never come to any good, and their preservation would only occupy the ground to the detriment of younger and more promising growth. Thisnings are useful and sometimes even necessary in uniform crops of Scots' pine poles. The requirements of the larch resemble those of the Scots' pine, but the stronger

held which it takes of the ground gives it an advantage over the latter species, in that individuals of it, reserved far apart when the older growth has been removed, are safe against injury from winds.

Moreover the detailed treatment of the various species referred to in the preceding paragraph is different for each of them. Thus in order to obtain a crop of seedlings of the silver fir, the apruce and the beech, it is an excellent precaution to prune off the lower branches of the trees a few years before they are felled; for the pines and the larch, the same end is served by a slight or partial working up of the ground, which, by loosening the soil where it is exposed to the light, furnishes the best means for sowing the ground. Such are the principal cultural operations, extremely simple as they are, that are required in a forest worked by Selection.

The risk attending the Selection Method, when it is badly carried out, or removes too many trees from a given area, is not less great in pine forests than in those of silver fir, in larch forests than in those of the spruce. It is most to be dreaded at high elevations, precisely there where the application of that Method is always necessary and demands great skill. At such elevations, where extreme cold prevails, the years of seed are few and far between; the summer, which brusquely succeeds the winter, often injures germinating seeds and young seedlings; and, lastly, the forests suffer severely from atmospheric influences, chief among which is the wind.

Under these peculiar conditions two opposite series of phenomena may be met with. Where the land is partially covered with young forest growth, such as scattered seedlings, patches of thickets, and bouquets of saplings, the cover thus formed becomes more and more effective every year as the forest developes, and the moisture of the soil is better and better preserved during the summer. Vegetation is active, the sparse crop meets and closes overhead, and soon the forest completely covers and takes possession of the ground. On the other hand when the forest growth, composed of old or middle aged trees with lofty crowns, begins to thin itself naturally and let in light everywhere over a certain area, the trees are desrived of the mutual support which they gave each other,

and the soil is exposed alternately to be washed away and to be caked. Vegetative vigour diminishes, the larger trees die off one by one, seedlings are produced in decreasing numbers, and the ground at last becomes entirely denuded of its forest growth. These two sets of phenomena may be noticed in many and many a locality. They are especially frequent and well marked in the South. The former of them furnishes a valuable lesson to those engaged in hill reboisements, while the second above us the danger of immoderate Selection Fellings.

CHAPTER II.

ORGANISATION OF FORESTS IN WHICH THE SELECTION METHOD IS TO BE MAINTAINED.

The organisation of forests worked by Selection is as elementary in its character as the corresponding method of treatment itself. The first care which it requires, is moderation in the exploitations, this being the only means of systematising them (as far as that can be done in this Method of Treatment), and of ensuring the carrying out of all necessary works of improvement and development. We will now proceed to examine separately the method of organising forests under all the three classes of circumstances which, we have seen above, necessitate the maintenance of the Selection Method; that is to say, we will show to what it practically reduces itself in forests kept up for protection, what measures it requires in the case of forests situated at high elevations, and in what particular respect it may have to be modified for high forests of altogether limited extent.

SECTION L

FORESTS OF PROTECTION.

Forests maintained for the purpose of protection perform their rôle more effectively, the taller and, hence, the older they are. The emploitability to be adopted here is, therefore, that termed by us Physical, and is determined by the natural death or complete decay of much separate tree. The consequence is that the date of the exploitations, as well as the quota of produce to be extracted at each exploitation, are always unknown quantities; and, indeed,

the figure or quality of the yield can possess only a secondary and often insignificant interest in the case under consideration. Thus the Organisation Project must make no attempt at laying down any prescriptions with regard to the exploitations; these should be left entirely to the discretion of the Executive Forest Officer, who would from time to time submit specific proposals connected therewith as the occasion required.

The organisation of such forests is, therefore, limited simply to their complete closing against grazing after being clearly demarkated. To this end, it may be necessary to prescribe the execution of certain protective works, such as ditches, walls, and fences; and also certain works of conservation and improvement, such as the partial sowing up of blanks, and the weeding out of bushy vegetation to clear the ground for the natural sowing of forest species. In the majority of cases, it is in the closing of the forest against grazing that the real means of safety lies.

SECTION II.

FORESTS SITUATED AT HIGH ELEVATIONS.

Under the above heading we include all those forests in which reproduction is too uncertain or too slow to be obtained within a given time, as well as those which are exposed in a special manner to injury from high winds. The majority of such forests are actually situated at high elevations, where agriculture, properly so called, is impracticable, and which in France, as a rule, begin at about 3,300 feet above the sea. And indeed, speaking generally, wherever similar rigours of climate prevail as at those elevations, it is the Selection Mathed that is the treatment most generally applies ble.

The first point to determine in organising such forcets seletes to the exploitability of the trees, which, as a rule, ought enver to be felled except singly; so at to avoid producing gaps through which the wind sould noter. On this subject Section 72 of the Rayal Edict putting into force the Forest Code lays down that his forests worked by Selection the Organisation Project shall pro-

scribe the age or the dismeter which the trees ought to attain before being felled." The foregoing rule is an excellent one. It prescribes, in a word, that the exploitations shall remove only those trees which are capable of satisfying in the happiest manner possible the interests of the owner. In forests under the control of the State Department, it enforces the adoption of Qualitative Exploitability based on the diameter which the trees ought to attain in order to furnish the most useful produce they can. As regards the reference made to the age of these trees, the word "age" could only have been used in the sense of the stage of growth attained, since in a forest worked by Selection it is impossible to tell the age of any tree, until it has been felled. The Amenagiste must therefore ascertain what diameter would enable the trees to serve the most important purposes or to furnish the best. possible descriptions of produce. The result of this inquiry, the corner stone itself of the whole Organisation Project, may be different for different parts of the country. In the silver fir forcets of the Volges, where the great majority of the trees are destined to be worked up with the saw, it has been remarked that the maximum of utility for unity of volume is attained with a diameter of very nearly 2 feet at 41 feet from the ground: trees of less diameter do not work up into planks so well, while the timber merchant. does not care to pay a higher rate for trees of larger diameter. As a rule then, the silver fir in a Selection-worked forest of the Vosges becomes exploitable as soon as it has attained a diameter of 2 feet measured at 41 feet from the ground. It is unnecessary to observe that it is not every forest, especially if it is situated at a high altitude, that can produce trees of that size; but, at the worst, we can always endeavour to keep as near it as the special capabilities of the given forest allow. In the Jura, a portion of the ailber and spruce firs produced is cut up to planks for the cabinetmaker; but the finest and thickest and longest logs are exported to considerable distances after being simply rough-squared, and are used as beams by the builder. These entire logs are in great demand and fetch higher prices than the same wood worked up into planks; but they must measure from 28 to 30 inches in diameter at the base. In those forests, therefore, the soil and climate of which allow the trees to attain that size, the diameter of the exploitable silver ar should be fixed accordingly.

In determining the yield of Selection Fellnigs, i. e. the number of trees to be exploited each year, the Amenagiste may either allow himself to be guided by the figures of the previous exploitations or by the number of exploitable trees actually standing on the ground. For example, if anterior to the organisation of the forest the number of trees felled annually is 4 for every 5 scres, he must either maintain this figure or raise or diminish it according as he finds the forest well-stocked, overstocked or understocked as regards large trees. This he could not know, with the certainty necessary for the work in hand, except by studying close: ly the various crops, noting the annual increment of the trees that are near the exploitable dimensions, and, lastly, reviewing the results of the valuation survey of all the formed trees of the forest arranged into size-classes. If the yield of the previous Selection Fellings cannot be ascertained, the production of the soil per acre must serve as a guide. The amount of this production can generally be estimated with sufficient approximation by men well up in the forester's craft; those who have had much to do with the exploitation of forests easily acquire this faculty. Moreover it may be obtained in various other ways, by an actual valuation survey, for instance, of the standing material in Judiciously selected canopied masses of trees of the same age. 1

^(1.) The study of the growth of trees also enables us to estimate the production of the soil in exploitable timber. Suppose, for instance, we have a forest in which healthy trees may be expected for certain to attain a diameter of 24 inches. Suppose also that the average annual radial increment has been found, by means of measurements made on felled timber, to be one-tenth of an inch. Hence it would take 60 years for a tree of 42 inches diameter to attain a diameter of 24 inches. The time required for a tree to reach a diameter of 12 inches, rarely the same for any two trees even of the same crop, might be on the whole much longer than 60 years. If we suppose it to be half as long again, i. a: 90 years, then the time required to obtain trees of 24 inches diameter would be 150 years, then the time required to obtain trees of 24 inches diameter would be 150 years. In the next place those portions of the forest, in which several trees of this size are found grouped together, show how many of them, could stand on an acre completely stocked with them. Bay that this number has been found to be 75. From the preceding data may now be calculated the total annual sum of production per acre in mature timber. Thus it might be half a tree per acre per annual, measuring from 50 to 70 cubic feet scoording to the height attained by the trees.

The known yield of adjoining forests growing under similar conditions and there systematic treatment would also furnish a safe guide.

These various methods can be used to check one another, but their application requires no little experience on the part of the Aménagiste.

The annual outturn of silver fir forests usually varies from 28 to 56 cubic feet per acre at high elevations, and from 28 to 98 cubic feet where the climate is less rigorous. By comparing the average annual production calculated for the whole forest with the contents of the exploitable tree, the Aménagiste can test the correctness of his conclusions relative to the yield of the former exploitations, and in any case guard himself against the risk of being much above or below the true figure. Suppose, for instance, that the annual sum of production per acre is about 70 cubic feet, and that the exploitable tree (take it to be a silver fir) measures 2 feet in diameter and contains 140 cubic feet on an average; the yield would thus be half a tree per acre, or, in other words, if the area of the forest was 500 acres, 250 trees per annum.

The order and succession of the Selection Fellings are regulated in a very simple manner. Instead of spreading the annual cutting over every crop in the forest, the practice has always been, and with good reason, to allow an interval of rest between two consecutive exploitations in any one place. Hence in order that these exploitations may be reduced to a regular system, it is expedient to fix a periodicity for the Selection Fellings. Thus, for instance, if it is considered advisable to return once in ten years to the same compartment, it will be necessary to work through the entire forest in 10 years, a procedure which necessitates the division of the forest into 10 portions or coupes. With natural lines, as far as possible, for boundaries, these coupes need not be equal in area. Nevertheless any great difference of area is to be deprecated, at the same time that the relative extent of the several coupes should be so fixed that their productive capabilities may be appreciably the same. The partition of the forest into such coupes and the determination of the order in which they should be respectively taken up constitutes the Working Plan or permanent framework of the Organisation Project.

Continuing the illustration of the last but one preceding paragraph, suppose the forest to be divided into 10 equal coupes; each coupe would thus contain 50 acres and the annual fellings would remove from it 5 trees per acre every tenth year. If that number was found to be too considerable, if in other words.

a single acre, the thing to do would be to reduce the number of the coupes. Suppose that number reduced to 6, then the Selection Fellings would return to the same spot once every 6 years and remove therefrom only 3 trees per acre. It is thus apparent that the first point of all to determine is the number of trees that may be extracted in a single operation from one acre without endangering the safety of the forest. It is only then that the periodicity of the fellings and the number and boundaries of the coupes can be fixed. The Working Plan is thus indissolubly connected with the yield of the forest. In high forests worked by Selection, more so even than in those subjected to the Natural Method, the combinations of the Organisation Project should be subordinated to cultural requirements, that is to say, to the rules of exploitation necessary for the preservation of the forest.

It is evident that by felling every year the same number of trees without any regard to their size, the annual yield cannot be the same either in respect of quantity or money-value; but in proceeding thus, the constant maintenance of the forest in a well-stocked state, or its continued improvement until it reaches that state, is guaranteed. In the first place, it is easy to see that the same number of trees may be exploited year after year in a Selectionworked forest for an indefinite period of time. If the contents of the exploitable tree be 140 cubic feet, and the sum of production of the forest 70 cubic feet per acre per annum, it is quite possible that the forest may be sufficiently well stocked with trees of all ages to bear half a tree or 70 cubic feet being removed per acre without either becoming richer or poorer. But if, on the other hand, the forest actually contained but little large timber, the same number of trees would be still cut, but these would be mostly of smaller size than the type tree of 140 cubic feet; and so the stock of the forest would go on increasing every year. On the contrary, if the trees exploited contained more than 140 cubic feet, the quantity extracted annually would exceed 70 cubic feet per acre, and the stock would go on diminishing.

Again if the total production of the soil was not 70 but only 60 cubic feet per acre, the effect of exploiting half a tree per acre would, even without any consciousness on the part of the operating forester, be that the volume of the type tree would go on diminishing until it reached 120 cubic feet. Thus under any circumstances, the system of felling by Selection so many trees per acre invariably results in eventually bringing the forest into a certain stationary condition, the stock in that state being larger, the smaller the number of trees exploited per acre is.

And more than this, the same result follows for each separate coupe, and it is this very peculiarity that enables Selection Fellings based on number of trees to be carried out in a systematic manner. The object of reducing them to a system is to concentrate each annual exploitation into a definite portion of the Working Circle, a condition that is a necessary guarantee for the judicious marking of the trees to be felled and a most fruitful source of economy in making the fellings. Moreover another systematized result of this manner of working is that the area of each coupe is then sufficiently large to admit of a short periodicity, and thus render it possible always to exploit at the right time all mature or dying trees and to avoid the simultaneous felling of any considerable number of trees within a given limited area. The periodicity of the Selection Kellings depends entirely on the forest concerned and its component species. As a rule, it is 5, 8, 10, 12, or 15 years. It ought to be short for the spruce, long for the larch, shorter in fertile soils than in barren soils, longer in rigorous climates. The periodicity of the Selection Fellings having been determined, the order in which . the compartments should be exploited may be fixed at once for the whole Rotation. At the beginning the well stocked compartments will yield large timber, those poorly stocked small timber; but a. certain equilibrium will soon be established, provided the annual fellings go over areas of nearly equal productive power. The only disadvantage in fixing the yield at so many trees per unit of area fe the inequality of the outturn from year to year. But this inequality is more apparent than real, and it can be easily remedied by dividing the forest into Working Circles, which need not be large in. forests worked by Selection.

Such is the procedure which we recommend in organising forests in which the Selection System has to be maintained. It now semains for us to say what, we consider necessary as regards the actual execution of the Organisation Project.

The yield for the whole forest being fixed, as also the number of trees to be extracted each year, the Executive Officer must mark for the axe all trees that are dead, dying or unsound, as well as some others that are still growing and in a healthy condition, the latter naturally being the largest of all the trees in the coupe and limited to such as are absolutely required to make up the full number of trees fixed for the annual yield. Dead and decaying trees under 12 inches in diameter must also be felled, but ought not to be included in the yield, since they are no better than mere poles. But formed trees of that girth and upwards, which are felled because unhealthy or unsound, can on no account be omitted from the yield of the year. The unavoidable premature exploitation of formed trees under the fixed exploitable girth is compensated for by the healthy growth of the larger trees that are preserved, an indispensable set off in cases of this kind.

Besides this, it is certain that in actual practice the determination of the number of trees to fell per acre is not difficult. For it is evident that by cutting on an average two-fifths of a tree per acre per annum in Selection-worked forests managed by the State, the owner obtains from them all they can yield that is most in conformity with his wants. The result must be that 70 cubic feet will be extracted where the actual annual increment is only 70 cubic feet per annum, 140 cubic feet where it is 140 cubic feet, and so on. Is not this in truth a desirable state of things to have?

In forests worked by Selection it is advisable to establish a Reserve Fund based on area, one of one-fourth of the whole area for instance, as in communal copses to be described further on.

SECTION 3.

HIGH FORESTS OF LIMITED EXTENT.

In a grove or forest of very limited extent worked by Selection, although the conditions of growth may be all that can be desired, yet the interests of the owner (it may be a Commune) may require Annual Exploitations and a Sustained Yield. In that case the quantity to cut yearly must be deduced empirically from the average contents of the trees to be felled, due account being taken both of the number of trees that would correspond to the annual

sum of production and of the available material on the ground. That quantity should be fixed only for a limited period, and will be large or small according as the forest is well or poorly stocked with old trees. The annual yield would vary only once after a fairly long interval, to be sustained again for another interval of more or less equal duration. As to the march of the exploitations, there is no reason here for limiting them to fixed areas; for it would be a matter greatly to be deplored if poorly stocked compartments were overworked and well-stocked compartments worked under their full capacity. The Aménagiste can therefore only give the order in which the compartments should be severally taken up and state whether the periodicity should be long or short.

It is necessary to revise frequently the annual yield of forests worked by Selection, when it has been fixed according to cubical contents and not to number of trees to be felled. Such revisions constitute the entire provision against the evil results that may arise out of the necessarily complete uncertainty regarding the annual sum of production. The present condition of the forest compared compartment by compartment with what it was at the beginning of the Period, as described in the Organisation Project, and the volume of the formed trees it now contains as compared with the volume of the trees that have been exploited, will furnish data of the highest necessity for the redetermination of the yield.



CHAPTER III

ORGANISATION OF SELECTION-WORKED FORESTS. UNDER TRANSFORMATION INTO REGULAR HIGH FORESTS.

A silver fir forest subjected for a long time to judicious treatment by Selection offers a very simple case of an irregular high forest. Trees of every age from the youngest to the oldest being all mixed up together everywhere, the irregularity is of a uniform character throughout the forest, and the climate and soil then serve chiefly or solely as a guide in the formation of the compartments. The state of the crop, since its composition and density and the utter confusion of ages are generally the same everywhere, carinfluence the operation only in a secondary or even exceptional manner. As forests worked by Selection are usually situated in hilly or mountainous country, the configuration of the ground becomes a matter of great importance and it seldom happens that it does not indicate in a clear and definite manner a natural series of compartments. As the division into compartments is thus founded on the constant factors of production, it follows that it possesses a character of permanence.

The formation of the Working Circles is independent of what is usually the most difficult condition to satisfy in that eperation viz: a proper distribution of the age groups, for all the different ages are necessarily mixed up together everywhere. But it may be found expedient, before everything else, to separate from the mass of the forest those portions in which the Selection System must be maintained. By reason, say, of its elevated situation or of the absence of shelter, a forest may sometimes contain certain portions

⁽L) This Chapter refers in a special manner to our silver fir forests that were formerly worked by Selection. The transformation of pine forests is an event of rarer occurrence, and is besides a loss difficult matter.

in which reproduction and even simple growth may be possible only under great difficulties. The constant preservation of the leaf-canopy is here a more important condition than the transformation or regularisation of the forest. Such portions constitute the natural protection for those situated below them, and the maintenance therein of the Selection System is necessary for their own existence. They may ordinarily be recognised from the portions capable of transformation by certain distinctive characters; for instance, the beech or the spruce may there be more numerous than elsewhere, or the trees there may be dwarfed and misshapen, or the leaf-canopy may be incomplete in places or vary in density from point to point; or, lastly, special and diverse phenomena observable may point out the particular portion or belt which must be continued to be worked on the Selection System.

The requisite separation just described being effected, the rest of the forest should then be divided off into Working Circles according to the general rules regulating that operation. And, as in forests treated by Selection, trees of all ages are found mixed up together without any order whatsoever, the main point to bear always in mind is the grouping into one and the same Working Circle of only such portions of the forest as require all the same Rotation.

The length of the Rotation to adopt must, of course, depend on the diameter the trees must attain in order to yield what is in greatest demand in the market and is the most useful to the country at large. In our finest silver fir forests of the Aude and the Jura, it is only when the trees have acquired a diameter of 28 inches at the height of a man from the ground, that they are classed as large timber and possess for every cubic foot of their volume the highest money-value and the largest sum of utility they can ever attain. In such forests the problem to solve is at what age the silver fir grown in Regular High Forest will attain this diameter. The trees of a forest worked by Selection reach this size at very different ages, according as they have been overtopped for a longer or shorter time, have maintained themselves in a more or less vigorous condition, and possess more or less healthy and well-furnished crowns. But amongst these trees there must always be some that have grown up so if they had been reared in a regular high forest; they may be

easily recognised by the form of their boles which are clean up to a great height; and by the thickness and aspect of their annual rings. It is the age of such trees, which have grown in a regular manuer and under average conditions of fertility, and which have besides attained the dimensions corresponding to the maximum of utility, that ought to be adopted as the figure for the Rotation.

The General Working Scheme gives the order in which the various portions of the forest shall be taken up for transformation during each successive Period of the Rotation. The Periods should as a rule, be long on account of the component species, which is with us generally the silver fir, and on account of the climatic conditions peculiar to high mountainous regions. The reason is evident, for in silver fir forests regeneration progresses very slowly, and in order to obtain it in a completely successful manner, great caution is necessary in the cultural operations. We do not estimate at less than 25 years the period of time that must elapse between the Primary and Final Fellings, and within this period at least*one Secondary Felling has to be made.

The Periodic Blocks should all be of equal extent whenever the ground permits of it, or, better still, of equal productive power. Each of them should, as far as possible, form a compact mass bounded by natural limits. The observance of this rule serves in the majority of cases to indicate the proper number of Blocks to adopt, that figure being no longer, as in regular forests, determined by the number of the component age-groups, but by that of the natural topographical divisions of the ground. In forests hitherto worked by Selection, it may be a matter of great importance to have the successive Blocks of the same Working Circle following one another on the ground in the order in which they shold be taken up and in the direction opposite to that of dangerous winds. Indeed such a disposition of the Blocks is seldom impracticable in the forests under consideration. The Working Scheme is thus usually a very obvious one, and is, in any case, always well-defined.

The Special Scheme of Exploitations does not present the alightest difficulty as regards the nature of the cuttings to be prescribed—Transformation Fellings in the Block under transformation, Selection Fellings in all Blocks, the transformation of which has

net ret been commenced. The duty of proposing the Improvement Cuttings to be made in the portions already transformed and, therefore, already regularized, may be left entirely to the Executive Officer, no reference thereto being made in the Organisation Project. The Cleanings, even when their utility is greatest, as, for example, in a forest of mixed silver fir and beech, could not possibly be prescribed; while Thinnings, less useful in silver fir forests than almost anywhere else, never assume an urgent character, and are, moreover, it badly executed, extremely dangerous. In the majority of cases, therefore, it is eafer to leave them to those who are to execute the Organisation Project: they can judge better than any one else where and when such cuttings should be made, and will undertake them only when their utility is unquestionable. To tie the Executive Establishment down to carrying out a multitude of various operations, especially where mountain forests are concerned, would be the greatest mistake the Aménagiste could commit.

It remains now to show how the yield of principal produce for the duration of the current Period is calculated. This yield is naturally derived from two sources, (i) the produce of the Transformation Fellings, (ii) that of the Selection Fellings.

The Transformation Fellings, which are before everything else true Regeneration Fellings, ought to be based on volume. As a rule, they remove all the formed trees, in other words, trees other than mere poles; to remove anything else would be defeating their very object, which is to leave, after the cuttings have passed through, young canopied crops capable of forming a harmonious whole and of soon constituting a high forest little removed from the regular state. The Aménagiste is thus obliged to include in his estimate of the yield trees having a diameter of only 16 inches, and even of 14 inches in the majority of cases. It is clear that if such trees exist in any numbers, the transformation of the forest entails a heavy sacrifice. However it be, the enumeration and measurement of trees above a certain diameter affords the means of readily ascertaining the actual contents of the standing timber. The future increment of these trees up to the time of their exploitation cannot be determined in the same manner as that of canopied crops composed of trees of the same age. If it is desired to take this future

increment into account, the Amenagiste must, in order to estimate it, go back to the figures yielded by the former Selection Fellings, or find out the sum of production of the soil. But it is better to neglect the future increment altogether, in which case care should be taken to prescribe several revisions of the annual yield string the course of the current Period.

The yield of the Selection Fellings to be made in the Blocks that have not yet come under transformation presents no difficulty. This is obvious, for in order to obtain the most desirable results possible, it is expedient to remove only such trees as could not maintain themselves in a sound state until the crops containing them reached their turn for transformation. The effect of this rule is, if we wish to work with some certainty as to results, that only mature trees are removed in the successive Selection Fellings. Treated thus, the crops still worked by Selection end by becoming gradually more and more complete. Each successive Period finds the small and healthy trees of the preceding Period grown up into a higher age-class, and in this manner the general appearance of the crops, as they approach their turn for transformation, resembles more and more that of old high forest, a most favourable circumstance whether we regard it from the point of view of improved produce or the regeneration of those crops or the maintenance of a sustained yield during the various Periods occupied by the transformation. All these results may be obtained with certainty simply by restricting the Selection Fellings to a limited number of trees, at the rate. say, of two-fifths of a tree per acre at the outside, or even at the rate of only one-fifth of a tree if the forest contains only a small stock of large timber.

This point being settled, our own opinion is that the march of the Selection Fellings in the Blocks not yet brought under transformation should be arranged in a very simple manner. Given, for instance, a silver fir forest of 1000 acres that is worked on a Rotation of 144 years, divided into 4 periods of 36 years each. We will suppose that it is considered advisable that the three Blocks which are still to be treated by Selection should be completely worked over every six years. Then their total area should be partitioned off into 6 coupes, the successive order in which these 6 coupes should be taken in hand and the number of trees that should be

removed annually being fixed at the same time. If it was decided to cut on an average one-third of a tree per acre, then the total number of trees to be felled by Selection during the Birst Period in these three Blocks would be 250 per annum.

If there was reason to fear that too short a periodicity for the Selection Fellings would have the effect of exhausting the crops operated upon, then it could be raised to 9 years; in other words the area would be divided into 9 coupes of equivalent productive power and the successive order and yield of these coupes determined as just described. At the end of the Period, or even at each revision of the yield; the results obtained by these restricted Selection Fellings should be noted, and in this manner it would be easy to judge whether it would be expedient to maintain, raise, or reduce the number of trees fixed at starting.

With the Selection Fellings restricted to really mature trees, no matter what their size, it is possible to maintain a selection-worked forest unchanged, as regards the density of the component srops, for an indefinite period of time. Our finest silver fir forests prove this. The Blocks to be transformed last must, as a consequence of such treatment, assume more and more the appearance of regular Old High Forest until regenerated each in its proper turn, provided always that overtopped poles are on no condition removed.

Besides this, it is easy to see that with the produce derived? from Transformation Fellings in one part of the forest and from Selection Fellings everywhere else, the yield of the First Period can searcely ever fail to reach a sufficiently high figure. The extraction of material over and above the outturn of these cuttings, if it must be effected in some portions of the Working Circle in order to fill upany deficit, should hence be restricted to a few really exceptional localities, and he exploitation of such produce should be spread over a number of years so as to remove only moderate quantities at a time and avoid all risk of converting its extraction into a series of operations disastrous from a cultural point of view and dangerous in every other respect. We would deprecate any attempt to fix the Botation for transformation below the figure that would have been required for the same forest had it been already regularised. There-

is no advantage to be gained by trying to burry on; on the contrary two disadvantages inevitably follow. In the first place, too much would thereby be cut during the First Period, a result that must, imperil to a considerable extent the success of the transformation operations. We know of certain silver fir forests that have been thus overworked for only 30 years, and already they have reached such a stage that they can now stand nothing severer than the most circumspect Selection Fellings. In the second place, it is impossible to form a regular high forest presenting a complete series of graduated age-classes with a curtailed Rotation.

In the case of Selection-worked forests that are poorly stocked, it may even be found expedient to put them through a period of special preparation in order to render them capable of being transformed. For this purpose, it would be enough to let the stock of a single canton mature on by restricting the Selection Fellings therein to as low a figure as possible, or even by not touching it at all and confining such fellings to the remainder of the Working Circle. After this Preparatory Period the conserved canton may be regenerated under the most favourable conditions and without necessitating the extraction of any considerable quantity of immature timber.

In most forests worked by Selection there are always some portions, and these very generally young, which have grown up in a regular manner either as the result of accidental circumstances or of Final Regeneration Fellings. To turn such crops to the best account, it is enough if they are placed in the right Block, say, the last, for instance. But in an ill-stocked Working Circle it is often useful to include these young crops in the First Block, so that they might together constitute a notable proportion of its area, and thereby render possible the preservation of growing timber on an equal area for one Period more than in the contrary case, often assuring by that means alone the success of the transformation.

As regards blanks and glades, they ought to be restocked as soon as possible, whatever their position in respect of time in the General Working Scheme. In silver fir forests this restocking is usually a very slow operation. Shelter of every kind, whether it be afforded naturally by existing trees, scrub, and bushes, or by piness

or spruce firs planted out as nurses, is indispensable in the majority The consequence is that the restoration, like the creation. of a silver fir forest is the work of two generations of men. and its difficulty can therefore be easily appreciated. And, indeed. the important nature of the task before us cannot but strike any one, if he only bears in mind that we have barely 500,000 acres of silver fir and spruce forests under the control of the Forest Department, that all the remaining areas containing these species are comparatively of very little value, and that we depend on foreign countries for an immense proportion of our annual supply of deal timber when our own mountain forests could produce it all. But silver fir forests are as quick to disappear as they are slow to reform Thus it is a matter of no little importance how we regulate the working of such of these forests as are managed by the State, by means of judicious' Organisation Projects, and above all by practising throughout the utmost economy and moderation.



CHAPTER IV.

IRREGULAR HIGH FORESTS OF THE BROAD-LEAVED SPECIES.

SECTION I.

CULTURAL REQUIREMENTS.

The method of treatment known as that à tire et aire consisted in the clean-felling of equal areas in unbroken consecutive order. The Royal Edict of 1669 made its observance compulsory in high forests as well as in copses. That Edict prescribed the reservation of ten trees per French acre (1.275 English acres).

Moreover, when once a clean-felling had been made in any place, the method in question admitted no further cuttings of any kindemutil the next clean-felling took place on the expiration of a whole Rotation, the only exception to the rule being the Extraordinary Fellings executed under the special orders of the King's Council. Thus from one end of the Rotation to the other, the growth of the new crop was left to chance and Improvement Cuttings were not even so much as thought of.

This method of treatment was especially employed in the plains forests, which were stocked with broad-leaved species, and the produce of which could be exported for general consumption. Its essential object was the production of the large timber required by the country at large and the Royal Navy. The rigid consecutive order which the Edict prescribed for the fellings was intended before everything else to assure the complete and unqualified preservation of every crop during an entire liotation of from 150 to 200 years, that is to say, until it had attained complete gesturity.

By the time a forest reached this advanced age, the cover of the trees must everywhere have become lofty, all low undergrowth must long since have disappeared, and the soil must have been already covered with a more or less abundant crop of seedlings. The trees that had to be spared at the exploitations, were reserved simply with a view to the production of timber of exceptional size and quality. Indeed, at the age fixed for the clean-fellings, the oak trees, if there were any, could neither have possessed great diameter, nor have contained very close-grained wood, owing to the overcrowded state in which they necessarily grew up. And it was precisely in forests of oak and hornbeam, or of oak and beech, that this method of treatment was in full force.

The limited area under State control that now remains to us of our old high forests of the broad-leaved species (about 500,000 acres) was formerly subjected to the tire et airs method. These forests, such as they were 50 years ago, are faithfully described in the "Cours de Culture des Bois" of Messrs. Lorentz and Parade, and although their aspect and condition have been singularly modified by the exploitations that have been made in them since those days, yet we must still go back to the description of those forests as given by our Masters, in order to draw therefrom the necessary inspiration to enable us rightly to understand how to organise and treat them so as to regularise them.

Nearly all these forests are situated in the plains, or in undulating country where the climate is mild. Of the principal species, all well adapted to the soil and climate, they contain the oaks; beech and hornbeam, besides, in an exceptional manner, the Scots' pine, which is artificially introduced in order to repair damage caused either by accidents or faulty operations. The oak is too often found in them in a pure state, the result of a systematic attempt to exterminate the beech and hornbeam. The sessile flowered cak adapts itself better to this state than the peduncled species, the result being that we have now completely canopied masses of pure sessile-flowered oak aged from 150 to 200 years, perfectly healthy, but making exceedingly slow growth and thus yielding spongy and nerveless timber. We could cite several cases in which the trunks measure scarcely 20 inches in diameter, whereas if they had grown in associasion with the beech in dry soils and with the hornbeam in moist localities, they would have attained twice that thickness. The

peduscled oak requires richer, deeper, and moister soil than the other species; it is the oak of low and wet situations, where it produces tough close-grained wood and attains the largest dimensions, but, like its congener, only on the condition that it is associated with other species. The hornbeam is its most useful companion and auxiliary.

The majority of the class of high forests just described offer more or less numerous instances of irregularity. Here and there we still find in them superannuated trees of oak or other species, crops holding out no promise whatsoever or containing but a small proportion of the principal species, portions that have undergone deterioration or have been completely ruined, &c. Again, even the consecutive order of the cuttings which essentially constituted the method, has seldom been observed; exploitable trees have been taken out wherever they were found, and especially from such places as offered peculiar facilities for export and sale. The result of all this has been the frequent and entire absence of any consecutive order in the exploitations and an utter confusion of age-classes. Then again, the area of the annual coupes varied from year to year, according as more or less produce was required in particular years, or in consequence of marked changes made in the length of the Rotation. The inevitable result was a defective gradation of the various age-classes. Moreover, circumstances of a special nature aggravated the evils already enumerated; thus, for instance, in a great many forests, towards the end of the last century, an unlimited number of trees in crops aged from 20 to 30 years were systematically cut back, with the result that whole age-classes were thereby completely wiped out. Repeated again and again, these irregular fellings have given rise to veritable copses, both simple and compound, in certain parts of the forests we are describing. Elsewhere artificial restocking has preduced whele crops of brief longevity of an entirely special type. Lastly, offences and injury of all kinds, such as the cutting down or topping off of trees, the lopping off of branches, the repeated removal of the layer of dead leaves on the ground, grazing, the browsing of cattle, the depredations of game, &c., all these causes have, singly

⁽¹⁾ In a pole crop from 40 to 50 years old and containing from 2000 to 2000 stems, one or two of oak to every nine or eight of brech and hornbeam would be a sufficient proportion to have.

After what we have just said, it is easy to understand how certain forests of our plains have been brought into a state of the utmost irregularity. The effects produced continue to manifest themselves even now, long after the causes, which gave rise to them and which we have just enumerated, have ceased to exist, and although the Method of tire et aire has long since been abandoned. The organisation of the forests treated by that method is thus a singularly complicated and difficult task and is for that very reason all the more an urgent one.

SECTION II.

ORGANISATION OF IRREGULAR HIGH FORESTS OF THE BROAD-LEAVED SPECIES.

When, after having formed the Compartments and the Working Circles and determined the length of the Rotation, the Amenagiste sets himself to draw up the General Working Scheme, he nearly always finds himself confronted with difficulties of no trifling nature. These difficulties are, as a rule, due to the defective constitution of certain crops, the irregular distribution of the various Age-classes, and the unequal repartition of the crops corresponding to the principal age-classes. The formation of the Blocks thus becomes a very delicate operation. In the same manner as in regular high forests, every endeavour should be made to form them in accordance with the general principles already laid down, that is to my, they should be equal in extent or be of equivalent productive power, and be all in one piece as far as that is possible. Besides this each Block should comprise a convenient group of compartments, in other other words, the whole or at least the greater portion of it should be composed of crops that will become exploitable during the Period assigned for its regeneration.

With respect to single compartments surrounded on all sides by others of entirely dissimilar character, and which their age, state of growth, composition or density prevent from being regenerated at the same time as the general mass of the Block in which they are situated, they must be considered apart from the rest of that Block. The Special Scheme of Exploitations should prescribe, at

the beginning of each Period, the separate treatment required by each such compartment so as to turn it to good account. The Special Scheme should also endeavour to bring about the necessary harmony between the various compartments composing the Block, but without rendering necessary any great sacrifices in order to attain it.

It is impossible to foresee all the various special circumstances that one may have to deal with in organising these irregular forests. The student will gather from the annexed example, which we have expressly drawn up, some idea of the principal difficulties to be encountered in this work, and of the combinations by which it is often possible to satisfy the requirements of an effective treatment, as well as at the same time to realize, within the measure of the possible, the principal benefits to be derived from a good Organisation Project.

Given a Working Circle stocked with oak, beech, hornbeam, and other broad-leaved species; area 5000 acres. Suppose that the Rotation suited for the forest, when it has been regularised, is 180 years, and that this figure is adopted as the basis of the General Working Scheme during the regularisation. Granted also that it has been ascertained that no crop of this forest ought to be exploited before it is 160 years old, at which age the oak acquires, under existing conditions, a diameter of 26 inches, or after it has reached the age of 200 years, when the trees begin to decay. We will further suppose that the configuration of the ground and the distribution of the crops have led to the formation of five Blocks as shown in the subjoined Tabular Statement.

Periodie Blocks	Compartments	Area.	Nature and condition of standing stock.	Age of stock at consmencement of Organisation.	Probable Perfod for regeneration.
		acres.		years.	
; ~	A	45	Thickets and Saplings of mixed species.	18 to 20	10
I	В	100	Old High Forest of oak and beech.	190	1
	C	37	Pole crop of alder, dotted with old oaks.	75	1
	D	45	High Forest of beech.	140	1
	E	62	High Forest of oak sprin- kled with hornbeam.	140	2
11	F	105	Pole crop of hornbeam and scattered oak.	50	2
	G	70	High Forest of beech, interspersed with blanks	120	2
	н	105	and glades. Half-grown High Forest of oak and beech.	90	3
	I	30	Pole crop on stools; horn- beam, oak, and the soft woods.	35	: 2 :
ш	K	55	Young pole crop of pure oak, an old plantation.	32	- 4
	L	70	High Forest of oak and hornbeam with reserves of oak,	120	3
	M	75	High Forest of pak, beech, and hornbeam.	100	3
	N	80	Pole crop of the soft woods, with scattered oak and mixed with hornbeam.	40	1 and S
	0	35	Alder copse.	10	1 and 31

Periodio Blocks.	Compartments	Area.	Nature and condition of standing stock.	Age of Stock at commencement of Organisation.	Probable Preiod for regeneration.
	P	92	and beech.	80	4
	Q	32	Pole crop of oak and beech. with an upper stage of very numerous reserves of the same species.	45	- 4 ;
IV.	R	45	Sapling crop of oak and hornbeam, over-topped with soft woods.	25	5
	ន	20	High Forest of beech mix:	. 100	2 and 4
	T	65	Copse with standards, the hard woods badly re- presented.	5 to 16,	1,2 and 4
	U	57	Pole crop of oak, beech.	GO	4
	(v	135	Pole crop of oak, hornbeam and the soft woods.	35	
	x	17	Open High Forest of pure	180	1 and 5
	Y	30	Seedling crop of beech and oak under reserves, state of a Secondary Coupe.		1 and 5
	Z	40	Pole crop of birch torming the dominant species, with beech and oak.	65	1 and 2
	LAB	65	Crop of High Poles of beech and oak, in good condi- tion, sprinkled with re- serves of two different	70,140 & 200	2 and 5
		1492	ages.		Fig. 4

The figures in the last column deduced from the actual state of the crops, may be entirely conjectural, but they cannot be dispensed with, as they afford the necessary basis for the General Working Scheme, which could not otherwise be framed. From them we conclude that the following exploitations should be made during the First Period:—

Irregular High Forest Fellings in compartments X. Y. and Z. Ares 87 acres.

Regular High Forest Fellings in compartments B, C, and D, area 182 acres.

Irregular Coppice Fellings in compartments N, O, and T, area 165 acres.

Compartment X, with a limited area, is necessarily placed in the last Block, in the very middle of which it is situated. Compartment Y, which is in course of regeneration, requires only the last Secondary Fellings and the Final Felling over the new seedling crop, which will become exploitable in the last Period of the current Rotation. Compartment Z, which contains, considered as a whole, a crop of no promise and of little value, must be regenerated during the current Period, but all oak poles should be spared; these poles will form a valuable portion of the new crop. As a necessary and sufficient set off against these irregular exploitations, compartments A and E ought not to be exploited during the First Period. Compartment N must be worked as a copse with Standards, the object in view being to preserve all the useful hardwood portion of the crop; that, with the new regrowth, will together form an old copse of 72 years at the commencement of the Third Period, when the compartment in question will reach its turn for regeneration by Seed. Compartments O and T will be exploited as copse when about 36 years old, the proportion of the hardwoods in them being in the meanwhile increased by means of thinnings followed by artificial planting under the cover overhead. At the beginning of the Second Period it will have to be seen whether it will be necessary to repeat ouce more the Coppice Fellings in these two last mentioned compartments.

Such are, in a few words, the principal exploitations that should be made during the First Period. They are restricted to an area equal to the extent of one Block, and their object is to renew several crops that have no present promise whatsoever. In making these exploitations every thing must be done that will facilitate matters for the next exploitation, during the proper Period, of the regenerated and reformed crop. These preliminary operations will thus be the first step towards order and permanent improvement.

If a similar Tabular Statement with regard to the crops to be exploited during the Second Period is drawn up, it will be seen that their exploitation will have been greatly facilitated by the work done during the First Period. It will be found possible, in the next Special Scheme of Exploitations, to arrange for exploiting with a sparing hand those crops and individual trees, respecting the good growth and promise of which there can then be no doubt. It is quite possible that compartments A and B, with their mature standards only gradually cut out, could be maintained standing until the Fourth Period, and that compartment S could be transformed in as happy a manner by means of judicious Thinnings, so as not to require, contrary to present expectation, any partial regeneration in view of the beech during the Second Period.

The student will now understand that it is easy to obtain some previous idea of the extent to which a sustained yield can be assured for each of the Periods of a Rotation, and especially for the first two or three. He will be able to note how the various crops of a Working Circle are regenerated by seed one by one, each in its turn, either during the Period to which it is assigned in the General Working Scheme or during the immediately preceding or immediately following Period. He will observe how, when the position of each compartment in the General Working Scheme is known, the object of every operation to be carried out become? clear and well defined. Lastly, he will perceive how the General Working Scheme, although sketchy, yet absolutely necessary at the commencement of the every Organisation Project, becomes better and better defined as Period after Period passes, until it entirely loses its artificial character, and forms with the actual state of the forest a harmonious and natural whole.

SECTION III.

NECESSARY RESULTS.

The Method of Organisation by Area is as simple as any that can be applied to high forests. In it the Organisation Project consists of two essential parts; (I) the General Working Scheme, which has a permanent character on the ground itself and may be indefinitely maintained unchanged; (II) the Special Scheme of Exploitations, which arranges and prescribes the operation to

be made during a necessarily limited time. The whole scheme of work can thereby be taken in at a glasce and its control and execution become thereby easy.

If the necessity of organising high forests is incontestible, it is equally obvious that the Method based on Area supplies the necessary starting point for the regularisation and improvement of a forest. If it be asked what we understand by these two words, which express one and the same idea? The reply is easy. They mean, in the first place, the bringing into a favourable condition or the restoration of the component crops of the forest, chiefly with the aid of time, but also by means of well-conducted operations, such as Cleanings and Thinnings. In the second place, they imply the beneficial results following from certain cultural works, such as the re-stocking of blanks, the re-introduction of the principal species which have disappeared, the augmentation of the proportion of the auxiliary species now too rare, &c. Lastly, they signify the replacement, by means of natural reproduction, of defective by well-constituted crops. All these various cultural operations merge into one common object, viz., the regularisation of the component crops of the forest—the very highest possible order of improvement we can affect, acting gradually and with moderation, in each of them.

Another class of improvement operations, the organisation works properly so called, comprises the arrangement of the exploitations according to some fixed order of succession, the creation of a convenient gradation of age-classes, and the collocation of the crops to be regularised in the strictest comformity with the Rules for locating coupes. The exploitations made in a Working Circle require to follow a very simple order; the Method of Organisation by Area permits of the establishment of this order to the farthest extent that the actual state of the forest can admit of. means of a proper gradation of ages a sustained yield is assured and a stock of exploitable timber can never at any time fail, both ends being secured by the General Working Scheme. A judicious collocation of the crops favours their growth and permits of their being exploited in successive order: the formation of Blocks, each generally in one piece, guarantees the early attainment of this twofold object once for all.

Cultural improvements, by which the crops are brought into a favourable condition for growth, are evidently of the highest importance; and such of this class of improvements as can result directly from the Organisation itself are assured to a sufficient extent by the judicious employment of the Area Method. It is in this indispensable exercise of the judgment and of provident moderation that lie the difficulties of that Method. Just as the greatest of all improvements that can be effected in a forest results from the growth and consequent increase of the component' crops, the greatest danger to which an Organisation Project is exposed is the exhaustion of the forest for which it is drawn up. For when once it is found necessary to reduce the figure of the annual exploitations, it is nearly always impossible to effect the reduction to the requisite extent. Thus the crops are felled too young, and the impoverishment of the forest continues indefinitely. Indeed, when once matters have reached this stuge, it is only a short step to make, by progressively lowering the age of the crops brought under the axe and hastening their deterioration, to accomplish the ruin of the forest. But the Method of Organisation by Area affords a sure means of obviating this danger and even of creating anew, in the shortest space of time possible, those very age-classes which are now wanting; for by means of it the exploitations can be curtailed to any extent required, and in order successfully to restore the forest, it is generally sufficient to remove, in the Fellings of the current Period, only such trees as are really exploitable.

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