



FOR THE COMPREHENSION OF NET REVENUE SILVICULTURE AND THE MANAGEMENT OBJECTIVES DERIVED THEREOF

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The original article "Aus der Holzzuwachstlehre (zweiter Artikel)" was published in "Allgemeine Forst- und Jagd-Zeitung, 36, 173-191, (1860).

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PART TWO. INCREMENT THEORY

The forest economic theory frequently mentions "real capital" but is inconsistent as it almost disregards or rather does not take the economic characteristics of this selfsame real capital into proper consideration.

Thus, is it surprising or is reproach in order when the theory is not put into practice? Is it surprising when a contemporary, outstanding forester, (in his commentary on my "holzwirtschaftliche Tafeln" [Timber Economic Tables] published in the 1858 volume of the *süddeutsche Monatsschrift* [Southern Germany's Monthly Journal]) publicly declares that the theory and knowledge of increment percentage plays a subordinate role in the economy.

Each producer, each economist and each political scientist is well aware that the interest rate, being synonymous with the yearly increment percentage, is the most appropriate and most commonly used measure or criterion for determining the productivity of real capital. It is universally accepted that anyone responsible for administering, maintaining and putting capital stock to use, has the obligation of being guided by the interest rate upon which his capital will grow — bearing in mind the varying conditions and different purposes to which he will put his working capital to use, nothing could be more obvious.

It was only in scientific timber production, only in systematic forestry, which has been organized in such a manner that this became a matter of secondary importance. In consequence, even Oberforstrat *König*, who among all experienced foresters applied himself most intensely to the mathematical side of silviculture, was not able to reveal this supposed matter of secondary importance in such a way as to show its practical clarity and significance in its true light — as one of silviculture's fundamental theories put to practice: a fundamental theory at least for those who are not indifferent to net revenues and for those for whom maximum net revenue is the objective. When looking at the vast majority of literature and especially contributions to journals, it is evident to which extent even currently net revenue, the financial and capital aspects of silvicultural activities are seen to be of secondary importance.

But it would simply be unjust to aver that we have absolutely and principally been ignoring the capital aspect of forestry. Since *Hundeshagen*, we have at least been provided with the mass-utilization-per-Cent theory and we know that in a forest which is cut by compartments (without an active initial cutting) and under ideal forest conditions with a 20 year rotation period, the mass utilization per-Cent amounts to about 10 percent of the "real capital"; at a 40-year rotation to 5 percent, at an 80-year period then to 3 percent and at a 120-year rotation period barely to 2 percent. In conclusion, we anticipate that mass utilization per-Cent will generally be higher, the shorter the rotation period and, consequently, the less real capital is needed for a sustainable yield. Reasoning foresters have long since realized that mass utilization per-Cent, although undeniably useful for certain purposes, has no bearing on the financial dimension of silviculture. That is the reason why we went one step further.

Here and there we find analyses and reports on the so-called "growth in value" and the "value utilization per-Cent" even in *Pfeil's* "Kritischen Blättern" ["Discerning Paper"]. These contributions are partially lacking in the simplicity needed in practice, while others, particularly the latter, often lack scientific clarity. Therefore, it is not to be expected that they will offer substantial enlightenment or bring about operational results in our economy. Both ap-

proaches neglected important and fundamental facts of the increment theory.

Within the narrow framework of this article, I will now try to illuminate the capital aspect of the increment theory, in order to at least offer some theoretical clarity in respect to a few of its cardinal points as well as demonstrating its relevance to practice.

In this context we wish to interpret tree increment in two different manners: as an *increment of mass* (in Kubikfuß, Klafter) and as an *increment of net revenue per mass unit*. We will define the former as the **first** and the latter as the **second** increment.

Usually, we call the first the mass increment. But that is not quite correct, at best it is ambiguous. A young pine or poplar tree experiences an increment of 3 Kubikfuß, and so does a mature pine and a mature oak. As seen, our first increment is the same in both cases, however, the increment in mass of the mature trees might be double that of the young ones. This is due to the fact that the Kubikfuß of mature soft and hardwood has considerably greater weight, containing more wood pulp, with a greater actual mass than a Kubikfuß of a luxuriantly grown and, therefore, more porous timber.¹ The more precise definition of "volume increment" would be preferable, or as all branches of the forest and timber industry equvalate volume to quantity, we could use the alternative term *quantity increment*.

If from time to time we then use the generally adopted term "mass increment" in future chapters in denoting our *first or quantitative increment*, it is expected that this will not be a source of misunderstanding for our readers as we already have discussed the terms above. In addition, a particular focus on wood pulp production might be of scientific interest, but is surely not of practical or economic importance. Herr Professor *Dengler*, however, maintains quite the opposite (see his commentary on our "Rationellen" in the April 1859 issue of his monthly magazine), but as long as we are neither able to nor are forced to estimate and

¹ A short overview on Table V of my "Timber Economic Tables" (V.c. weight of dried seasoned timber) shows, e.g. that on the average, one Kubikfuß of dried seasoned oak contains 74 parts wood pulp, in contrast to willow and poplar with 42 parts.

process our stands as seasoned and duly weighed timber, we will continue to hold forth that it is Herr *Dengler* who is mistaken in this point.

It is harder to find a truly fitting definition for our *second* increment as "quality increment", "price increment", "value increment" are not quite correct. Let us assume that we harvest, e.g., 30 year-old fuelwood, perhaps in the course of thinning. At a price of 5 Thaler per Klafter and harvesting costs of 2 Thaler per Klafter, we realize a net revenue of 3 Thaler per Klafter. Ten years later, with constant fuelwood prices of 5 Thaler and harvesting costs of 1 Thaler the (more intensive) thinning would maybe yield a net revenue of 4 Thaler. It was this mass increment, then, to which no quality, no price, no value increment was attributable but which nevertheless experienced a second increment at the keen relation of 3 to 4, in the decade concerned.

Apart from *reduced harvesting costs* due to the increased age of the timber stands (which, in our example, was the only reason for the second increment) an additional incentive for a second increment could be the *higher price* that the market in general is willing to pay for the older and more mature wood pulp. Furthermore, the *higher quota* and the yield of *first-class timber* in older stands is responsible for the second increment.

It seems the most appropriate to compare our first, or quantitative increment, to our second, or *qualitative* increment, keeping in mind that one should not interpret the term "qualitative" in the strictly literal sense but rather in the purely scientific sense of the meaning. If, for example, through the interaction of all the above-mentioned economic influences, the clearing of our 60 year-old stands yields an average net revenue of 5 Thaler/Klafter whereas the 70 year-old stands tend to realize 6 Thaler/Klafter, then this second increment (at a ratio of 5 to 6) exerts the same effect on our economic production results, as if stand quality had increased by one-fifth during the transition from a 60 to a 70 year-old stand. We can conclude, that at least from the producer's point of view, the average *net revenue of one mass unit* is the *measure of its quality*. We could also say "grade", if this word did not tend to have a more restricted meaning in daily life.

Thus, let us agree that if and when we use the term "*quality increment*" for our term "*increment of the net revenue of the mass unit*" (to avoid monotony) it be understood that this is only in the sense of the previously mentioned net revenue. Furthermore, it would seem to be the easiest and the most appropriate way to avoid any misunderstandings, if we would simply call the selfsame the "second" in the future.

Whether we should consider an additional, a *third* increment, i.e. *price increment*, is dependent on the specific situation. If the forester is greatly interested in speculation, this third increment could be very important and may even become the most significant factor, if on the market in question, a strong and steady increase of timber prices is to be expected. Moreover, it might be reasonable to take the third increment into account, too, if one not only focuses on forest speculation but on market speculation, as well.

The interaction of the two or three increment types, forms the *actual net revenue increment of the single tree or total stand*. This is the *relevant increment*, as it shows the real capital increase at its true value and in unambiguous figures. As this *decisive increment* is not only attributable to the capital represented by the timber stand itself, but also to the capital invested in the land covered by the stand (see the preceding article), its periodical amount represents *equally the net revenue production of the corresponding land*. Therefore, we have to primarily comprehend it in relation and comparison to the capital invested in the timber and the land ($h + g$), when the amount is to be a relevant and indicative figure of net silviculture revenue. For this reason we shall define this simply as the **indicator increment** and its yearly figure — calculated in per-Cent — as the *indicator per-Cent*, in the future.

Permit us now to analyze each of the various increments in depth.

THE FIRST, OR QUANTITY INCREMENT, AND THE FIRST INCREMENT PER-CENT

As we well know, each tree and each stand starts its life's course with an exceptionally small mass. A Kubikzoll recording is barely possible in young poles. However, within

the first decade the yearly increment often doubles or triples from the initial amount (i.e. 200 to 300 per-Cent), the growing stock increases rapidly. Simultaneously, the tree's limbs and roots gain strength and multiply. Year by year, the tree consequently increases in mass until it reaches the peak of its strength and herewith the maximum of its yearly increment; a maximum, which in the case of favored trees increases up to a quantity of several Kubikfuß yearly.

Having reached this productivity peak, the tree or stand sustains for some time its maximum mass increment. But then the aging process sets in and with it a reduction of the perennial increment which continues to dwindle, so that at the moment of death the tree is once again at its starting point of minimum increment. Everywhere, in the physical as well as in the moral world an inscrutable order has ordained "that trees do not grow in heaven." Trees, too, experience phases of *development*, of *strength* and of *old age*. During the first *increasement*, during the second *culmination* and in the final phase — *decreased* mass increment.

If, and in what measure, the observation of *height growth* and its patterns could become a satisfactory aid in detecting the three stages externally, is a question that has not yet been fully answered, but is a field in which further research is highly recommended.

We do know that the life course is of an either longer or shorter duration (slow, medium and fast growing species) *depending on the species*.

In addition, we know that the natural *habitat* (soil, climate, incl. site) exerts a powerful influence on increment. The less steady and sustainable the habitat's source of nutrition, the faster increment incline and decline. Thus, high-alpine larch, birch and pines of the North show a slower production than even the oak in temperate zones.

Furthermore, increment is influenced by the way *the trees germinate*, whether through *seedling* or *sprouting* plant. Whereas a beech high forest growing on poor soil and in a warm climate, reaches its peak of strength in the fourth decade, a stand growing on good soil in a temperate zone will not culminate before the sixth decade (an oak seedling plant not culminating before the tenth decade). In coppice forests, where the stool shot starts with greater but less

steady energy the culmination period of the perennial mass increment can generally be observed within the third decade; irregardless of whether it is softwood or hardwood, whether the soil is poor or rich, but only if the climate is not adverse.

Lastly, we know that in addition to the points above-mentioned *silvicultural measures* (such as the establishment and tending of the stands) have an extreme influence on the amount and the pace of mass increment. Hence, trees growing without interference in an open stand, develop differently than those growing in a fully stocked stand. Differently again, if growing in an open stand, they are interfered with or thinned (axed, trimmed, etc.) and once again differently under differing silvicultural methods in fully stocked stands (e.g. irrigation and draining; regular or erratic thinning, light or heavy thinning, unchanging or changing thinning methods; by-product involving loosening of the soil on the one hand and litter raking on the other, etc.).

All these are impacts which are able to influence the incline and decline of increment, which may prolong or shorten, enrich or lessen the stand's period of strength, altogether causing manifold modifications in increment and strength when compared to the general or normal average.

Anyone, namely, who is even vaguely familiar with forests, knows which differences in development tend to occur among one and the same stand's tree classes — depending on whether they belong to the *dominating* or *dominated* and *suppressed* trees, i.e., to the main or intermediate stand; differences that become more and more pronounced the more closed a stand is and the more light-demanding the species are. As every one, at least every forester, knows, it all depends on if, and to what extent, the inherence of the individual tree species deviates and to what extent the other species will take their places within the stand, according to the more or less defined laws between the extremely *non-tolerant* trees and the *tolerant* ones (i.e., between the most light-demanding and the most shade tolerant).

The forester who is aware of the manifold influences and causes as to why the increment of the different stands differs considerably, in accordance to silvicultural treatment, therewith knows equally the reasons why it is *impossible to*

formulate stand tables based on experiences that correctly and operationally show the increment of the various species on differing stands; and why, on the whole as well as in this specific case, one should not over-generalize.

Nonetheless, it is a matter of importance to classify average stand development in Germany not only from a scientific viewpoint but from a practical or at least *general economic* one, as well as to show the *average* development of a stand that is treated consistently, independent of the dominated intermediate trees, consequently of a normal fully stocked stand. For this reason the author has tried to fulfill the not very complicated but very laborious task of analyzing the occasionally truly differing, but in most cases only apparently inconsistent discoveries and classifications of those notable German foresters such as *Cotta*, *König*, *Hartig*, *Pfeil* and recently, *Feistmantel*, who have focused their attention on the stands' development. I have tried to condense and to document the results of my discerning and comparative analyses, uniting them in the "*allgemeine deutsche Normalertragstafel*" ["General German Normal Yield Table"] in as concise a manner as possible and to permit usage (without conversion being necessary), for most states. As a more detailed discussion of this topic would lead us astray we must stick to the "N. holzwirtschaftliche Tafeln" ["N. Timber Economic Tables"], Nos. X^a to X^f, the Appendix and the explanations thereto (pg. 210 to 221 of the duodecimal and pg. 186 to 197 of the decimal issue).

These tables, as well as the stand tables of the above-mentioned foresters, are among those which Herr Forstrath Th. *Hartig* called "unprincipled" in his latest "Forstwirtschaftslehre" [Forest Economic Theory] because they only contain information on the growing stock of the respective fully stocked stands for the various age classes, indirectly derived from the perennial and average increment thereof, from the increment per-Cent, from the normal growing stock and from the utilization per-Cent (at different rotation periods), etc. But they do not provide information on stand characteristics such as number, height, diameter and form of the trees (or, simply on the space number and the orientation height). Without judging *Hartig's* stand table definition to be quite correct, one still has to completely agree with him that such tables are inadequate for specific

and exact management purposes, as it is well known that the single stand often differs considerably from the general average.

Such is the case with the frequently discussed Bavarian mass-tables which, in regard to timber mass estimates for *general economic purposes*, provide considerable support and facilitation. In their present form, however, only rather rough mean values have been listed, which have often proven to differ to a great extent for individual trees and stands, thereby providing incorrect and unsatisfactory data in *concrete cases*. If they are highly esteemed by the majority of foresters despite these deficits, then this is due to the fact that for the general or somewhat more comprehensive purposes for which they were developed, occasional significant positive and negative errors are sufficiently balanced in specific cases, whilst for certain economic estimates the rough average suffices.

However, as the economical forest estimator absolutely needs a *trustworthy* working aid, it has in time become more and more desirable for each local forestry to start researching and drawing up their own concrete and characteristic stand tables. Taking into consideration that forest science and systematic forest practice are relatively new fields, and in view of the considerable complexity and difficulty involved in developing tables for practical use, we cannot blame the various forest firms when they are not in a position to *provide* completed and correct material. However, for the most part they have not, even to this day, commenced making any efforts in regard to these interesting mathematical stand biographies.

But when bearing in mind that just such concrete, local experience tables are jeopardized by changing stand cultivation methods, we could safely assume that adding characteristic specialties to the general yield table (apart from the intermediate yield and the mean height of the stands) is nothing but a meaningless burden; all the more so as the purposes for which those tables are created, can and should be kept general in nature. That, however, they can provide the manager with some noteworthy practical insights will be demonstrated with an example that I do not find superfluous, as past experiences have shown that quite a few foresters demonstrate indifference to research and tables

in this respect; an indifference which is seen to be disadvantageous for an economically-run forest firm.

Therefore, I have chosen a section of the General German Normal Yield Table which can be found in the author's above-mentioned *Holzwirtschaftlichen Taschenbuch* [Timber Economic Pocket Book]. There, we will find the following data on the respective stand's growing stock in *Massen-* or *Normalklaftern* à 100 customary *Kubikfuß*² of timber mass based on the average development of fully stocked pine and beech stands situated on "*mediocre*" sites (site class II.: between poor and good):

X^a for Austria per Joch.				X^b for Prussia per Morg.			
Age Years	Pine Klft.	Beech Coppice Klft.	H. Forest Klft.	Age Years	Pine Klft.	Beech Coppice Klft.	H. Forest Klft.
10	3,3	2	3	10	1,5	1	1,4
20	10	5	7	20	4,3	2,4	3,2
30	16	9	12	30	7,5	4,1	5,4
40	24	14	16	40	11,1	6,3	7,1
50	33	19	18	50	15,1	8,7	8,4
60	42	24	20	60	19,0	11,2	9,0
70	49	30	—	70	22,4	13,8	—
80	56	37	—	80	25,4	16,5	—
90	62	42	—	90	28,1	19,3	—
100	67	49	—	100	30,5	22,1	—
110	72	55	—	110	32,6	24,7	—
120	76	59	—	120	34,3	26,9	—
130	78	63	—	130	35,4	28,6	—
140	79	66	—	140	35,9	29,9	—
150	—	68	—	150	—	30,9	—

In addition, concerning pine, 10 to 20 per-Cent of root and stock wood and 20 to 30 per-Cent thinning material. Concerning the beech high forest we have to add 5 to 15 per-Cent root and stock wood and 25 to 40 per-Cent thin-

² If in the following we speak of *Klafter*, then we are always referring to these "*Massen-* or *Normalklafter*" à 100 *Kubikfuß* of timber.

ning material, if the stands are cleared within the range of forestal felling age (pine 60 to 100 years, beech 80 to 100 years).

As our tables are based on the Prussian tables (X^b), those of other countries' tables, however, on (X^a to X^f), the latter working with rounded figures which are, therefore, rougher; we will primarily be using the Prussian tables for the following investigations.

Everybody knows that if we divide the mass production of the respective stand by its economic age (a) (i.e. starting from the afforestation of the stand in view), uniformly distributed over the preceding years, then we will get the "yearly average yield". When dividing the stand's growing timber stock, the returns from the final cutting or the stand's primary yield (h) resp. we get

$$\text{the average primary yield} = \frac{h}{a}$$

(some call it the average stand increase). If we add the yields realized from thinning up to now, the intermediate yield (v), then results in

$$\text{the average total yield} = \frac{v+h}{a}$$

(differentiated from those seen as the average stand increment of the stand). Consequently, the above-mentioned 80-year old pine stand would bring about a primary yield of $25,4 : 80 = 0,32$ Normalklafter or 32 Kubikfuß above ground whereby we have to add — as can be seen from the Appendix — 3 to 6 Kubikfuß of stockwood and 6 to 9 Kubikfuß of intermediate yields; so it would produce an average total yield of 44 Kubikfuß per year and Morgen [about 0,67 acre].

It is also well-known to our readers that if we subtract the successive masses from our yield table figures and then divide the difference by the interim (here, 10 years) this will give us the perennial average increment for the respective decade. We will find the latter, e.g. for the above-mentioned pine stand, from the 10th to 20th year or the second decade to be

$$= \frac{4,3 - 1,5}{10} = 0,28 \text{ Klfr.} = 28 \text{ Kubikfuß;}$$

in the sixth decade (50th to 60th year) as

$$= \frac{19,0 - 15,1}{10} = 0,39 \text{ Klfr.} = 39 \text{ Kubikfuß;}$$

in the tenth decade (90th to 100th year) as

$$= \frac{35,3 - 28,1}{10} = 0,24 \text{ Klfr.} = 24 \text{ Kubikfuß.}$$

Where it is possible to prove that a tree or stand at the age (a) had the mass (m) and, (n) years later, i.e., at the age of (A), possesses the mass (M), the previous average yield had been

$$\frac{m}{a} \quad \text{thereafter it was} \quad \frac{M}{A}$$

consequently, the average perennial increment per year for this period is then

$$\frac{M - m}{A - a} \quad \text{or} \quad \frac{M - m}{n}, \text{ respectively.}$$

However, we must not overlook that the situation changes, depending on whether one considers the intermediate yields realized up to now. To deal more precisely with the subject let us state

Age of Tree or Stand	Mass of Primary Yield	Mass of Intermediate Yield	Total Mass	Average Increment of		Perennial Increment of	
				Primary Yield	Total Yield	Primary Yield	Total Yield
a	h	v	$h+v$	h/a	$\frac{h+v}{a}$	$\frac{H-h}{A-a}$	$\frac{(H-h) + (V-v)}{A-a}$
A	H	V	$H+V$	H/A	$\frac{H+V}{A}$	$\frac{H-h}{n}$	$\frac{(H+V) - (h+v)}{n}$

Let us assume that any one of our stands provides a primary yield of 15,1 Klfr. in the 50th year and furthermore, we realized up to that point intermediate yields of 3 Klfr. In the 60th year it produces a primary yield of 19,0 Klfr. and up to that point 4 Klfr. of intermediate yields (by producing additional intermediate yields of $V - v = 4 - 3 = 1$ Klfr. for this decade), thus, in the sixth decade of the tree's or stand's economic life, the results are:

$$\begin{array}{l} \text{current stand increase} \\ \text{(primary yield' s perennial increment)} \end{array} = \frac{19,0 - 15,1}{60 - 50} = 0,39 \text{ Klfr.}$$

$$\begin{array}{l} \text{perennial increment of the stand} \\ \text{(total yield' s perennial increment)} \end{array} = \frac{(19,0 - 15,1) + (4 - 3)}{60 - 50} = 0,49 \text{ Klfr.}$$

It is of the very greatest importance to know and to always be aware of the perennial increment of a stand's timber in the different age classes and under different silvicultural treatments, expressed in per-Cent, in order to achieve silviculture of the highest net revenue. But in contrast to the incomplete and mistaken interpretations and calculations that can often be observed in this respect, we have to first realize that the manager's primary purpose in investigating the increment per-Cent of his real capital, is to compare or to measure his capital growth. It goes without saying that the foresighted mathematician records this increase in *yearly* interest (which one usually calls compound interest); and that, consequently, the quantity (m) at a yearly increment of (p) per-Cent after (n) years is transformed to the added value $M = m \cdot 1,0p^n$ (see the B. forstl. Finanzrechnung p. 225 in which $e = p/100$ or $0,0p$): so the calculation of the increment per-Cent is to follow the correct rule

$$(1) \quad \text{yearly growth factor} \quad 1,0p = \sqrt[n]{\frac{M}{m}}$$

wherefrom we can easily and obviously derive the

$$\text{yearly growth per - Cent} \quad p = \left(\sqrt[n]{\frac{M}{m}} - 1 \right) 100$$

For example, a tree or stand might have increased its mass between the 20th to the 30th year from 25 to 37. Then its yearly growth factor can be calculated as

$$1,0p = \sqrt[10]{\frac{37}{25}} = \sqrt[10]{1,48} = 1,04.$$

Thus, its perennial increment amounts to 4 per-Cent of the current growing timber stock. And indeed, if the real capital (25 Klfr.) increases by 4 per-Cent of its initial amount over a 10-year period then after 10 years it reaches 37 Klfr.

Therewith, the increment per-Cent is the same for all years of the observation period (not so the absolute increment); *as indeed it should be when compared to the increment of capital.*

One will achieve the same result, which is sufficiently correct, by using the following approximation:

$\frac{M-m}{n}$ is the figure of the average perennial increment (Z);

in contrast

$\frac{M+m}{2}$ is the average figure of the current growing timber stock;

consequently

$\frac{M+m}{2}$ divided by $\frac{M-m}{n}$ gives the relation of the growing timber stock to its yearly increase.

If you wish to express the latter in percent, you have to search for the proportion

$$\frac{M+m}{2} \text{ to } \frac{M-m}{A-a} \text{ as } 100 \text{ to } p \text{ easily yields}$$

$$p = \frac{M-m}{M+m} * \frac{200}{A-a} \text{ per - Cent, or}$$

$$(2) \quad p = \frac{M-m}{M+m} * \frac{200}{n} \text{ per - Cent.}$$

Using this equation for the above-mentioned example yields

$$p = \frac{37-25}{37+25} * \frac{200}{10} = \frac{240}{62} = 3,84 \text{ per - Cent,}$$

so narrowly 4 per-Cent.

The difference between the equations (1) and (2) is, in view of the nature of our practical conditions, a negligible one which decreases in importance in direct proportion to shorter periods or, as is nearly always the case in old and medium stands, with lower increment per-Cents.

If e.g., we focus on the pine stands of our table above, then in the sixth decade the yearly increment is nearly

$$\frac{19,0-15,1}{19,0+15,1} * 20 = 2,3 \text{ per - Cent,}$$

and exactly calculated

$$1,0p = \sqrt[10]{\frac{19,0}{15,1}} = 1,0238, \quad \text{thus} \quad p = 2,4 \text{ per - Cent.}$$

If, as it is usually done, we calculate the perennial (average periodical) increment as per-Cent of the initial quantity (m), then we get an overestimated and surely false result.

If, in addition, between the periods (m) and (M) one realized some intermediate yields, then the formulas

$$\sqrt[n]{\frac{M}{m}} \quad \text{and} \quad \frac{M-m}{M+m} * \frac{200}{n}$$

only show the increment per-Cent of the primary stand. To investigate the total increment per-Cent one should increase (M) by the intermediate yields realized up to now.

In the preceding example we assumed that the stand's growing timber stock increased in the sixth decade from 15,1 to 19,0 Klfr. If at the same time it produced 1 addi-

tional Klfr. of intermediate yield then indeed, the yearly production of the time in question is not 2,4 per-Cent but

$$\frac{20 - 15,1}{20 + 15,1} * \frac{200}{10} = 2,8 \text{ per - Cent of the initial mass.}$$

It is also of some interest to call to mind and to comprehend how to derive the *total growing timber stock* from a simple yield table that our forest possesses and has to possess for a given or arbitrarily chosen rotation period, if the forest is in ideal condition, i.e., that all stands basically correspond to the ideal yield table's model of a *real sustainable forest with a yearly felling area of only one Morgen* (Joch, Acker) and are in a normal condition pertaining to age, size, and characteristics (and when possible the site, too). In accordance with a well-known rule, one finds the total growing timber stock (for each $4n=u$ area unit of an ideal, sustainable stand) using a stand table that, e.g., is like the following,

year.	timber growing stock
n	a Klfr.
$2n$	b Klfr.
$3n$	c Klfr.
$4n=u$	d Klfr.

where $4n = u$ represents the rotation period and (d) shows the yearly yields from final cutting, then introducing this information in the equation $(a + b + c + d/2)*n + d/2$.³

In as far as the oldest stand (here: (d)) shows a consistent primary yield and, therewith, the normal yearly increment of all stands (intermediate uses excluded), it too, fur-

³ For proof see Note 7 below Table X in my *Holzwirtschaftlichen Taschenbuch* [Timber Economic Pocket Book]. This formula is quite correct when assuming that felling takes place in autumn and afforestation is done the following summer so that at the moment of felling there are no gaps but only 1 to n year old stands. — Assuming, however, that felling is done at varying times and logging operations are basically carried out in mid-year, then the ideal forest with an n years rotation consists of $1/2$ to $(n-1/2)$ year-old stands and it, consequently would be more appropriate to sum up with the equation $(a+b+c...x/2)*n$. (See in this respect the author's contribution to the *Tharandt's Jahrbuch* 1859 [Tharandt's Yearbook 1859], p. 214.)

ther demonstrates the relation between yearly mass-utilization and the mass of the growing stock of a regular forest. Even if this relation in the first instance is only valid for the primary stand, in most cases, it is sufficiently correct for total mass-utilization and the total mass of the growing timber stock. This is valid because if we, for example, have to add 20 per-Cent of intermediate yields to the yields from final cutting or to the primary yields, then one is entirely justified in saying in all cases where intermediate yields are distributed *proportionally* among all age classes that one has to add 20 per-Cent of thinning yields to the *primary growing timber stock*.

If we then express the mass of an older stand (in our above-mentioned example =d) as a percentage of the respective sustainable growing stock [$V = (a + b + c + d/2) \cdot n + d/2$] then, in general we will get: "*One hundred times the yield from the final cutting divided by the normal growing timber stock*", the normal utilization per-Cent which, as it is well-known, *Hundeshagen* used as the base of his forest yield rules; and which, at least for certain evaluation purposes, retains its validity and practical significance.

In illustration for the forestry laymen we will use, in example for the above-mentioned purposes, the Austrian table for a beech coppice of medium site quality (p. 177) for a 60-year, for a 40-year and a 20-year rotation period as well;

For the 60-year rotation period. Normal growing timber stock = $(3 + 7 + 12 + 16 + 18 + 20/2) \cdot 10 + 20/2 = 670$ Klfr. per 60 Joch; the average results are therefore, $670 : 60 = 11,2$ Klfr. per Joch; yearly utilization (oldest stand) = 20 Klfr. or = $(100 \cdot 20) : 670 = 3$ per-Cent (= utilization per-Cent);

For the 40-year rotation period. Normal growing timber stock = $(3 + 7 + 12 + 16/2) \cdot 10 + 16/2 = 308$ Klfr. per 40 Joch; the average results are therefore $308/40 = 7,7$ Klfr. per Joch; yearly utilization (oldest stand) = 16 Klfr. or $(100 \cdot 16):308 = 5,2$ per-Cent (= utilization per-Cent);

For the 20-year rotation period. Normal growing timber stock = $(3 + 7/2) \cdot 10 + 7/2 = 68,5$ Klfr. per 20 Joch; the average results are therefore $68,5/20 = 3,42$ Klfr. per Joch; yearly utilization 7 Klfr. or $(100 \cdot 7) : 68,5 = 10,2$ per-Cent.

If we apply the preceding substantiated rules to the pine tables shown above, we are now able to complete them with the following derivations and supplements:

General German Yield, Increment and Growing Timber Stock Table for the Normal Pine Forest of Medium Site Quality; Excluding Intermediate Stands, Root and Stock Wood; in Prussian Measurements.

Age Decades	a Year (a)	Mass of Growing Timber Stock <i>m</i>		Average Yearly Increm.		Perennial Increment			Normal Mass Growing Timber Stock		Normal Yearly Utilization in pCt. of Normal Growing Timber Stock pCt.
									Total per a Morgen	Average per 1 Morgen	
–	0	0	Kl.	0	Kfß.	Kfß.	or	pCt.	Stklft.	Klft.	
1	10	1,5	“	15	“	15	or	20	8,2	0,8	18
2	20	4,3	“	21,5	“	28	“	10	38,6	1,9	11
3	30	7,5	“	25	“	32	“	5,5	99,3	3,3	7,5
4	40	11,1	“	28	“	36	“	4	191	4,8	5,8
5	50	15,1	“	30,2	“	40	“	3	327	6,5	4,6
6	60	19,0	“	31,7	“	39	“	2,3	500	8,3	3,8
7	70	22,4	“	32	“	34	“	1,6	708	10,1	3,2
8	80	25,4	“	31,7	“	30	“	1,25	949	11,9	2,7
9	90	28,1	“	31,2	“	27	“	1	1217	13,5	2,3
10	100	30,5	“	30,5	“	24	“	0,8	1511	15,1	2,0
11	110	32,6	“	30	“	21	“	2/3	1828	16,6	1,8
12	120	34,3	“	29	“	17	“	1/2	2164	18	1,6
13	130	35,4	“	27	“	11	“	1/3	2553	19,6	1,4
14	140	35,9	“	25	“	5	“	1/7	2870	20,5	1,2

From the experience table listed above, we have gained empirical knowledge of the development of mass increment and its associated relations, such as, for example:

- that the period of the highest average yield, or the forest's mature stage, (where the perennial increment is equal to the average increment or starts sinking below it) commences with the onset of old age;
- that (with an interference-free growth) the perennial increment per-Cent steadily declines;

- that with an increasing rotation period, real capital has to increase and the utilization per-Cent has to decrease, and the like;

A mathematically-inclined thinker lacking any experience in forestry could have derived all these things simply by sitting in his room and considering the basic rule: that with undisturbed development, yearly increment increases over a certain period and then decreases just as gradually. From this, one can derive in a purely mathematical sense, the following principles:

1) The yield from final cutting or the primary stand (***h***) produces in its lifespan the highest mass yield at the cutting age (***a***) where the average increment (***h/a***) equals the perennial increment (which has long since started to decrease).

2) The total (or primary and intermediate yields) yield (***h+v***) reaches its maximum at that age (***a***) where the average increment of the primary and secondary yield (***(h+v)/a***) equals the (already decreasing, too) perennial increment of the primary stand.

And as simply as that the mathematically-inclined thinker concludes herefrom the very significant truths which apparently are seldom observed or totally ignored:

3) The (more or less steady, but on the whole continuously) declining mass increment per-Cent of the wood, having reached the highest average yield at an age (***a***), has decreased to a value that correctly can be calculated by the formulas:

$$p = \frac{100}{a} \quad \text{and} \quad p = \frac{100 + v'}{a'}$$

whereby the former is the principle governing the perennial increment per-Cent of the mass growing stock at the age (***a***) of the highest average primary yield and the latter represents the same principle under the assumption that (***a'***) defines the cutting age of the highest average total yield and (***v'***) the amount of the intermediate yield as its per-

centage of the primary yield.⁴ — Before reaching the culmination of the average yield, the perennial increment per-Cent is higher, after culmination lower, than the figure: 100 divided by age.

If consequently, a forester alleges that he cuts his pine trees at a 70-year rotation period because this age corresponds to the highest average yield, then he definitely and simultaneously admits to allowing the quantity increment of his stands to decrease to ($p = 100/70 = 1 \frac{3}{7} = 1,43$ pCt.), before harvesting. (Compare herewith the calculated increment table above which shows the 70th year as the age of final cutting and, indeed, demonstrates a perennial per-Cent of $(1,6 + 1,25)/2 = 1,43$ pCt.). — If in contrast, the self-same forester would have taken age 70 as the rotation with the highest total production and, if the intermediate yield (v) had amounted to 30 pCt. of the primary yield, it would then follow that the 70 year-old stand had at the moment of final cutting, a mass increment of ($p' = 130/70 * 1 \frac{6}{7}$ pCt. = 1,9 pCt.). In this case the increment development of the stand would have been more perennial, than the above calculated table shows, as that increment per-Cent (1,9) occurred in the 60th year, or approximately 10 years earlier.

If we delve deeper into the criteria (*cutting age and increment per-Cent*), a forest firm needs to meet which is supposed to be producing 50 per-Cent intermediate yields while simultaneously providing the highest average total yield, then, in accordance to the above mentioned formula, it follows that ($p' = (100 + 50)/a' = 150/a'$). Thus, in the case where the intermediate yields can be calculated as a 50 per-Cent share of the primary yield, the maximum total yield ought to be harvested at age (a) at which point stands would still experience a mass increment of ($p = 150/a$ pCt.); an equation, which when taking the nature of the wood increment into account, could only then be valid, if the rota-

⁴ Proof: If (h) is the mass of the primary stand, (p) its perennial increment per-Cent, (a) the age; then $((h * p)/100)$ gives the perennial and (h/a) the average increment. And as $((h * p)/100 = h/a)$ must be, it simply follows that at the cutting age ($p = 100/a$ pCt.). If in contrast (v) is the mass of the intermediate yield and (a') the age of the highest average total yield $((h + v)/a)$, then the perennial increment per-Cent (p') at cutting age is $((h * p')/100 = (h + v)/a')$ and $(p' = (100/a') * ((h + v)/a) = (100/a') * (1 + v/h))$; if we set ($h = 100$) then ($p' = (100/a') * (1 + v/100)$).

tion age of the stands in mind would be less than 60. It is only at this younger age that a stand would have attained such a high increment per-Cent in a final cutting. At a final cutting age (a) of 50 with intermediate yields (v') of 50 pCt., for example, $p = (100 + v')/a = 150/50 = 3$ pCt. should be the result. If utilization of this type is to be equivalent to the highest total yield, then the real capital would have barely attained an initial increment of 3 pCt. at the final cutting age of 50 (An observation which is not in accordance with the experience table above, but does coincide with a warmer, drier flatland stand, which contributes to premature aging).

A further result hereof: the final cutting age for the highest natural yield possible, has generally to be so much the lower, the richer the intermediate yields one could strive for. The primary stand's production or increment per-Cent should not fall below the degree to which the realized average increment of the intermediate and primary yield has been increasing up to now. This can be substantiated, as at least this amount has to be reached in future yearly production of growing timber stock, if losses are not to occur in the total natural yield when leaving the stands untouched.

Therefore, if the net-revenue principle partially requires forest enterprises to shorten the rotation period for financial reasons, while simultaneously recommending an active advance cutting (see Nat. Waldw. II. Chapter 6, Rules 1 to 3), then, as we can see above, this is not as contrary to the system of highest mass yield as many would assume. Certain conditional and institutional circumstances could cause both to often go nearly hand in hand.

If, moreover, a Bavarian forest authority declares (see Forst- und Jagdzeitung of 1859, p. 83) that the Spessart beech stands were cut at a 144-year rotation period because they had just reached their highest average increment, then we have proven in the above, that these stands at the moment of final felling had attained only $100/144 = 2/3$ pCt. or, if this age relates to the total yield and if the latter consists of 30 pCt. of intermediate yields, then they just produced $130/140$ or a *scant one per-Cent* of the mass increment.

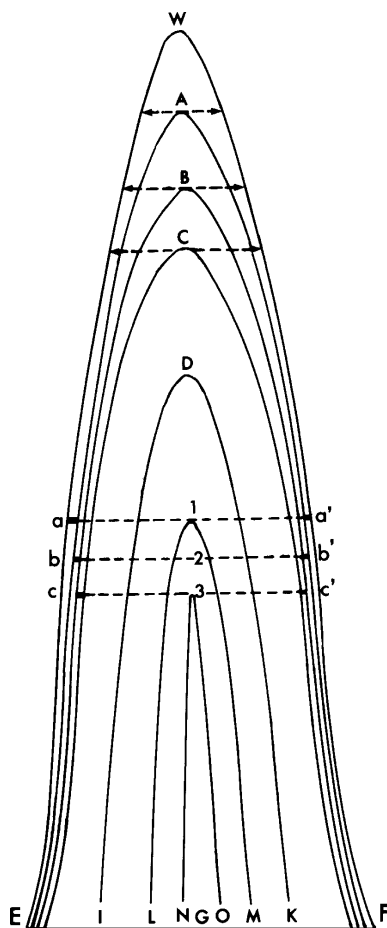
If, furthermore, one of the latest forestry textbooks

teaches that spruce, pine and beech forests accordingly produce the highest yield of material in their 80th year then this, as the above mathematical enlightenment proves, can only hold true for certain very specific production processes and treatments of stands but will possibly be quite incorrect for many sites as well as for the differing silvicultural methods and utilizations. Through minor or major activities and opportunities to carry out advance cutting productively, both the final cutting age (a) with the highest primary yield and (a') with the highest total yield are affected. The former is drawn out because the perennial increment per-Cent of the primary stand often increases if there are frequent clearings, consequently it takes longer for it to drop to the figure $(100/a)$, unlike the latter which is shortened as the figure $((100 + v')/a')$ corresponds to a higher increment per-Cent to the degree at which the intermediate yield per-Cent is higher, consequently, to a shorter rotation age. There are, however, many cases where these contrasting effects compensate one another. This is true when a significant increase of the increment per-Cent results from intermediate uses. In this respect, we have also to take care not to turn a special case into a general principle.

In as far as the yield tables already in existence, as well as all future ones, can only fulfill general purposes with sufficient certainty and because a forester *managing and caring for the growth potential of real capital* must, at given periods, wish to study the reproduction thereof, it goes without saying that the reasoning forester and financially speculating producer would be interested in an aid which offers appropriate support in their investigations of the real capital's *yearly increment*. As the yield tables constructed by *König* for similar purposes seemed to be insufficient for various reasons (see my N. holzw. Tafeln VIII) [N. Timber Economic Tables], Note 1 to Table), I have tried supplying practitioners by means of Table VIII of my *Holzwirtschaftlichen Taschenbuch* [Timber Economic Pocket Book] with just such an aid. Its substantiation and practice is shown there. In order to avoid repetition, we will only recapitulate the latter, using two examples.

The figure shows a greatly enlarged drawing of a sample tree's width belonging to an age class in which one wants to investigate the yearly increment per-Cent of the

last 5-year period. To be on the safe side, the stem will be felled and be cut from the top, where 5 year-rings can be observed. This is the case at A. Tree stem GA is likewise cut from the top then notched on both sides or sawed through the middle. Furthermore, the diameter, excluding the bark, as well as the increment of the last 5-year period ($a + a'$) is measured in Zehntelzoll and then divided by the latter. If the former was 10,8 Zoll (of the bare mid-diameter) or 108 Zehntelzoll, respectively, and ($a + a'$) amounted to 11 Zehntelzoll then the resulting *relative mid-diameter* is $108 : 11 = 9,8$. In this manner Table VIII^a mentioned above, gives us an increment of 21,4 pCt. (for the entire 5-year period) and 4,3 pCt. yearly.



If you are contented with an indefinite, but sufficiently correct estimate then there is no need to fell the tree but only to cut it horizontally and vertically at the (highest possible) breast-height at two opposite points using a saw and a chisel or, more quickly, with a hatchet. Assuming that the barkless diameter is $17\frac{1}{2}$ Zoll or 175 Zehntelzoll and the increase in base-diameter, for both sides totals 13 Zehntelzoll, then the relative base-diameter is $175 : 13 = 13,4$. In respect to this, Tab. VIII^b says "between 17,4 and 23,2", which means five times less than that per year, i.e. between 3,5 to 4,6 per-Cent. — If we were looking for the relative base-diameter of 13,4 in Tab. VIII^a, then we would be able to derive the increment per-Cent of the *basal area*; here, with $15,5/5 = 3,1$ pCt, therefrom.

In stems revealing primarily an upper growth in volume — i.e. where height accretion is present, or lacking height

accretion but having a high crown position, consequently, full boled stems — one employs the maximum, in the other case the minimum in addition to the average. Whereby the latter would be $(3,5 + 4,6)/2 =$ a good 4 pCt.

Increment per-Cent, which in connection to the hitherto existing aids is simply and well investigated, is, for the time being only valid for bole mass, but is also sufficiently correct for total mass. In general, this simple method is entirely sufficient for economic purposes. If felled stems are considered, too, it is even sufficient for the most exacting purposes.

Naturally, the highest degree of certainty is guaranteed by determining the internal and external basal volume which, indeed, is very complex. The calculation then can still be done using the formula $p = ((M - m) / (M + m)) \cdot 200 / n$ pCt. with the mass (m) of the younger, the mass (M) of the older and (n) the age difference if you do not prefer the more exact

$$\sqrt[n]{\frac{M}{m}} = 1.0p$$

Some forest enterprises in southern Germany spare no efforts and carry out just such special increment measurements. I have quite nice studies carried out in the Black Forest at hand. It is, however, a pity that the employed method is a misleading one. In this method, the sections' year rings and diameters are often counted and measured at 1m above ground and deriving therefrom all past and future stem volumes by always using the same reduction factor. Thus, the youngest and the oldest stems are treated as similar entities. In addition, increment per-Cent is derived by employing the hitherto current and incorrect formulas. One of these studies, for example, reported a yearly increment of 8,7 pCt. in the last decade for a 72-year old fir situated in a closed stand, a thing that is absolutely impossible.

Where one wishes to investigate the future development in mass increment of the unfelled stem or stand as exactly as possible, one then has to carefully record the increase in diameter, height and form factor, from time to time. I have been told such observations have been formally organized in Baden, for some time. That is highly commendable. How-

ever, at the same time I heard with regret that the gradual change in the true form factor — an often highly influential and from a scientific point of view fundamental point — is neglected in their calculations. It has to be admitted that the form factor itself can not be measured directly but it can be calculated if the diameter (g), the height (h) and the volume of the stem (m) is known resulting, as is known, in the factor

$$f = \frac{m}{g^* h}.$$

But, you would reply, it is the mass volume of the unfelled stem which is and remains, in particular, the primary point of interest you are searching for; the form factor being only the means or a secondary purpose. This is quite true. However, an altimeter that measures a stem's height within an exactitude of 1 to 2 Fuß and a perspective instrument capable of recording the upper diameters with a precision of a Viertelzoll would enable the forester to solve the problem. In my experience, however — at least in a conifer forest — it is much more simple to attain your goal with the same precision when using our Table VI (holzw. Taf. VI. Stehende Stämme nach der Richthöhe). You learn to determine the point where the stem reaches the half-way mark of its basal area (orientation point) and then, over the years need only to observe the gradual ascent, thereof.

Even if a mistake of a couple of Fuß is made, then the error's influence on the result is not nearly that which incurs if you make a mistake in the diameter measurement by $\frac{1}{2}$ or even only $\frac{1}{4}$ Zoll. — Anyone wishing — as is reasonable — to make sure if, and to what extent this method is trustworthy, should employ it on a felled tree which still has a crown. Let us assume the calipers show $18\frac{1}{2}$ Zoll 4 Fuß above the section (= measuring point); and they are then set to half, you would then locate the mid-diameter of this ($9\frac{1}{4}$ Zoll) at a height of 60 Fuß = height of the orientation point. If we move what Tab. VI calls the orientation height up by half the measuring height (in our case by 2 Fuß), then we can immediately derive the stem's volume from the section to the top, i.e. at a $18\frac{1}{2}$ Duodezzoll diameter and an orientation height of 62 Fuß, 77,2 Kbfß by using the author's newly introduced formula "basal area *

2/3 orientation height".)

If you now measure the same stems, which still have their crowns, too, with the usual economic methods: a) by recording the mid-diameter, only; b) by recording the diameter in 2 sections, i.e. the mid-diameter of the stem's upper and lower section; c) by recording the diameter of numerous sections; you can then conclude by comparing the results of the special method c) whether, and to what extent the orientation-point method works less perfectly than the methods of measurement a) and b), which are now commonly used in practice.

Irregardless of the method by which we have calculated the first increment of our timber, nor how close to the truth our calculations are, we have seen by our above debate that *future increment per-Cent will surely be lower, if we do not promote the growth of the tree class in question by means of clearing, thinning and providing nutrients — both above and below the ground level.*

For this reason, this inquiry and the findings thereof are, in more than one respect, of significance for an economy trying to realize maximum yield or striving for the highest net revenue. Therefore, an economic forester has every motivation in supporting and promoting anything which facilitates and improves all economic undertakings based on the inquiry into and the findings of his woods' *first increment per-Cent*. Anyone who thinks the method behind Table VIII (of my *Holzwirtschaftlichen Taschenbuch*) [Timber Economic Pocket Book] for measuring or for estimating the perennial mass increment does not yet suffice, should gain merit by providing practice with something superior. The forest utilization theory will show what significance the question and answer has on purely scientific silviculture.

THE SECOND, OR QUALITY INCREMENT, AND THE SECOND INCREMENT PER-CENT

Whereas timber quantity increment is essentially determined by nature, quality increment in the previously explained sense, as a *duly economic increment of the net revenue per mass unit* represents a complete contrast to the former, since the latter predominantly depends on civilization, na-

tional economic culture or on the consumption and market conditions of the marketing areas upon which a forest enterprise is thrown.

As already has been mentioned, this second increment is mainly affected by two factors: a) the relative decrease of harvesting costs in the older stand; b) the higher value and price of the mature stand with greater diameters (increment in class). Due to the interaction of both factors, the tree's or stand's net revenue of the mass unit (q) will become (Q) in (n) years which corresponds to a yearly increment of

$$\frac{Q - q}{Q + q} * \frac{200}{n} \text{ per - Cent.}^5$$

The aspect mentioned in a) is often the only one which increases the net revenue of the older mass unit in regard to the production of fuelwood, resulting in a second increment of our timber. This effect is of utmost significance in the period where a stand is upgraded from a very poor to a higher assortment of quality wood. — Take, for example, a coppice that produces timber, no matter whether brushwood or faggots, that sell for 20 Pf. per Kubikfuß; the production of either a Schock of brushwood à 30 Kubikfuß or a Klafter of faggots costs about the same, i.e. 15 Sgr. or 150 Pf. Accordingly, the Kubikfuß of brushwood would allow a net revenue of $20 - 150/30 = 15$ Pf.; the faggots of $20 - 150/60 = 17\frac{1}{2}$ Pf. Let us assume now that the 15-year rota-

⁵ As this formula is perfectly analogous to that of the perennial mass increment per-Cent

$$\frac{M - m}{M + m} * \frac{200}{n}$$

its justification and substantiation also correspond to that of the latter. It goes without saying, therefore, that the formula

$$\left(\sqrt[n]{\frac{Q}{q}} - 1 \right) 100$$

is a bit more correct, being equivalent to the one discussed in the preceding chapter

$$p = \left(\sqrt[n]{\frac{M}{m}} - 1 \right) 100.$$

tion produces only brushwood, i.e. only timber with a quality-digit $q = 15$ (Pf.), unlike a 20-year rotation which brings

forth 40 per-Cent faggots and 60 pCt. brushwood, i.e. an assortment of medium quality

$$Q = \frac{17 \frac{1}{2} * 4 + 15 * 6}{4 + 6} = 16$$

it then follows that the respective stands in the period in question show an economic quality increment of

$$\frac{16 - 15}{16 - 15} * \frac{200}{5} = 1,3 \text{ pCt. yearly.}$$

It is well-known that in high forests consisting purely of fuelwood this second increment, starting from middle age on is very low, often even = Zero so there is no need to go into deeper detail.

In this respect the factor we dealt with under b), the real class increment, is of a much higher significance. This, however, only holds true, in as far as our trees and stands contain with increasing age more and more of those assortments for which there is a *ready market* willing to pay higher prices per Kubikfuß or Klafter. Even though *timber of greater diameter and maturity is undoubtedly of higher quality*, it would still be worthless for the producer, if consumers are not willing, or cannot be induced, to *recognize the higher quality by paying higher prices*. *Apart from that, one can only describe the foresters' striving for a higher quality of that kind, which entails sacrifices, as a vague and unhealthy economic philanthropy, whose costliness they must first perceive and then look straight in the eye, before they start supporting it and holding forth on its merits.*

In those areas where the timber trade has already reached a higher standing, e.g. areas with navigable waters for boats and rafts, they have started to direct more attention to this class increment in practice. It is not rare in such areas (e.g., the Black Forest) for owners of small forests, who are actively growing trees for speculative purposes, to climb high trees using climbing irons in order to measure the upper diameters just because the estimated price or the trade price is greatly influenced by the top log diameter. If, for example, just such a grower of trees had learned by experiences indicating that his timber, from a certain diameter or age on, would be upgraded from the class of 30 Kreuzer per Kubikfuß to the class of 50 in 20 years, then the respective

parts of his trees would experience in the period in question a quality increment of

$$\frac{50 - 30}{50 + 30} * \frac{200}{20} = \frac{200}{80} = 2\frac{1}{2} \text{ pCt. yearly.}$$

In order to calculate properly we should not overlook that in the case presented, the analyzed sections only, realized the second increment. But it is quite easy to figure out the total increment per-Cent by calculating with the mean values, namely by defining the total equivalent to 100. If, e.g., the commercial timber of a tree or stand class amounts to 40 pCt. of the total mass, with a second increment of $2\frac{1}{2}$ pCt. and fuelwood with $\frac{1}{2}$ pCt. making up the remaining 60 pCt., then, on the average, the net revenue of the mass unit or the economic quality of the total mass increases by

$$\frac{40 * 2\frac{1}{2} + 60 * \frac{1}{2}}{100} = 1,3 \text{ pCt. yearly.}$$

The administrating forester can use several informative methods for properly interpreting the other side of his real capital increase resulting from reduced harvest costs and value increase such as: sample felling, estimates, accounting, depending on whether he has to calculate more or less correctly or takes an average or approximation. In the latter case it is sufficient to investigate and compare the quality figures of the younger and older stands. Where one wishes to establish an economic thinning policy in the sense of the highest net revenue, it would be necessary to treat the primary and the intermediate stands separately.

In most cases, special sample plot surveys would be the best way of recording the relation between fuelwood and commercial timber and for clearly assessing commercial timber assortments in the different age classes of comparable stands. Therefore, you do not necessarily need to stick to age classes with a net age difference of 10 to 20 years, if the chosen samples are not entirely unsuitable. So, by interpolation, it is quite simple to estimate from the quality figure of a 40-, a 53-, a 65- and a 92-year old stand that of a 50-, a 60-, a 70-, a 80- and a 90-year old stand. The only exceptions are where growth increase is not gradual but rather irregular and sometimes even suffers a reverse. Even in such cases, an approximate knowledge is preferable to no knowledge at all.

The following example shows that the task becomes quite easy when recording the assortment of each age class in per-Cent of the total mass, additionally taking the mass unit's value of each sort as the net figure, i.e., after subtracting harvest costs.

If we find the commercial timber of a 30-year old stand amounting to 10 per-Cent per Klafter, at a net value of 6 Thlr.; fuelwood making up the remaining 90 per-Cent à 3 Thlr., then we get the stand's average quality figure $q = 0,10 * 6 + 0,90 * 3 = 3,3$ Thlr.

That can be shown a bit more specifically in the following example. Let us assume that in the 40-year old primary stand of the same species there is

5	pCt.	commercial timber at	8	Thlr.	per	Klafter
5	"	commercial timber "	7	"	"	"
10	"	commercial timber "	6	"	"	"
40	"	cloven logs	4	"	"	"
10	"	stockwood	2	"	"	"
30	"	brushwood	2	"	"	"
<hr/>						
100	"					

then by simply multiplying the average quality

$$Q = 0,40 + 0,35 + 0,60 + 1,60 + 0,20 + 0,60 = 3,75 \text{ follows.}$$

Therefore, the primary stand in question would have experienced a second increment in the fourth decade as compared to the preceding age class of

$$\frac{Q - q}{Q + q} * \frac{200}{n} = \frac{375 - 330}{375 + 330} * 20 = 1,3 \text{ pCt.}$$

Let us now assume that the intermediate stands, having been similarly investigated, show at the onset of the decade in question a quality figure of 2 Thlr. and at its end, perhaps due to a significant decrease in wood cutter's and skidder's wages, increased up to 3 Thlr, would then consequently, bring forth with the intermediate yield a (triple) quality increment of

$$\frac{3 - 2}{3 + 2} * 20 = 4 \text{ pCt.}$$

From the separately calculated quality increment of the primary and intermediate stands, using the rules of ordi-

nary averaging, the mean quality increment of the total stand can be derived; a procedure that becomes particularly useful if one wants to clear cut the stand as a whole, i.e. without any specific intermediate cutting. In this case you would only have to quote the intermediate stand's percentage share of the total mass. Let us assume the latter amounts to 10 pCt. in the 30th year and to 15 pCt. in the 40th year of the total mass. Then you would get the average quality of the total stand in the 30th year by $0,90 * 3,3 \text{ Thlr.} + 0,10 * 2 \text{ Thlr.} = 2,97 \text{ Thlr.} + 0,20 \text{ Thlr.} = 3,17 \text{ Thlr.}$ and in the 40th year by $0,85 * 3,75 \text{ Thlr.} + 0,15 * 3 \text{ Thlr.} = 3,19 \text{ Thlr.} + 0,45 \text{ Thlr.} = 3,64 \text{ Thlr.}$ Wherefrom, by following the known formula, the common yearly increment of

$$\frac{364 - 317}{364 + 317} * 20 = 1,4 \text{ pCt. results.}$$

Even where the silvicultural conditions are such that it seems too complicated to employ the measurements and calculations described above and even where the scientifically-inclined forester finds it too tricky or too theoretical, even there we have to counter with the fact that generally speaking, *the knowledge of the development of real capital as indicated by the performance of the quality figure is no less important to an economic timber industry than is the knowledge of product quality and product-quality changes for any other industry.* Furthermore, we have to draw attention to the fact that it only seems to be hard to commence with the above-mentioned procedures. Moreover, even the work with approximate estimates is preferable to the *absolute lack of information with which we are confronted when asking most of the firms for information on the second increment of their timber.*

It is the exception when we find a small haven in this large void of our forest sciences and knowledge. So it is with the work of Herrn Oberforstrath *Grebe* on the beech high forest system, that we can, e.g., derive the following experience tables on *the quality increment of beech stands in the surrounding regions of Eisenach* ("with an average of 5 and seldom more than 10 pCt. of commercial timber utilization"):

		Net revenue or Quality	
at an	Average		at an

Age of Stand or Year	Price per Austain Maßkluft. à 100 Kubikfuß a Grosch.	Harvest Cost b Grosch.	Figure C = a-b Grosch.	Increment pCt. $\frac{C - c}{C + c} * \frac{200}{10}$	Age of Stand or Decade pCt.
40	123	25	98		
50	138	24	114	1,5	5.
60	151	23	128	1,2	6.
70	163	22	141	1,0	7.
80	173	21	152	0,7	8.
90	180	20	160	0,5	9.
100	185	20	165	0,3	10.
110	188	20	168	0,2	11.
120	190	20	170	0,1	12.

We can calculate the average of the second, or quality increment, of the beech forests in the vicinity of Eisenach

from the 40th to the 80th year as a good 1 pCt.,

from the 80th to the 120th year as a good $\frac{1}{4}$ pCt.,

and in general

from the 40th to the 120th year as a good $\frac{1}{2}$ pCt.

Herefrom, we are able to conclude how simple the calculation and knowledge can be. Where, after all, might indeed the difficulties lie for a striving forester in gathering information on the second increment of his stands, or at least a part of them, applying the above-presented procedure? Let us assume, he would only have roughly applied the method on a stand beneficial to the production of commercial timber,

and there he realized

so, he simply concludes in regard to
the Second Increment
the Net Revenue per Mass Unit

at a Stand Age of	on the Average of all Assortment		the Net Revenue per Mass Unit			and this in the decade
	a Gross Returns per Kl. Grosch.	b Harvesting Expendit. à 100 Kfß. Grosch.	c Figure	d Increment Grosch.	e Increment per-Cent	
30	100	24	76			
40	130	22	108	32	3½	4th
50	180	20	160	52	4	5th
60	210	19	191	31 barely	2	6th
70	230	18	212	21 a good	1	7th
80	270	17	253	41 "	1½	8th
90	300	16	284	31 "	1	9th
100	320	15	305	21 "	½	10th

After reflecting on the nature, formation and development of the second increment per-Cent, its essence is self-evident and is illustrated here by concrete figures. These are e.g.

- 1) That the increment is the more beneficiary the more commercial timber dominates fuelwood.
- 2) That it possibly — as a result of the particular utilization and preference conditions — will fluctuate, as can be seen from the yearly figures (row d), sometimes increasing, only to decrease and then to increase and decrease again.
- 3) In spite of the fact that for the example above a very irregular development was intentionally chosen (4th decade 3,2 Gr. yearly, 5th decade 5,1 Gr., 6th decade 3,1 Gr.) *its percentage in general shows a tendency to decrease, so that on the whole, it constitutes a declining sequence.*

Of course, as our example shows, it increases in the very beginning from 3½ to 4 pCt. and once again in the 8th decade from 1 to 1½ (maybe due to the fact that at this age the more preferred assortments start playing a more dominant role), only to decrease in the following decade to 1 pCt. However, the fluctuations can be eliminated, balancing each other out, if they disturb the forester's general overview. Therefore, if there is no need for him to go into detail, he simply has to add together the growth periods between the years of 60 and 80, doing the same for those between 80 and 100. He then gets a periodical yearly increment for each doubled decade of

$$\frac{253 - 191}{253 + 191} * \frac{200}{20} = 1,4 \text{ pCt. and for the latter}$$

$$\frac{305 - 253}{305 + 253} * \frac{200}{20} = 0,7 \text{ pCt.}$$

Despite the value increment's rather significant fluctuation within the single decades, the second per-Cent would decrease not necessarily conformably but continuously decrease in accordance to the following sequence:

Between	the 40th and 50th year	the perennial second increment amounts to	4 pCt.
“	“ 50th “ 60th “ “ “ “ “ “ “	“	“ barely 2 pCt.
“	“ 60th “ 80th “ “ “ “ “ “ “	“	“ barely 1½ pCt.
“	“ 80th “ 100th “ “ “ “ “ “ “	“	“ barely ¾ pCt.

Now the burning question arises as to what the administering forester should do to best promote the second increment of his timber. We will deal briefly with this question in the third contribution ("Aus der Nutzungslehre") [Taken from the Yield Sciences].

If, at last, we take a *third, or price increment*, into consideration, it cannot be denied that it is neither of a general and forestial nor of a permanent and steady nature as are the two preceding increments. The latter could even take a negative turn, which would be the case when a market price increase is followed by a decrease. But nevertheless, understanding and considering of this third increment and its percentage as mentioned above might, under certain circumstances, be of considerable and sometimes even of the greatest importance if you are striving for a production focused on the highest net revenue.

If, for example, within a period of 10 years, the timber market prices or even those of certain tree classes had noticeably increased from an average of 160 Gr. to 240 Gr. and, thus (in accordance to Formula 2 on p. 179) increased yearly by

$$\frac{240 - 160}{240 + 160} * 20 = 4 \text{ pCt.}$$

and if there was a high probability that a similar price increase was to be expected over the next ten years, then it would be obvious that a forester *who is not only forestially or technically inclined but also susceptible to market speculations* would merit a significant additional contribution to the perennial value increment of his timber; but, however, only for those trees which could or would be cut during that period of rising prices.

In regard to a stand that is to be managed sustainably and to be arranged uniformly, this conceivable third increment, as pointed out in our first article ("Aus der Finanzrechnung") [Taken from Finance Theory] can not exert a principal and systematic influence. At the most, you could reduce cutting to the admissible minimum as long as the yearly increment of timber prices and as long as the price increment remains at a level which, in the main, permits covering the trees' increment loss resulting from the steady decrease of the 1st and 2nd increment.

The point that you have to bear in mind is that this third increment immediately drops to zero, as soon as the price increase comes to a halt. If you had been counting too much on its duration, consequently, accumulating a stock higher than usual, then from one moment to the next you would be saddled with a surplus of timber which, following the sudden loss of your third increment, would lead to a very unsatisfactory value increment. The previous advantage could now be outweighed by the disadvantage resulting when immediate utilization and sale of these overly matured stands together with the now mature stands — cannot be realized without a mark down. Even if a mark down could not be avoided when selling the merchantable reserves, it could still come about through no fault of our own, but through an increased supply from elsewhere. If such a situation is of longer duration, then anyone who had speculated on a price increment and who, consequently, reduced the cutting of his economically mature stands might often enough have cause to worry about this market speculation. When, nevertheless, price increment plays a justified dominant role in some small forest operations — especially in those with easy access to the marketing areas — in large-scale sustained yield systems it will always remain a matter of secondary importance and will generally be ignored.

If we, therefore, do not bodily integrate this more or less coincidental and fluctuating factor of the timber's net revenue increment, which is a law unto itself, for the reasons given into the system and management objectives of forest operations, but rather deal with this subordinate factor on the side then we, however, have to be aware that "dealing on the side" is to not be understood literally but rather theoretically in respect to forest economic management; and furthermore that the speculating forester could be justified under certain circumstances, to temporarily deal with it as a matter of primary importance.

THE TOTAL NET REVENUE, OR VALUE INCREMENT, AND THE INDICATOR PER-CENT

If a forester is able to show (and he indeed can, with more or less accuracy, if he only tries) that certain age classes of his trees possess a first increment of (a) per-Cent and a second of (b) per-Cent, at a given moment of time then he has

simultaneously determined the future yearly growth of the net revenue or of the growing timber stocks' value of his stands, whereby the harvesting costs are subtracted from the latter.

This future growth, calculated in relation to the present amount, is given by⁶

$$\left(a + b + \frac{ab}{100}\right) \text{pCt.}$$

This expression or its figure can also be called the value increment per-Cent of the timber. However, the term "value" or "more valuable" is not to be interpreted in the sense of "quality" and "better" in regard to the *properties* of the mass. They are not related to the mass *unit* itself, but simply are to be seen as the monetary value of the total tree or stand and as its net figure or its total reduced by the harvesting costs.

Let us assume that the 40-year old stands of a certain forest operation showed a first increment of 3 pCt. and a second of 5 pCt. Herefrom we can deduce that the future net revenue will increase by

$$3 + 5 + \frac{15}{100} = 8,15 \text{ pCt., yearly.}$$

Taking the pertinent conditions into consideration, in most cases you can ignore the third term of the formula presented above so that, in consequence, one can postulate the principle:

If a tree or a stand shows a first increment of (a) pCt. and a second of (b) pCt., then it itself possesses a net revenue increment of $a + b$ pCt.

⁶ Proof: Let (*m*) be the mass, (*q*) its quality or net revenue figure (related to the mass unit) then its value is $w = m \cdot q$. If (*m*) grows now by (*a*) pCt. and (*q*) by (*b*) pCt. then (*W*) becomes

$$\begin{aligned} W &= m \left(1 + \frac{a}{100}\right) \cdot q \left(1 + \frac{b}{100}\right) = mq \left(1 + \frac{a}{100} + \frac{b}{100} + \frac{ab}{100 \cdot 100}\right) \\ &= mq + mq \left(a \text{ pCt.} + b \text{ pCt.} + \frac{ab}{100} \text{ pCt.}\right) \end{aligned}$$

The increment of the net revenue and the respective percentage can also be derived directly from a net revenue experience table as presented in the preceding article. If, e.g., it is confirmed that the cutting of a 40-year old stand would bring forth a net revenue of 200 Thlr. and the self-same stand at the age of 50 a net revenue of 400 Thlr. — including the returns realized from thinning in the meantime — this would then result in the perennial yearly increment of the net revenue for that decade (following formula 1)

$$\sqrt[10]{\frac{400}{200}} = \sqrt[10]{2} = 1,072$$

which would amount to exactly $7\frac{1}{3}\%$ pCt. or using the well-known approximation (2)

$$\frac{4-2}{4+2} * \frac{200}{10} = \frac{1}{3} * 20 = 6\frac{2}{3}\% \text{ pCt. which is approx. } 7\% \text{ pCt.}$$

Even if the derivation of the total increment per-Cent from a net revenue table seems to be easier, in practice it is indeed harder to do and often even not feasible. The reason for this is the lack of the experience tables needed. Often they simply can not be developed because the requirements of stands with sufficiently uniform tree and stand characteristics do not exist, or because of the disadvantageous circumstances in recording the yield sequences such as in intermediate stands, in the upper crop of the standard coppice. Furthermore, often only one age-class exists for a certain tree or stand species. Nevertheless, in all cases, i.e. for such single stands, by investigating the diameter's increment and by comparing the present diameter assortments with those that will follow, one is naturally able to determine the first increment per-Cent with precise and the second with sufficient accuracy. Furthermore, the sometimes considerable divergences of the individual from the average development — on which yield tables, even the local tables provide information — has to be considered. — Therefore, one can conclude that net revenue experience tables (mentioned in our first article) provide the forester with the information necessary *to economically manage the forest operation as a whole, with information important for general management decisions*, whereas, the investigation and the knowledge of the first and second — of the quantity

and quality increment — (analyzing yield increment in its many factors) is important and necessary for the *detailed and concrete forestry*: significant as indicators in increasing the net revenue production in the *various individual cases of the tree's treatment and utilization*.

In addition to the parts (a) and (b) of the total increment, under certain circumstances, we might consider a third one as mentioned before. If in the present or future, a price change of (c) pCt. is in view for the respective tree class, we have then simply to substitute (b) in the formula presented above (p. 188) by $b \pm c$, adding or subtracting depending on whether the timber price rises or falls.

In regard to a first increment of (a) and a second of (b) pCt. and a steady price change of (c), which always has to be considered, we would get the *total yearly net revenue increment* of the respective stand by the approximation (a + b c) per-Cent or, more precisely, by

$$\left(a + b \pm c + \frac{a * (b \pm c)}{100} \right) \text{ per - Cent.}$$

If we would, therefore, add a quantity increment of 3 pCt., a quality increment of 5 pCt. and a general price increment of 2 pCt. to the above-mentioned 40-year old stand then its net revenue would have grown yearly by $3 + 5 + 2 = 10$ pCt. or, more precisely, by

$$3 + 5 + \frac{21}{100} = 10\frac{1}{5} \text{ pCt.}$$

As our production, however, is to be of an economic, consistent and conservative character, we must also bear in mind that this yearly increment of the growing timber stock's value, or of the timber capital, is not only to be attributed to the value of timber (h) alone but furthermore to the capital invested in the land (g).

For reasons which will be given in detail in the third article, we will call the figure which expresses the timber's net revenue production *to the added capital invested in timber and land*, in the future, the indicator increment and its percentage the **indicator per-Cent** because of its decisive or indicating significance for a silviculture oriented towards

the highest net revenue. Furthermore, for simplicity purposes, we will always measure the respective (net) value of the timber capital (h) in relation to the corresponding land capital (g) and we will designate this *relative timber value* = h/g with (r). The (r) shows by how many times the timber capital exceeds the corresponding land capital; so $r * g = h$ is always valid.

If, e.g., the timber capital $h = 400$ Thlr. and the corresponding land capital $g = 80$ Thlr. then the relative timber value would be

$$r = \frac{400}{80} = 5$$

i.e. the timber capital is 5 times greater than the land capital. The next principle can easily be proven.

If timber capital (h) is (r) times greater than the corresponding land capital, and has a first increment of (a) and a second of (b) pCt. then it possesses an indicator increment (of the timber and land capital) of

$$(a + b) \frac{r}{r + 1} \text{ pCt.}^7$$

whose term in parenthesis still has to be supplemented with the third increment per-Cent $\pm c$, if one has to consider a yearly change in the market price of (c) pCt.

⁷ Proof. If the timber capital of (h) Thlr. experiences a net revenue or net value increment of (p) pCt., yearly, then its yearly increment can be calculated as

$$= \frac{hp}{100}.$$

If the latter is to be expressed as the percentage x of the timber and land capital then one has to search for the proportion:

$$(h + g) : 100 = \frac{hp}{100} : x \quad \text{for} \quad x = p * \frac{h}{h + g}$$

$$\text{or, using} \quad h = r * g \quad x = p * \frac{r}{r + 1}.$$

This important and interesting formula concerning the indicator per-Cent gives occasion to some significant observations. The factor $r/(r + 1)$, which we will call the reduction factor, is naturally always a proper fraction. This fraction is quickly found as soon as you know the relative value of the capital because then you have the numerator and need to add only 1 to get the denominator of the fraction.

If, in its youth, the timber capital is smaller than the land capital which is oriented on costs (constituted by land expenses, taxes and administration) then the reduction factor, too, is very small. If, e.g., (h) amounts only to $1/10$ of (g) then the reduction factor is $= 0,1/1,1$ or $1/11$. If (h) had increased after one or several decades to the value of (g), i.e. $h = 1g$ or $r = 1$, then the reduction factor would amount to $1/(1 + 1) = 1/2$. If, however, the real capital had increased to a value equal to 10 times the land capital then $r/r + 1$ would have reached the value $10/11$.

Whereas with an undisturbed development or regular thinning, the summary of value increment per-Cent, after having reached an early culmination point, begins to decrease steadily, its reduction factor will increase continuously and quit decreasing to the degree to which the relative timber value grows; or in other words: the lower the economy values the land and the higher the real capital.

In consequence, despite its determining and simple rules, the *development of the indicator increment* might often be individual and different, depending on the situation, the individual enterprise and the respective market.

Let us assume that a certain high forest operation is situated on a (soil, tax, plantation and administration) land capital of 60 Thlr. (per unit area). Its 20-year old stands could represent a net growing timber stock value of 30 Thlr.; its 40-year old stands of 120 Thlr; its 60-year old stands of 300 Thlr. In this example, therefore, the numerator of the reduction factor increases from 20 to 40 and from 40 to 60 years from $30/60 = 0,5$ to $120/60=2$ and to $300/60 = 5$ and the reduction factor as a whole from $1/3$ to $2/3$ and to $5/6$.

Let the 20-year old timber experience a first increment of 6 pCt. and a second of 12 pCt., consequently, a yield increment of $6 + 12 = 18$ pCt.; the 40-year old stand in

analogy a total per-Cent of $4 + 6 = 10$ pCt. and the 60-year old stand of $2 + 4 = 6$ pCt., then the indicator increment in these three age classes would amount to (1,) $= 18 * (1/3) = 6$ pCt.; (2,) $= 10 * (2/3) = 7$ pCt. ; (3,) $= 6 * (5/6) = 5$ pCt. In contrast, the same stand in the 10th year, with a growing timber stock value of 6 Thlr. (i.e. $r = 6/60 = 0,1$) and a first increment of 10 pCt. and a second of 20 pCt., showed an indicator increment of only

$$\left(10 + 20 + \frac{10 * 20}{100}\right) * \frac{1}{11} = 3 \text{ pCt.}$$

From this example, the reader, who has closely followed, will be able to sufficiently derive the causes as to why the indicator per-Cent of our timber generally starts at a low figure, slowly increasing until it reaches a certain amount and from then on decreases gradually.

By means of economic measures, however, the course and the constancy of this development can be modified and disturbed. Therefore, the indicator per-Cent of the moment could be sharply reduced if high grading takes place, because the resulting decrease of the relative timber value (r) decreases the reduction factor, too. In general, this is followed by an increase of the first and the second increment as the stand is now opened. So it is with the indicator per-Cent, as all components which constitute its value (a , b and r) tend towards a common and rapid growth.

Surely, there is no need to draw my readers' attention to the why and wherefore that one of the main objectives of economic silviculture is to attain the highest net revenue, which demands *reaching and maintaining the highest indicator per-Cent of the timber*.

It is therefore advisable to attempt, *right from the start, to work with the highest reduction factor's numerator or relative timber value ($r = h/g$) possible*; i.e. to establish the most valuable timber capital (h) on the smallest possible land capital (g); and further, *trying with all economic efforts conceivable to maintain the first as well as the second increment ($a + b$) at the largest possible level*. Therefore: the cheapest possible afforestation of dense crops with rapidly producing or valuable tree-species — which is certainly a well-known practical rule but one which is not sufficiently substantiated, analyzed and appropriately interpreted, yet, because it is

not the increment figure as such, but rather the yearly net revenue production and above all its perennial and average *indicator per-Cent* which is decisive.

Those of our gentle readers for whom I am not unknown could bear witness to the fact that I am not a purely formalistic forest-mathematician and that I am far from burdening the foresters in this respect simply because of theoretical ambition.

So much the more I feel free and even forced to strictly oppose a fairly wide-spread and very disadvantageous view which significantly influences our business, the view, that theory and practice represent two directly opposed undertakings which entirely, or at least partially, exclude one from the other.

Nothing seems to be more ridiculous and more erroneous, from a scientific and truly logical man's point of view, than the often postulated empty phrase: "In theory it might be right but in practice it is wrong, — or at least useless—." Because what is wrong in practice is also wrong in theory and vice-versa. *Both have objectives sharing a common nature which only differs to a certain degree*: in postulating its objectives, science neglects all the small and unavoidable secondary disturbances which occur when we try to realize the theory-based objectives in practice. Science has to ignore them so as not to postulate a confusing theory.

What is required from a *good theory* has to be respected by *practice*; and practice has to at least try to meet theory's requirements. Even where it is not possible to precisely and literally abide for various reasons — practice has to follow theory at least in general and in accordance to its principles.

Therefore, it would never occur to me to demand from the manager or the inspector of a large-scale forest district to investigate the various increment per-Cents and reduction factors of all his commercial timber species. However, I would require that he begins to investigate the figures for certain decisive age and tree classes and that he always be aware of their perennial indicator per-Cent, directing all actions for them accordingly. Meaning that he always has the formula

$$(a + b) * \frac{r}{r + 1}$$

in mind so as not to harm the net revenue unnecessarily.

As long as a timber producer or a forester is in the dark about the indicator increment of his timber in the various age-classes, under different treatments and especially in regard to clear-cutting — he will bear resemblance to a producer, user and manager of values, forces and capital who, in this respect, tends to deal rather scientifically and systematically with matters of secondary importance, without considering the essential point, i.e. the virtual mode of operation of these values, forces and capitals. In consequence, such a forester foregoes the understanding which merits being considered as most important, namely in all those cases where the maximum net revenue is one of the main economic objectives.⁸

⁸ In the first article in the February-issue we wish to add the following correction: pg. 50, in the second column of the Net Revenue Table 60 + 5 instead of 60 and in the third row from the top “in ihren 4prozentigen” has to replace “in ihren 3prozentigen.”

