PRINCIPLES
OF
FOREST ORGANISATION

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BOOK III.

THE WORKING SCHEME IN THE ORGANISATION OF HIGH FORESTS.

GENERAL NOTIONS.

HAVING decided what Régime, Method of Treatment, and Rotation or Age of Exploitability to adopt for an entire forest, or for each of the several large masses which compose it, the next step is to prescribe the series of exploitations that must be made in each compartment, to fix their serial succession for the whole of each Working Circle, and to ascertain the annual yield. This work constitutes what we will call the WORKING SCHEME; it is the very pith of the Organisation Project, and is the law which is to govern the foresters charged with the execution of that Project.

The Working Scheme is generally drawn up in tabular form embodying in one or two statements the prescriptions relative to the exploitations, so that any one may take in the whole series at a glance. The particular form differs according to the method of treatment to which the Working Circle is subjected; since the nature and succession of the cuttings, as also the manner of determining and expressing the yield, necessarily vary with the method of treatment.

High forests worked by the Natural Method yield extremely variable products according to the age and dimensions of the wood cut. The timber removed in the Regeneration Fellings comprises, what we will term, the PRINCIPAL PRODUCE of the Working Circle. The Improvement Cuttings, which are made while the forest is

growing up, yield produce of minor importance, which we will designate the ACCESSORY[1] PRODUCE of the Working Circle.

In foresters' parlance, we thus include under the name of PRINCIPAL PRODUCE the timber obtained from the series of Reproduction or Regeneration Fellings, and usually also windfalls and dead standing trees; while the ACCESSORY PRODUCE comprises all the wood cut in the thinnings and weedings, or, speaking in general terms, in the Improvement Cuttings.

In high forests worked by the Natural Method, the yield of principal produce is expressed in cubic measurement. With equal areas exploited annually, the quantity of material obtained would often differ very considerably from year to year, while it would besides be impossible to predict, within several years, the date of the appearance and establishment of the new generation of seedlings, for the favourable development of which the number of the reserved trees acting as nurses must vary from point to point, according to the quantity of light required. Every attempt hitherto made to fix the yield of high forests by area has ended in unsatisfactory and, often, even disastrous results. On the other hand, it is expedient to base the yield of the accessory produce of a Working Circle on area, and not on cubical contents. The advantages attaching to this procedure are many; it is more simple, it is the surest means of securing the return everywhere of the thinning operations at the right time; it is the only way of preserving for these operations their essential character of Improvement Cuttings, since it leaves to the executive officer complete liberty of action as to the quantity to exploit, his only pre-occupation being how best to improve the growth of the forest.

The Working Scheme must satisfy several essential conditions. In the first place, it must, as far as is practicable, be so drawn up that each compartment may reach its turn for regeneration more or less near the age fixed for the exploitability of the forest. It must,

1.) This class of produce, accessory both from the Sylviculturist's and Administrative points of view, must not be confounded with the class of produce termed also *accessoire* in official language. This latter word is used for produce, whether ligneous or otherwise, derived from communal forests, and which are not liable to the Government charge of 5 per cent. for cost of administration. In the state forests such produce is termed minor produce.

moreover, distribute the annual exploitations of principal produce according to the requirements of the Rules for locating coupes.

Again, it is very important that the annual outturn should be sufficiently equal during the whole rotation. This condition of a sustained yield may be realized in high forests worked by the Natural Method, by exploiting during equal periods either equal quantities of produce or simply equivalent areas ,*i.e.*, areas of equal productive power. Here we observe the point of departure for the two different methods employed in the drawing up the Working Scheme for such forests, which constitute as many different methods of Forest Organisation. One of these, comprising several modes of procedure, we will call the VOLUMETRIC METHOD, the other we will term the METHOD OF EQUIVALENT AREAS. We shall examine each method separately; but before proceeding to do so, it is necessary to define clearly the practical value of the fundamental idea that essentially underlies them both, namely, the realisation of a sustained yield.

CHAPTER 1

A SUSTAINED YIELD.

In high forests, the yield of which is based on volume, it would seem possible to realise the condition of a sustained yield by dividing the total quantity of the timber to be felled during the course of an entire rotation by the number of years in the rotation. But this quantity would include not only the actual contents of the standing timber, but also the total annual increment of each crop up to the time of its exploitation. Now it is impossible to estimate with any degree of exactness the future increment of crops, that are still to grow on for a long series of years, up to the time they reach their turn for exploitation. It is for this reason that it is a point of doctrine in forest organisation to divide the rotation for high forests into a certain number of periods, and to estimate successively beforehand the yield of the given forest during the currency of each of them. To this end, the exploitations to be made during the course of the rotation are arranged in their order of succession and grouped together according to the periods into which they fall, in such a manner as to obtain as nearly as possible equal quantities of produce in equal periods of time. This distribution of the annual exploitations may be effected either according to volume or to area, and it is in this that lies the distinctive character of the two methods of forest organisation. The next step is to determine the annual quota of the produce to be exploited during the first period. The same process is repeated at the commencement of each of the following periods of the current rotation, and, if on passing from one period to the next, the calculated yield of the forest is found to be appreciably the same as it was for the First Period, it is clear that the yield is a sustained one; conversely, if the conditions necessary for assuring a sustained yield have been correctly determined and established, the annual yield of the forest cannot vary, or, at the worst, it will differ but little from period to period.

To assure a sustained yield and to estimate at the beginning of each period the annual yield during that period are thus two perfectly distinct operations in the organisation of a high forest. The first, which is the more important of the two, consists, we have said, in the proper distribution of the exploitations between the periods of the rotation. Now in whatever way the distribution is made, it stands to reason *à priori* that it is impossible to succeed at once in perfectly equalizing the total quota of produce for each period. The problem of assuring a sustained yield is thus not only a difficult one, but also one, of which we can obtain only an approximate solution. It even often happens that it is impossbile to assure a sustained yield without having to exploit a certain number of the crops either too late or too early. It thus becomes a question of importance to ascertain, from the very beginning, how far it is the interest of the proprietor of a given forest to secure a sustained yield and thus have the annual or periodic quota of produce equal.

The limits between which the yield of a forest may vary, while still remaining sufficiently uniform to be considered sustained, depend on the condition and situation of the forest, and, above all, on the character of the proprietor.

If the proprietor is a private individual, his main object will be to obtain the largest pecuniary profits from his property. As a rule, he will not pay any attention to the equalization of the annual or periodic quota of produce, and will admit no other principle but that of the satisfaction of his own personal wants and the increase of his wealth. He will exploit and sell on a large scale when the demand is high, and will diminish or entirely suspend his exploitations when the market is dull and prices low.

Nevertheless, if he possessed a real forest, which would ordinarily form no small part of his wealth, he could not afford to neglect all considerations of a sustained yield by suspending his exploitations, unless he was in a position to obtain from some source other than his forest the annual income which he required. Such a happy combination of circumstances is, however, the exception and not the rule, and the necessity of having a sustained yield

is only too often felt by him in its fullest force, the result being premature exploitations at the sacrifice of capital and income in the future.

If the owner is a Public Foundation or a Commune or Municipality, it is necessary to determine the capacity of its forest, and assure the yield being sustained as accurately as possible. It is obvious that the Commune is an imperishable collection of individuals, every generation of which has an equal right to enjoy the income derived from the communal property, either by receiving its own share of the produce, or by selling it in order to cover the annual budget expenditure. The same is the case with Public Foundations. But Communes and Public Foundations both partake of the same character as the State as regards their constitution, while they resemble the private individual in that they are subject to constantly pressing needs, since their resources are, as a rule, limited, and are often represented wholly by the produce of their forests. Every year their budget expenditure is based upon the quantity and value of this produce. It thus becomes important to correctly determine in advance the annual quota of such produce, which must on that account vary as little as possible from year to year. Besides this, it is indispensable to preserve and to save up resources in ordinary years in order to provide against future unexpected contingencies. The law itself has provided for this by ruling that one quarter of the forest of every such proprietor shall be reserved in view of extraordinary wants. Very often the condition of assuring a sustained yield, which places an effective check on immoderate cuttings, becomes an essential guarantee for the preservation of a communal forest. It is for this reason that the Royal Edict putting into force the Forest Code, while refraining from laying Communes under the obligation of organising their woods with a view to increased production and the rearing of high forests, has at least fenced round the exploitation of their forests with wise restrictions. To respect these restrictions is of the highest importance.

Lastly, in the case of forests belonging to the State, the question of assuring a sustained yield may be subordinated to the treatment which the crops stand in need of. There can be no dispute that the duty of the State is to bring into existence the largest

quantity possible of produce required for the daily wants of the population, as well as to guarantee an adequate supply of timber for large civil and naval public works. The state forests ought, therefore, to be subjected to that Régime and Exploitability, which, taking into account the constituent species and the special conditions of vegetation, shall guarantee the production of the most useful material. It is moreover evident that as the wants of the State and of Society, which is co-extensive with it, are ever changing, the state forests ought to be able to satisfy for all time, within the limits of the possible, the multifarious wants of the nation. It thus follows, firstly, that these forests ought to be so worked that the exploitations are annual and the quantity of produce the same from year to year; and secondly, that in treating and working those amongst them which are composed of the more valuable species, there ought always to be a certain number of reserved trees fit for exploitation at any moment. The object of maintaining this RESERVED FUND of standing timber is to provide against unexpected demands, like those of the navy and the army in time of war.

Such are the principles on which must be based the determination of the quota of the annual cuttings in state forests, principles the application of which would be easy, if all these forests were regular and composed of the better species, and if each one was subjected to the Régime, Method of Treatment, and Rotation that suited the most valuable of those species. But many of them are irregular and composed chiefly of inferior species, or are exploited at an age and according to a method of treatment which do not obtain from them the highest sum of usefulness that they could yield. Hence, it is necessary first of all to improve the actual constitution of these forests, and to bring them little by little into a better condition.

To effect the transformation or improvement of a forest, there is often no alternative but to neglect for some time the condition of a sustained yield, in order to carry out in a successful manner the cultural operations. Still this neglect of one of the fundamental principles of forest economy may prove in the end to be more apparent than real; for, if, instead of considering the particular forest by itself, we take into account the production of all those situated round the same centre of consumption, we shall

often find an equilibrium established on the whole by compensations between restricted cuttings on the one side and abnormally large cuttings on the other. Often also, in organising any given forest, it is possible to combine the exploitations in its various component Working Circles in such a manner, as to have the general yield of the whole forest appreciably the same from period to period. Let us in the last place add that the continuous improvement of our export lines and roads allows of a more equal distribution of forest produce throughout the country, and of its easy export from one district to another, so that the supply at once responds to the demand.

To summarise what precedes, we see that it is necessary, in organising high forests, to endeavour to combine the exploitations in such a manner, as to obtain sufficiently equal quantities of produce in equal periods of the rotation. Nevertheless, if in any given forest there is no exploitable timber at all to be found, it is certainly better to wait till the older portions of the standing stock are completely mature, than to fell them when they are, as it were, on the eve of acquiring all their finest qualities. If, on the contrary, old timber is abundant, while the age-class next below it is insufficiently represented, it is expedient to distribute the exploitation of this old material, already exploitable though it be, over the first two periods of the rotation, in order to reserve for the next generation the supply of large timber which it will require, and to allow the younger crops sufficient time to reach maturity.

The reason is obvious, for the production of large timber is the chief *raison d'être* of state forests, since all other descriptions of ligneous produce can be obtained from communal and private woodlands as well. The main duty of the Forest Department is thus to economize as much as possible what timber is still left in the state forests, and to be careful not to abandon to the axe vigorous well-formed and flourishing trees before they have attained exploitable dimensions. This recommendation of ours refers chiefly to our two principal species, the oak and the silver fir, which in our climate yield timber of a quality far above the average. Our state forests, such as they have come down to us, can furnish only a small proportion of the large timber required by the country, and we are reduced to go the foreigner for a considerable

portion of our supply of timber suited for the cabinet-maker and the cooper. The wants of the former are supplied from the countries round the Baltic, those of the latter from the countries on the Adriatic. Now we know on unimpeachable authority that the forests in the neighbourhood of those two seas are becoming impoverished and exhausted, and at no distant date, perhaps in less than a half a century, this source of supply will completely cease to exist. It is necessary, therefore, now more than ever, to apply ourselves with all the means at our disposal to the production of large timber, even if to attain that result we had for the present to forego a portion of our forest revenue and to neglect for a time, comparatively short after all, the condition of a sustained yield in our high forests.[1]

(1.) The forest of Fontainebleau offers to the observer at the very gates of Paris a sight full of instruction. Out of a total area of 42,500 acres about 2,500 acres are under full-grown high forest, 5,000 acres under pole crops from 50 to 90 years old, and 32,500 acres under copse and young pine plantations, while more than 2,500 acres consist of the bare rock. Thus out of a total productive area of 40,000 acres, only 2,500 acres contain old timber. These chiefly cover the fine cantons that are reserved in the interests of the artist. But had there been no special reason for conserving these high forest crops, it would have been not less expedient, in the interests of the forester, not to touch them except with the most sparing hand. It would be advisable to spread their exploitation over as long a period as would suffice to allow the next lower age-class over some considerable area to reach a large size. For what would happen if, to secure a sustained yield, a quantity equal to the mean annual production of the forest were taken out every year? In less than 10 years every vestige of the full-grown high forest would have disappeared. In another ten years the pole crops would have suffered the same fate, and by the end of the present century the memory itself of the large timber now standing would have passed away with the generation that had seen it all felled. *In those days perhaps people would* refuse to believe that the sandy soil there could produce tall high forest, and for time without end this forest would be devoted to utter ruin. The most rigid economy is now the one indispensible guarantee for the future prosperity of this fine forest, and the question of a sustained yield must be subordinated to that of the proper exploitability and the requisite rest.

But it must not be thence inferred that there are cases, in which the condition of a sustained yield may be entirely disregarded, and to such extent as to suspend the exploitations for a time, or even only to reduce them to the lowest figure possible. To understand this, a moment's reflection is enough. Suppose, for example, that at Fontainebleau the income, reduced to £4,000, is barely sufficient to cover cost of supervision and maintenance, and yields no immediate profit to the State Treasury, or that the produce extracted is too inconsiderable to supply the town inside the forest with wood for the most ordinary purposes, such as cooking, &c. Such a state of things could not continue for any length of time. Very soon there would be a reaction, and a too parsimonious organisation would be partially or wholly set aside. Besides this such excessive rigour is quite useless. There is no forest, however poor it may be, but contains some crops that hold out little promise, and which can be cut, without detriment to the forest, so as to yield a sufficient supply of secondary produce. Thus the condition of a sustained yield is always to a certain extent imposed on the Aménagiste, and some means always offer themselves by which it may be satisfied. Only to judge the right extent and to recognise the true means require on the part of the Aménagiste an unfailing power of appreciation and a thorough knowledge of facts.

CHAPTER II.

THE VOLUMETRIC METHOD OF ORGANISATION.

SECTION I.

Description of the Method.

The various volumetric methods of forest organisation are based on the division of the rotation and the quantity of produce into equal and corresponding portions. Among these methods we will describe that of Hartig, from which all the rest have been derived and which gives a good general idea of them all. To estimate the total quantity of produce that the forest can furnish, it is indispensable to know beforehand when each of the crops composing a Working Circle will be fit to cut. The Aménagiste is thus obliged to make a forecast of the various ages at which the different crops should be exploited. The rotation having been determined and the order of the successive annual exploitations fixed provisionally, this forecast naturally follows as the next step. Dividing the rotation into a certain number of equal periods, the Aménagiste must make a trial distribution of the various compartments amongst these periods taking care to follow, the order indicated by the age of the crops and the Rules for locating coupes. This distribution takes the form of a tabular statement, divided into as many compartments as there are periods in the rotation, and which we will call the Trial Working Scheme. He must then estimate the quantity of produce which each compartment of the forest is likely to yield during the course of the different periods. A separate estimate must be made for the principal and the accessory produce, for the first by supposing that each compartment will be regenerated towards the middle of the period to which its exploi-

tation is assigned, for the second by adding together the quantity of material that is likely to fall in each compartment in the thinning and other improvement operations during the several Periods of the Rotation.

This done, the Aménagiste must next sum up the total quantity of produce that would be obtained in each of the various Periods. But as these sum totals can never, save by a very exceptional chance, be equal to one another, he must set about equalizing the quantities to fall in each Period by transfers from one compartment of the Trial Working Scheme to another, taking care that he does not thereby anticipate or put off till too late the exploitation of the crops so transferred. The first distribution of the compartments amongst the various Periods of the Rotation being thus altered, the result is a second Tabular Statement which we will term the FINAL WORKING SCHEME, or simply The Working Scheme.

Then by dividing the total quantity of produce to be exploited during the First Period by the number of years in that Period, he obtains the annual yield, i. e. the number of cubic feet to be removed each year from the whole Working Circle both in the Regeneration Fellings and the Improvement Cuttings.

SECTION II.

APPLICATION OF THE VOLUMETRIC METHOD.

The preceding analysis of the Volumetric Method shows that it requires two principal operations:—(i), the quantitative valuation of all the timber to be exploited in each compartment, both in the Regeneration Fellings and Improvement Cuttings during each of the Periods of the Rotation; (ii), the equal distribution of this produce amongst the various Periods.

We have stated above that before beginning any of these operations the compartments must be provisionally grouped together according to the Periods during which they would be severally regenerated, if nothing more but their age and the Rules for locating coupes were taken into account. Now as the standing timber has to be felled in equal quantities every year, we may, for purposes of calculation, suppose each compartment to be

regenerated towards the middle of the corresponding Period. This enables us to determine, first, the probable quantity of the principal produce which each compartment will yield during the Period in which it will be regenerated, and, second, the respective years in which the various compartments will be subjected to improvement operations and the probable quantity of produce which each such cutting will furnish.

Let us first note that these figures cannot be arrived at without complicated calculations as to the quantity of the standing material and its future increment. It is necessary to estimate not only the quantity of produce which each crop will furnish at its regeneration, but also what each compartment would yield in the thinning and other operations during the various Periods of the Rotation, before as well as after the time fixed for its regeneration. In whatever way these quantities may be obtained, they must be totalled up by Periods. But the original distribution of the compartments having been effected solely with regard to their age and the order of their successive exploitation or regeneration, without any consideration as to the extent or density of the crops grouped together under each Period, it follows that in the Provisional Working Scheme, the periodic quantities are necessarily very unequal. Hence, the necessity for equalising them by judicious transfers of certain crops from one Period to the next above or below it.

To effect this equalization, the quantities of both principal and accessory produce for all the Periods of the Rotation, as shown in the Provisional Scheme, are totalled up. This grand total is then divided by the number of the Periods, and the quotient thus obtained gives the quota of produce to exploit during each Period. For instance, if the total quantity for the whole of a Rotation, divided into four Periods, is 5,000,000 cubic feet, then the quota for each Period would be 1,250,000 cubic feet. If (to continue our illustration), according to the Provisional Working Scheme, the quantity of produce that may be cut in the First Period is 1,500,000 cubic feet instead of 1,250,000, the former figure must be reduced to the extent of 250,000 cubic feet by transferring the compartments to be regenerated last to the next following Period. If, on the other hand, the total produce for the First Period according to the Provisional Scheme was only 1,000,000 cubic feet, then 250,000

cubic feet would have to be added to it, by transferring to the First Period a sufficient number of the compartments to be regenerated according to the Provisional Scheme, at the commencement of the Second Period. The same process is continued for the other Periods until an equal distribution has been made. But easy as the process seems, the final result is arrived at only after a great deal of careful manipulation, of trial transfers and calculations; for each transfer means that the time for regenerating the compartments concerned is changed, the yield both of the Principal Fellings and the Improvement Cuttings being thereby altered. The effect of this is to obtain each time a new figure for the total produce to be felled during the whole Rotation. Going back to the case we have taken for illustration, the total quantity of produce after the transfers in question have been effected may be reduced to 4,800,000, and the periodic quota thus become 1,200,000. In any case, it is only in determining the quota for the last Period, when the yield of all the remaining compartments is added up, that the effect of the changes can be fully appreciated and it be decided, according to the extent of the resulting difference, whether these changes may be considered final and be accepted for the Final Working Scheme, or a fresh series of transfers be undertaken in order to arrive at a more approximate equalization. In the latter case, the Periodic Distribution Statement last obtained must be considered as a fresh Provisional Working Scheme, and the process described above repeated.

SECTION III.

VALUE OF THE VOLUMETRIC METHOD.

The operations of a forest organisation based on the Volumetric Method are necessarily very complicated. They imply the quantitative valuation of all the standing material in the entire Working Circle; the estimation of the future increment of every crop up to the moment of its exploitation; and, lastly, the determination of the quantity of accessory produce that will be furnished during the current Rotation by the crops, which will have taken the place of those regenerated early enough in the Rotation, that is to say, crops that have no present existence whatsoever. Indeed, it is the very essence and spirit of the Volumetric Method to determine

the annual yield by taking into account every kind of produce realizable.

In practice this method inevitably yields uncertain results, for how is it possible to estimate the future increment, for an interval of time as long as 50 or 100 years, of crops now much below the age of maturity? Whatever procedure is adopted, it can offer no adequate guarantee of accuracy.

This uncertainty of the results obtainable could not, of course, escape the originators of the method; and, in order to avoid an undue accumulation of errors necessarily arising from a too low or too high figure fixed for the annual yield, they laid down the rule that the Working Scheme was to be frequently verified, every 10 years for instance. These frequent verifications are a necessary concomitant of every system of forest organisation based on volume. They amount to the drawing up each time of an entirely new Working Scheme, since it naturally follows that all the original crops must have undergone radical and characteristic changes since the date of the previous Working Scheme. The consequence is the inevitable instability of the prescriptions relative to the treatment of the forest, and indeed of the whole of the Organisation Project itself. The time for exploiting any particular crop, as it depends on the figure of the annual yield, of course varies with it; and it may thus happen that all the operations now prescribed for any compartment may have to be changed at the next verification. These disadvantages, which are inherent in the method itself, would of themselves suffice to justify its condemnation, especially in France where the desire for order, simplicity, and stability in forest organisation had led to the universal adoption of the system of *Tire et Aire*. But all volumetric methods must be rejected on account of the very principle they imply. Basing, as they do, the distribution of the exploitations entirely on the element of volume, they have for essential object the exact determination of the annual yield. As a matter of principle, they seek to obtain a sustained yield independently of all considerations relative to the improvement of the forest. Whether the quantity of old timber is excessively large or totally insufficient, a certain fixed quota of it must be worked out every year. In the former case the last old trees will be found in full decay by the time their turn for exploitation comes; in the second case, after a few years all

the old timber will have disappeared and the felling operations will then perforce include trees still far removed from their maturity. Thus all the various systems founded on the Volumetric Method subordinate the production of the most useful timber to the condition of assuring a sustained yield.

The same is the case as regards the treatment of the forest, since these systems lead to the regeneration of some of the crops either too early or too late (both unfavourable conditions), and to the execution in them of Improvement Operations either in complete uncertainty as to the time for their regeneration, or, in the contrary case, in view of Regeneration Fellings to be made at some time other than that of their maturity. Now, in our high forests of the more valuable species, the treatment, and the cultural operations which this treatment requires, are often of far greater importance than the mere equalization of the yield. It is thus in our oak forests, in our numerous irregular high forests, in our silver fir forests which were formerly worked by Selection, and especially so in our copses under conversion into high forests. In principle, therefore, the Volumetric Method is radically defective.

The Volumetric Method has never been adopted in France. It had its *raison d'être* in Germany at the end of the last century. The forests there were in those days very irregular, and frequently contained no well marked gradation of age-classes. A great number of these were high forests abounding chiefly in beech, and belonging to petty principalities. They furnished a very considerable proportion of the receipts of the prince's exchequer. It was impossible to subject them to the Natural Method with the annual exploitations based on area, without compromising very considerably the equality of the annual returns. Besides the advantage of securing this equality, so necessary in such forests, Hartig's method of forest organisation possessed another great merit: it was the first step towards the regular organisation of high forests. Its inherent defects were soon discovered; its application, and criticism of the results obtained, showed at one and the same time these defects and the manner of correcting them. The Method of Forest Organisation by Area followed as a necessary consequence. This method has been formulated and developed in France according to the special necessities of our forests, and has been taught at our Forest School for many and many a year.

CHAPTER III.

FOREST ORGANISATION BY AREA.

SECTION I.

DESCRIPTION OF THE METHOD.

The Method of Forest Organisation by Area is based on the twofold division of the Rotation and of the Working Circle into equivalent or corresponding portions. It begins, by first dividing the Rotation into a certain number of, usually, equal Periods, and then the Working Circle into as many portions, each to be regenerated, in regular succession, during the respectively corresponding Period. These portions of the Working Circle we will term PERIODIC BLOCKS. They are intended to be exploited in equal periods of time, and ought therefore to be so formed that they may, as far as possible, furnish severally the same yield.

The correlative division of the Rotation into Periods and the Working Circle into Periodic Blocks must be made according to certain rules, which we will examine further on.

It is generally exhibited in the form of a table, in which the various compartments belonging to the several Periodic Blocks are grouped together according to their respective Periods, the characteristic letter and area of each compartment being duly entered. This table is thus a general skeleton plan of the exploitations, and constitutes what we shall call the General Working Scheme. Being drawn up once for all for the duration of a whole Rotation, it should contain nothing more than what concerns the simple composition of the Blocks, *i. e.*, give the compartments of which they are composed and the order in which they are to be regenerated.

But these meagre indications would not be enough to serve as guidance for the Executive Forest Officer. It is therefore necessary to complete them by prescribing the nature, succession, and extent of the exploitations to be made throughout the whole Working Circle. The portion of the Organisation Project which gives these details, we will designate the SPECIAL SCHEME OF EXPLOITATIONS. It consists of one or more tabular statements, in which are consigned prescriptions relative to exploitations to be made during a single Period only.

Thus, whereas the General Working Scheme applies to the whole duration of the Rotation, the succession of the cultural operations, and the annual yield are fixed for one Period only. It follows, therefore, that at the beginning of each Period it is necessary to draw up a fresh Special Scheme of Exploitations, that is to say, to arrange in advance the succession of the cuttings and similarly as before the annual yield for that Period. This last operation, in its entirety, may be termed the PERIODIC REVISION OF THE ORGANISATION PROJECT.

Lastly, in order to provide against errors in the valuation surveys and against the effects of unforeseen disasters, it is the rule to verify the quota of the annual yield once or oftener, at fixed intervals, during the currency of each Period.

Having thus far described summarily the Method by Area, we will now proceed to show how to apply it to high forests that are to be treated according to the Natural Method.

SECTION II.

FRAMING OF THE GENERAL WORKING SCHEME.

The framing of the General Working Scheme for a high forest organised by area consists wholly in the division of the Rotation into Periods and the Working Circle into corresponding Blocks.

As regards the Periods, it is, for the sake of simplicity, taken for granted that they shall be equal. Now being equal, what ought their duration to be? We proceed to answer this question.

It has been a subject of much vehement discussion, and yet the answer to it seems to us very simple. It is the rule that all

the crops brought under regeneration during any Period must have their regeneration completed during that Period. Now in the majority of our forests it is impossible to effect, in a satisfactory, complete, and sure manner, the regeneration of a mass of high forest treated according to the Natural Method, without exercising great caution and judgment in locating the Primary, Secondary, and Final Fellings. Hence the necessity of making the Periods long enough to give the Executive Forest Officer sufficient time to complete the Secondary and Final Fellings with the care, precautions, and deliberate slowness, which can alone assure the success of such operations. On the other hand, the duration of the Periods ought not to exceed the number of years beyond which one could not forecast, with a sufficient degree of certainty, the cultural operations that the condition of the forest would require. These extreme limits for the length of Periods seem now to have been fixed by experience at thirty and forty years respectively, and it can only be by exception that there would be advantage in going above or below those figures. If we had a silver fir forest, the exploitable age of which was fixed at 150 years, we could divide the Rotation into five equal Periods of 30 years each, this duration of time being necessary and sufficient for a complete series of regeneration operations.

Hand in hand with this the Periodic Blocks have to be formed. To this end, the compartments, the regeneration of which is urgent (that is to say, those, as a rule, which contain the oldest stock), are, first of all, placed in the Block of the First Period, the next oldest compartments in the following Block, and so on up to the last Period, in which must be grouped together the youngest crops. The aim of the organisation must hence be to bring each compartment under regeneration as near as possible the term of its exploitability. But in distributing the various compartments thus, the fact must not be lost sight of that the Regeneration Exploitations should follow the Rules for locating coupes. And as the essential points enforced by these Rules cannot be satisfied except by laying out the coupes in the order in which they are to be exploited, it follows, as a matter of principle, that each Block should be formed of contiguous compartments, or of compartments forming together one continuous mass of forest.

Conversely, the large continuous masses of more or less uniform forest as regards age, into which the compartments naturally

group themselves (one group consisting of old timber, another of middle-aged timber, a third of young timber, and so on,) determine the number and position of the Blocks, and, as a consequence, the number and length of the Periods. If, for example, the silver fir forest taken for illustration higher up contained four almost equivalent groups of crops, well defined on the ground and presenting four principal age-groups, we would naturally divide the Working Circle into 4 Blocks and the Rotation into 4 and not 5 Periods. And as the figure there adopted for the Rotation is not an exact multiple of 4, it would be necessary, if it was found expedient to have equal Periods, to reduce or increase that figure so as to make it an exact multiple, a contingency of little consequence as respects a fir forest, which becomes exploitable *towards* the age of 150 years, *more or less*.

In the case which we have been considering, we have supposed that the four Periodic Blocks naturally marked out on the ground are of equal extent or of equivalent productive power, and capable of yielding the same quantity of produce when exploited each in its respective turn for regeneration. A sustained yield is thus assured, as far as that is possible, for the whole term of the Rotation, and the Working Scheme drawn up on this basis fulfils the three principal conditions it must satisfy.

It is seldom that the formation of the Periodic Blocks can be effected under such simple circumstances. For the most part the crops belonging to the principal age-groups are not distributed in a sufficiently convenient manner for this purpose in each Block. Sometimes certain age-groups are even entirely wanting, so that, in order to be able to secure a continuous series of exploitations, there is no alternative but to collocate in the Period of the Rotation corresponding to these age-groups, crops that are either too old or too young for the purpose. In the presence of such difficulties and of a great many others which it is impossible to enumerate, but which are met with in nearly every attempt at forest organisation, the Aménagiste may find himself no little embarrassed. The consequence is that it is difficult to arrange in advance for more than one Period the succession of the Principal Fellings to be made in any Working Circle, and still more so, to forecast the yield of each Period of the Rotation. Nevertheless without seeking to effect a perfect

equalization between the yields of the various Periods, it is at least necessary to form the Blocks in such a manner as to avoid too great a fluctuation from Period to Period. This object is usually attained by assigning them equal areas or, in some special cases, areas in inverse proportion to their fertility.

Thus by employing the simple procedure we have described for drawing up the Working Scheme, it is not always possible to ensure a very steady yield for the whole duration of the first Rotation; but if each Block is regenerated in its entirety and in its right turn during the Period assigned for it, the whole Working Circle will be found at the end of that Rotation to be composed of a complete series of graduated age-classes. Such a result is undoubtedly one to be desired. Nevertheless it is not to be sought by exploiting any valuable crops that may exist, long before they become exploitable. The reason is evident, for the essential object to be kept in view in organising any forest is, above all, by fixing the successive order of the exploitations, to make the most of existing crops and not to create at any price a perfect series of crops of well graduated ages—in other words, bring about the Normal State itself.

That state, which the organisation of every forest ought to endeavour to make it approach as closely as possible, is in reality a pure fiction. No forest, during the course of a whole Rotation of any length, can avoid escaping damage from various causes that suffice to compromise the existence of certain crops, break up the serial gradation of ages, and upset some of the provisions of the Organisation Project. When, therefore, in drawing up the General Working Scheme it is found necessary to include in the same Block crops of widely differing ages, it does not necessarily follow that all these crops need be exploited during the course of the Period corresponding to that Block.

To establish our position it is enough to cite a few illustrative cases.

(1.) Certain compartments containing young growth (seedlings, thickets, saplings or young poles) exist side by side with the great mass of exploitable compartments. Both sets of compartments may be included in the First Block; but the old crops alone should be

regenerated during the First Period, while the young compartments should, during the same time, be subjected to Improvement Cuttings, viz., Cleanings and Thinnings. Similarly we may collocate in the last Block, with quite young crops, exploitable trees, whether these grow apart from one another or form continuous leaf-canopy. Under such circumstances, these latter would be exploited during the First Period in order to effect the desirable uniformity.

(2.) Supposing that in the pine forest which we considered higher up a fine crop of poles is, under unavoidable necessity, placed in the First Block, because it is enclosed on every side by the great mass of exploitable compartments. Is it necessary to regenerate it during the First Period in order to effect the regularization of the age-classes in the shortest possible time? We answer, No; because to do so would be to incur a great sacrifice for an entirely secondary object; and besides this, there is nothing to prevent the same difficulty recurring through some unforeseen cause. Under these circumstances the Organisation Project should confine itself simply to prescribing Thinnings, and leave to those, who will revise it at the end of that Period, the task of proposing the treatment that will then be found to be necessary.

(3.) We will now suppose that we have a compartment containing mature and decaying timber, and that this compartment stands in the very heart of the Third Block: Here the procedure would be the same as in a crop that is still young but overtaken by premature decay.

(4). We will suppose that in order to give the most convenient form possible to the first two Blocks of a Working Circle exploited on a rotation of 160 years, it is considered necessary to collocate in the First Block a compartment aged 100 years, and in the Second a nearly equivalent compartment composed, however, of timber 150 years old. It would certainly be advantageous, as far as the produce alone is concerned, to exploit the compartment placed in the Second Block during the First Period, and that placed in the First Block during the Second Period. However it be, before this change of order could be proposed, it would be necessary to assure oneself that there would be no danger to fear from the action of the wind in consequence of this infraction of the Rules for locating coupes.

The special circumstances just described are not the only ones that are to be encountered in organising high forests. Every Working Circle, however perfectly it may be constituted, cannot but contain compartments of different degrees of fertility due to differences of soil and situation. When these differences do not affect their productiveness in any marked manner, or when it is possible to distribute more or less equally, amongst the various Blocks, compartments possessing the same degree of fertility, the division is effected by equal areas. This is the most simple and the most general case. When, on the contrary, one age-class, taken in its entirety, occupies good rich soil, while another is similarly situated on poor soil, it is necessary to include in the corresponding Blocks a larger area of the one than of the other.

However it be, the distribution of the principal exploitations and of the estimated total yield among the various Periods of the Rotation must always continue to be based on area. The result of this is that the Working Scheme acquires thereby a degree of precision and stability, which enables its main lines to be laid out on the ground in a permanent manner. On paper it may be represented in a very simple tabular form, thus :—

GENERAL WORKING SCHEME

OF WORKING CIRCLE LA HOUSSIERE, AREA 664 ACRES, 2 ROODS, 16 POLES, ORGANISED ON A ROTATION OF 160 YEARS.

COMPOSITION OF BLOCK TO BE EXPLOITED DURING THE

FIRST PERIOD From 1869 to 1908.			SECOND PERIOD From 1909 to 1948.			THIRD PERIOD From 1949 to 1988.			FOURTH PERIOD From 1989 to 2028.		
Cantons.	Compartments.	Area.	Cantons.	Compartments.	Area.	Cantons.	Compartments.	Area.	Cantons.	Compartments.	Area.
		A. R. P.			A. R. P.			A. R. P.			A. R. P.
La Houssière	A	50 0 0	La Fêchère.	F	64 2 0	La Taillette	I	12 2 0	La Noire-Roche	N	15 2 20
Do.	B	37 2 0	Do.	G	20 0 0	Do.	K	106 1 36	Do.	O	87 2 0
Do.	C	12 2 0	Do.	H	100 0 0	Do.	L	15 2 0	Do.	P	40 0 0
Do.	D	30 0 0	...			...	M	37 2 0	...		
Do.	E	25 0 0	...			...			...		
Total...		155 0 0	Total...		184 3 0	Total...		171 3 36	Total...		143 0 20

The General Working Scheme once drawn up, it is advisable to detail the reasons justifying it and to decribe the spirit in which it has been conceived with reference to the Organisation Project. It is useful to discuss all its essential points, to show why it has been preferred to every other, to explain the main idea on which its lines have been fixed.

The chapter in which these points are discussed should be worded in plain, sober language, free from all preconceived bias. It ought to bring out into clear prominence all facts special to the Working Circle and show what improvements are necessary or feasible. It should explain to what extent the Working Scheme has taken account of the conditions of exploitability, the Rules for locating coupes, and the necessity of a sustained yield, pointing out where one or more of these limiting conditions acquire greater importance than all the rest. It should state the reason for, and the object of, the various cultural operations that have to be successively executed throughout the whole Working Circle with a view to its improvement, as well as the agency and means by which these operations should be carried out.

SECTION 3.

Special Scheme of Exploitations.

At the beginning of the First Period, as well as of every subsequent Period, the exploitations of all kinds to be made in the Working Circle during that Period are determined upon beforehand and exhibited in what we shall call the Special Scheme of Exploitations for that particular Period. This Scheme should show the work to be done compartment by compartment, and should remain within the broad lines sketched out by the General Working Scheme. Thus, to take an instance, in a regular Working Circle the exploitations made during the First Period would be, for the First Block Regeneration Fellings with yield based on volume, for the intermediate Blocks Periodical Thinnings based on area, and for the last Block, containing all the youngest crops, Cleanings and the First Thinning.

The Special Scheme of Exploitations should prescribe first of all the nature of the fellings to be made in each compartment,

next the successive order in which the respective compartments shall be operated upon, and lastly the annual extent, volumetric or superficial as the case may be, of the various exploitations.

Usually the succession of these exploitations is exhibited in tabular form, showing at a glance the general plan of all the operations to be executed during the Period in question. Often the annual yield is similarly exhibited in one or more tables, which also contain the data from which it has been estimated.

§ 1.—*Order of the Exploitations.*

The tabular statement of the exploitations may, to give an example, be drawn up thus:—

NATURE AND ORDER OF THE EXPLOITATIONS TO BE MADE DURING THE FIRST PERIOD FROM 1869 TO 1908.

COMPARTMENTS.						NATURE OF CUTTING.		RELATIVE ORDER OF THE EXPLOITATIONS.
Blocks.	Cantons.	Compartments.	Area.	Summary description of standing crop.	Age at end of 1868.	Regeneration.	Improvement.	
			A. R. P.		Years.			
I.	La Housaière.	A	50 0 0	High forest of beech and oak, somewhat open.	150	Regeneration Fellings.	...	The regeneration of those compartments will be effected as nearly as possible in the following order:— C, D, A, B, E.
		B	37 2 0	High forest of beech, oak, and hornbeam, leaf canopy complete	160	Do.	...	
		C	12 2 0	Saplings of beech mixed with oak here and there	15		Cleanings and First Thinnings	
		D	30 0 0	State of Secondary Felling, surmounting seedlings and thickets of oak and beech	5-15	Secondary or Final Fellings.	Do.	
		E	25 0 0	High forest on stools, oak and hornbeam	120	Regeneration Fellings.	Last Thinning.	
II.	La Fechère.	F	64 2 0	High forest of beech and oak in complete leaf canopy	125	Do.	Decennial Thinnings.	
		G	20 0 0	Young high forest of oak and hornbeam irregularly mixed	90	Do.	Do.	
		H	100 0 0	High forest of oak, beech, and hornbeam	110	Do.	Do.	
III.	La Taillette.	I	12 2 0	Young high forest of pure oak, old plantation	70	Do.	Do.	The order of the Thinnings is fixed year by year in the table of the cuttings based on area.
		K	106 1 36	Poles of beech, oak, and hornbeam	85	Do.	Do.	
		L	15 2 0	Low poles of oak and hornbeam	45	Do.	Do.	
		M	37 2 0	Young high forest of beech with oak reserves	70-210	Do.	Do.	
IV.	La Noire-Roche.	N	15 2 20	Open pole crop of oak, beech and ash	40	Do	Do.	
		O	87 2 0	Saplings of oak hornbeam, and beech	25	Do.	Thinning in the 2nd, 3rd, & 4th, decades.	
		P	40 0 0	Seedlings of beech and oak, and high forest in the state of a secondary coupe	8 and 4 to 140	Secondary or Final Fellings.	Cleanings.	

The essential object of the preceding table is to give a list of all the compartments, the nature of the cuttings to be made in each, and the order in which they should be successively taken up.

The compartments are entered in a single column and are designated by characteristic letters or numbers. For greater completeness the name of the canton and the number of the Block are usually given to indicate the situation of the compartment in question. Similarly, there is a special column for the areas of the compartments, and two more for the age and a very brief description of the standing crop, information that helps to explain the treatment prescribed.

The treatment, which is nothing more than the *ensemble* of the cuttings to be made, must be noted separately for each compartment. These cuttings are expressed by their characteristic names; they may be the whole series of Regeneration Fellings here, Secondary and Final Fellings there, or simply the Final Felling in a third place, and so on to the Last Thinning, Periodical Thinnings, Cleanings and the First Thinnings, Selection Fellings, Compound Coppice or Simple Coppice Cuttings, &c., as the case may be. The main point is to characterise the cuttings by means of specific names, so that each name may represent a clear and definite idea.

The order of succession of the cuttings must be fixed in a general manner only, but to the full extent which each class of exploitations admits of. Thus the order of the Secondary and Final Fellings, which depend on the state of the crop (an uncertain element), naturally cannot be fixed. It is impossible to foretell the year in which the new seed-crop will make its appearance, or that in which it will be sufficiently complete and hardy to require a Secondary Felling, as also to forecast the quantity of produce that will have to be removed in each of the Regeneration Fellings from a given area. It would thus be folly to prescribe the order in which the compartments should be regenerated, except in so far as concerns only the succession of the Primary Fellings.

With respect to Improvement Cuttings, it is usually expedient to fix their order in the most precise manner for every year from the very beginning of the Period. This is done in the Table of the Annual Yield, in which the area to be operated upon is also given.

As regards the manner of making the cuttings, the Special Scheme of Exploitations must be entirely silent. The character of the Primary Felling (that is to say, whether it should be close or open), the more or less rapid succession of the different Regeneration Fellings, the special precautions they require, the manner of making the Improvement Cuttings, &c., all these are questions that perforce vary with the locality operated upon and with a host of natural or accidental causes. Any attempt to lay down rigid directions must run the risk of prescribing incomplete or untimely operations. Besides, there is always the liability of falling into grievous error in trying to predict the course of natural phenomena. The prescriptions of the Special Scheme of Exploitations are obligatory, once they are sanctioned by supreme authority, and it stands to reason that the Executive Forest Officer must be held responsible for the cuttings made by him. He must therefore be given full discretion in executing them in whatever way he considers best.

If it is necessary to avoid laying down in the Organisation Project the manner of making the cuttings prescribed, that is no reason for omitting to discuss and record facts that have been observed. But the place for this is not the Special Scheme of Exploitations. It should be done in the general portion of the Report, as being information that may be of the highest utility, especially to Officers appointed to a new charge. Thus, for instance, it might form a special Chapter coming after the General Statistical Report and immediately following that on choice of Régime, and styled "APPLICATION OF THE METHOD OF TREATMENT."

§ 2. *Estimation of the Annual Yield.*

Like the order of the exploitations, the annual yield must be determined for only one Period at a time.

In high forests worked by the Natural Method, the Regeneration Fellings are based on volume, and the Improvement Cuttings on area. Hence two different classes of yield, viz :—

(1) That of the Regeneration Cuttings, that is, of Principal Produce.

(II) That of the Improvement Cuttings, that is, of Accessory Produce.

In a regular Working Circle of high forest, the principal produce would be furnished exclusively by the trees felled in the Block assigned to the current Period; but, as a rule, the other Blocks also contain here and there mature trees either solitary or forming leaf-canopy, which it would be expedient or necessary to exploit as an exceptional measure during that Period. Usually in estimating the annual yield of principal produce, such trees are classed, without any qualification, amongst those of the Block of the current Period; only in the Organisation Project their relative number and importance should be clearly indicated and the compartments that contain them mentioned.

The determination of the quantity of principal produce offers no difficulty. It is obtained by enumerating the standing trees grouped into classes according to species and diameter, and multiplying the number of the trees in each class by the previously ascertained contents of a type tree, selected from amongst the standing material as presenting the average of that class.(1)

But the total quantity of produce ultimately removed during the Period necessary includes, besides the actual contents of the standing trees, also their future increment up to the time they are felled. To determine the amount of this increment it may be observed that the quantity brought under the axe is the same every

(1) It is unnecessary to obtain actual contents with rigid accuracy, but it is indispensable, in taking the measurements, to adopt a uniform practical system. It is the only way of arriving at results that admit of being compared one with another—an essential condition for the location of the coupes, and useful afterwards for the verification of the yield. If, for instance, in the valuation it was assumed after experiment that trees measuring 16″ in girth at the height of a man contain on an average 46 cubic feet each, then in locating the fellings also it would be necessary to assign the same volume to trees of 16″ girth. Whether the average contents assumed be exact or simply approximate, the quantity exploited would always be an invariable proportional of the quantity obtained by valuation. Thus 1000 cubic feet of felled produce would actually represent 1000 cubic feet of the estimated yield. It would be otherwise if any other procedure were adopted, that was not based on the *measurement of exactly measurable elements*. Hence it is necessary in calculating the yield by volume to avoid estimating the quantity of standing material with the eye, or by means of type areas, or with the aid of any other such system. And for the same reason the basis of all valuations must be solely and invariably the measurement of diameter, since that of height always involves some amount of individual appreciation.

year. For the purpose of calculation, therefore, it may be assumed that all the trees will be felled simultaneously at the middle of the Period. Again we may be allowed to take for granted that the future annual increment of trees near their term of exploitability is the same as their actual average annual increment up to date. Thus to obtain the total future increment we have simply to multiply this average annual increment by half the number of years in the Period. It is obvious that the determination of the future increment must be made separately for each compartment.

The yield of the annual cuttings is, therefore, found by dividing by the number of years forming a Period the sum of the two following quantities:—

(i) The standing material or actual contents.

(ii) The probable additional growth of the standing material, or future increment.

It is always easy to determine actual contents with a sufficient degree of approximation, whereas the future increment can never be estimated with any approach to accuracy. For this reason, unless special circumstances demand the contrary, no account at all should be taken of the future increment, since it is always better to be under the mark than to run the risk of erring on the fatal side of excess. Besides, the yield of windfalls, dead timber, and other trees, the exploitation of which cannot be foreseen, proves to be, in the long run, a complete set off against the neglected future increment. Lastly, this increment does utimately enter into our calculations when the standing trees are again measured at the verification of the annual yield during the course of the same Period, and must then permanently raise the figure of the yield for the remaining years of that Period. The natural consequence is that the outturn of produce goes on increasing by small and moderate additions at regular intervals, a result greatly to be desired in the organisation of every forest.

Simultaneously with the volumetric cuttings, which furnish the yield of principal produce, other operations, termed by us Improvement Cuttings, such as Thinnings, for example, must be made in various portions of the Working Circle, and can only furnish accessory

produce. These latter cuttings must have their yield based on area. By this we do not mean to say that Thinnings ought necessarily to go over equal areas every year, or that such cuttings ought to yield the same outturn year after year. Although the outturn of thinning operations is not entirely to be neglected, still it cannot be taken into account in determining the annual yield, since it is subject to too wide a fluctuation not only as regards quantity but also the class and quality of the produce obtained. Besides this, the principal and, so to say, sole object of Thinnings is to favour the growth of the promising trees forming an organic part of a canopied mass of forest, by giving those trees growing room in proportion as they require it, by the gradual removal of their less promising neighbours which prevent their crowns from spreading out. These operations demand great skill and caution, and in order that they may be well executed, the Executive Officer must be free from all preoccupation as to the quantity to cut out; and more than this, he must be in a position to judge, at the time that he marks the trees to be thinned out, when the next Thinning will have to be made over the same area. This reason suffices of itself to justify the expediency of making such cuttings within fixed limits marked out on the ground, of subjecting them to a regular rotation, and of basing their yield entirely on area.

When these exploitations can be so arranged as to annually pass over nearly equal areas during the term of a whole Period, no more desirable result could be imagined. But at the very commencement of working a forest according to some organised system, it is not always possible to secure such great regularity. Thus, for example, it may happen that a Thinning is urgently required in certain crops aggregating a large area; under such circumstances, it would be only at the second or third time of thinning those crops that it would be possible to establish a regular rotation for the operation, i. e. limit it to nearly equal annual areas by assigning to each year either one or more entire compartments or an aliquot portion of a large compartment, as the case may be. However it be, the main point to adhere to is to arrange the Thinnings in the simplest manner possible, paying due attention to the condition of the crops and to the superficies they occupy.

The Last Thinning made in a high forest may also have for object the early and gradual production of seedlings on the ground under the standing crop, such as might happen in a forest of silver fir, a seedling crop of which species makes its appearance very gradually but resists well the action of cover overhead. This Last Thinning, which may indeed be termed a Preparatory Primary Regeneration Felling, differs from all preceding Thinnings in that it clears the soil of bushes, removes overtopped trees, and occasionally raises the cover by a judicious lopping off of low branches. It is therefore expedient to characterize it by a special name. To call it a Preparatory Primary Felling would create an ambiguity, since this designation has been applied to another perfectly distinct operation. The term Final Thinning would perhaps be the best to adopt.

The following two tables are convenient for collecting together the data and information which it is expedient to adduce in support of the estimated annual yield. The first gives the yield of principal produce, the other, the area to be thinned every year, the compartments to be operated upon, and the order in which they should be taken up.

DETERMINATION OF THE ANNUAL YIELD FOR THE FIRST PERIOD.

YIELD OF THE PRINCIPAL FELLINGS.

COMPARTMENTS.		NUMBER OF TREES COUNTED.		CONTENTS.			REMARKS.
				Actual.	Future increment.	Total.	
	Acres.			Cubic feet.	Cubic feet.	Cubic feet.	
A	50	Oak	525	71,375	..	388,239	The Period consisting of 40 years, the annual yield will therefore be $\frac{1,139,605}{40}$ = 28,490 c. ft. Deducting every year ¼ of the above figure to form the Reserve Fund, the annual yield of the Principal Fellings will thus be 21,368 cubic feet.
		Beech	2,272	316,864	...		
B	37½	Oak	1,181	176,125	...	348,049	
		Beech	1,092	135,687	...		
		Hornbeam	672	36,235	...		
D	30	Oak	438	70,881	...	106,727	
		Beech	216	35,846	...		
E	25	Oak	863	36,058	...	155,181	
		Beech	92	10,418	...		
		Hornbeam	4,206	108,705	...		
P	40	Oak	240	34,540	...	141,409	
		Beech	815	106,869	...		
						1,139,605	

DETERMINATION OF THE ANNUAL YIELD FOR THE FIRST PERIOD.

YIELD OF THE IMPROVEMENT CUTTINGS—THINNINGS.

Year.	Compartments.	Area to be thinned.	Year.	Compartments.	Area to be thinned.	Remarks.
		A. R. P.			A. R. P.	
1869	E,I,L	53-0-00	1889	I,L,C.	40-2-00	The areas to be
1870	K.	35-2-00	1890	K.	53-0-38	thinned each year will
1871	K.	35-2-00	1891	K.	53-0-38	be taken up in accor-
1872	K.	35-1-36	1892	F.	64-2-00	dance with the pre-
1873	F.	32-1-00	1893	H.	50-0-00	sent Table, so as to
1874	F.	32-1-00	1894	H.	50-0-00	thin each Compart-
1875	H.	50-0-00	1895	O	43-3-00	ment at the most ap-
1876	H.	50-0-00	1896	O.	43-3-00	propriate time, and, as
1877	M.	37-2-00	1897	M.	37-2-00	far as that is possible,
1878	G,N.	35-2-20	1898	G,N.	35-2-20	take up entire Com-
1879	I, L.	26-0-00	1899	I,L,C.	40-2-00	partments or aliquot
1880	K.	53-0-38	1900	K.	53-0-38	portions of Compart-
1881	K.	53-0-38	1901	K.	53-0-38	ments at a time.
1882	F.	32-1-00	1902	F.	64-2-00	
1883	F.	32-1-00	1903	P. D.	70-0-00	
1884	H.	50-0-00	1904	H.	50-0-00	
1885	H.	50-0-00	1905	H.	50-0-00	
1886	O.	87-2-00	1906	O.	43-3-00	
1887	M.	37-2-00	1907	O.	43-3-00	
1888	G,N	35-2-20	1908	M.G.N.	73-0-20	

CHAPTER IV.

COMPLEMENTARY DISPOSITIONS RELATIVE TO THE WORKING SCHEME FOR HIGH FORESTS

The Special Scheme of Exploitations completes the Working Scheme, and with this the Organisation Project itself may be strictly regarded as completed, since it may now be executed without the help of any further prescriptions or data Nevertheless there are besides this some further measures to be prescribed, which are of great use in providing against contingencies likely to interfere with the Project, and in guaranteeing its faithful execution. Thus it is expedient to establish what may be called the Reserve Fund, to arrange for the verification of the yield, to suggest necessary works of improvement, and to provide for the revision of the Organisation Project before the commencement of each subsequent Period.

SECTION I.

The Reserve Fund.

The establishment of a Reserve Fund in the organisation of high forests is nothing more than the setting aside and preservation of a certain quantity of standing timber from among the crops brought under exploitation to serve as a sort of disposable savings. A Reserve Fund is as necessary in the management of forests as in every other large financial enterprise spreading over a long series of years. Without any such Reserve to fall back upon in the case of emergencies, an Organisation Project cannot but rest on an unstable basis; at some time or other immature timber would have to be cut or a deficit must occur.

In the organisation of high forests, the essential object of a Reserve Fund is to provide against extraordinary and unforeseen demands extraneous to the forest itself, or to prevent a falling off in the yield in passing from one Period to the next. On the other hand, this Reserve may, according to circumstances, also have for object the production of isolated trees of large size, or serve as a set off against accidental injuries to the forest. To take an instance: A Municipality requires an extraordinary felling, or the State is in immediate want of wood for the defence of the country; the forest must be able to satisfy either demand to a sufficient extent without its healthy regular growth being compromised thereby. Or, to take another case, it becomes apparent towards the end of the First Period that the Second Block is insufficiently timbered; some means must be found to make good this deficiency without upsetting the orginal Origanisation Project. Again in a given high forest of oak there are several choice specimens in full growth and far removed from their maturity when the time for exploiting the surrounding forest arrives. It would be a pity to fell them so soon. To take one more case, there is a fir forest in which numerous windfalls have occurred in the Block belonging to the next following Period; these windfalls must evidently be cut up and disposed of at once; and the only way to compensate for this unexpected loss is to reserve a certain number of trees in the Block under regeneration. Thus a sufficient Reserve Fund of trees provides against all such sudden contingencies.

The formation of the Reserve Fund may be effected in several ways. "Formerly" writes M. de Salomon, "it was customary to reserve a certain definite portion of the forest in one piece by itself." But this method was soon abandoned as being inadequate and failing to secure the end proposed. For except when trees of extraordinary size had to be grown, it was impossible to judge, with any degree of certainty, what crops were by their age best fitted to form this Reserve Fund. The reason is evident, for if mature or almost mature trees were reserved, it might be found necessary to exploit them at an inconvenient time on account of decay, and thus the very object for which they were reserved would be defeated; and if, on the contrary, the reserved trees were young and an extraordinary felling was urgently required under some

sudden emergency, there would be no alternative but either to cut nothing at all or to exploit small and immature timber."

The remarks just quoted apply to high forests worked by the Natural Method, in which of class forests the principal exploitations come back to the same point only after a very long interval of years. A Reserve Fund composed of trees all in one piece of forest would ill fulfil the condition of always offering immediately available resources, unless indeed it covered a very large area. But it is easy to obtain the most desirable results by forming the Reserve Fund of trees scattered over all the coupes and based on their aggregate contents, a method of procedure in perfect keeping with high forest exploitations.

In the organisation of high forests by area, the quantity of standing material to be set aside for the Reserve Fund may be determined by one of two methods or by both together. The one consists in leaving out of account the future increment when calculating the annual yield; the other in reducing by a certain quantity the quota of the annual cuttings. Take, for instance, a mass of forest 150 years old; the mean annual growth is evidently the 1/150th part of the contents of the standing timber. Given the Block and Period to which this mass belongs, the quantity of the stock to be reserved can be approximately deduced from the annual rate of growth thus determined. On the other hand, if the quota of the annual cuttings is 21,000 c. ft., 3,500 c. ft. may be preserved each year from the quantity that can be cut to form the Reserve Fund. In the latter case, the amount of the annual savings set aside is a determinate figure, while in the other case the future increment can never be known with certainty.

However it be, the Reserve Fund when based on volume always represents so much exploitable timber over and above the quota of the annual cuttings, and sometimes also comprises trees with a long future before them. At the moment of need, every cubic foot saved up, may be utilized except this last class of trees. To find out at any time the present quantity of the Reserve Fund, we have only to know according to which of the two methods above described it has been formed and the number of years it has been in existence. To utilize it, there is nothing more to be done than to cut everything in the Block under regeneration.

The quantity to set aside as a Reserve Fund is a matter of individual appreciation pure and simple. The law prescribes nothing with reference to it, except so far as communal forests of broad-leaved species are concerned, in which case the quantity to be reserved is one-fourth of the whole standing stock. Our own opinion is that this same proportion should, as far as possible, be maintained also in high forests, and that for this purpose the quantity to be annually set aside should include both the annual rate of growth and the 4th. part of the stock of the principal coupes, regular as well as irregular.[1] This latter quantity, definite and exactly known as it is, is naturally meant to be exploited first in case of need. The annual rate of growth, on the contrary, being an uncertain quantity from the beginning, the part of the Reserve Fund due to it would chiefly include growing trees or the accidental produce of the younger Blocks, the quantity of which is equally uncertain. Moreover the portion of the Reserve Fund resulting from the saving up of the annual increment does not necessarily go on increasing by the accumulation of this increment, for a portion of it naturally gets included in the valuation survey of the standing stock each time the annual yield is verified.

SECTION II.

VERIFICATION OF THE ANNUAL YIELD.

The yield of principal produce, after deducting the quantity to be placed in the Reserve Fund, serves as the basis for the principal fellings of the current Period. But it may happen that errors have crept into the estimate of this figure or that certain discrepancies are found to exist by actual experience of the cuttings; and the annual increment is, after all, always an uncertain quantity, and various accidents occur during the course of a Period of any length, that upset all previous calculations. It would thus be rash to go on working out the same quantity year after year as that fixed at

1. I must observe that in calculating the quantity to be reserved, no allowance at all is made for accessory or accidental produce. The result of this is that in setting aside a fourth of the total yield of principal produce, a smaller quantity is reserved than if one-fourth of the whole area were so set aside. And, after all, a large Reserve Fund entails no sacrifice: it is itself productive, and the only difficulty in connection with it is when at the outset it has to be established. Thereafter it yields no inconsiderable amount of irregular produce, variable in quantity from Period to Period.